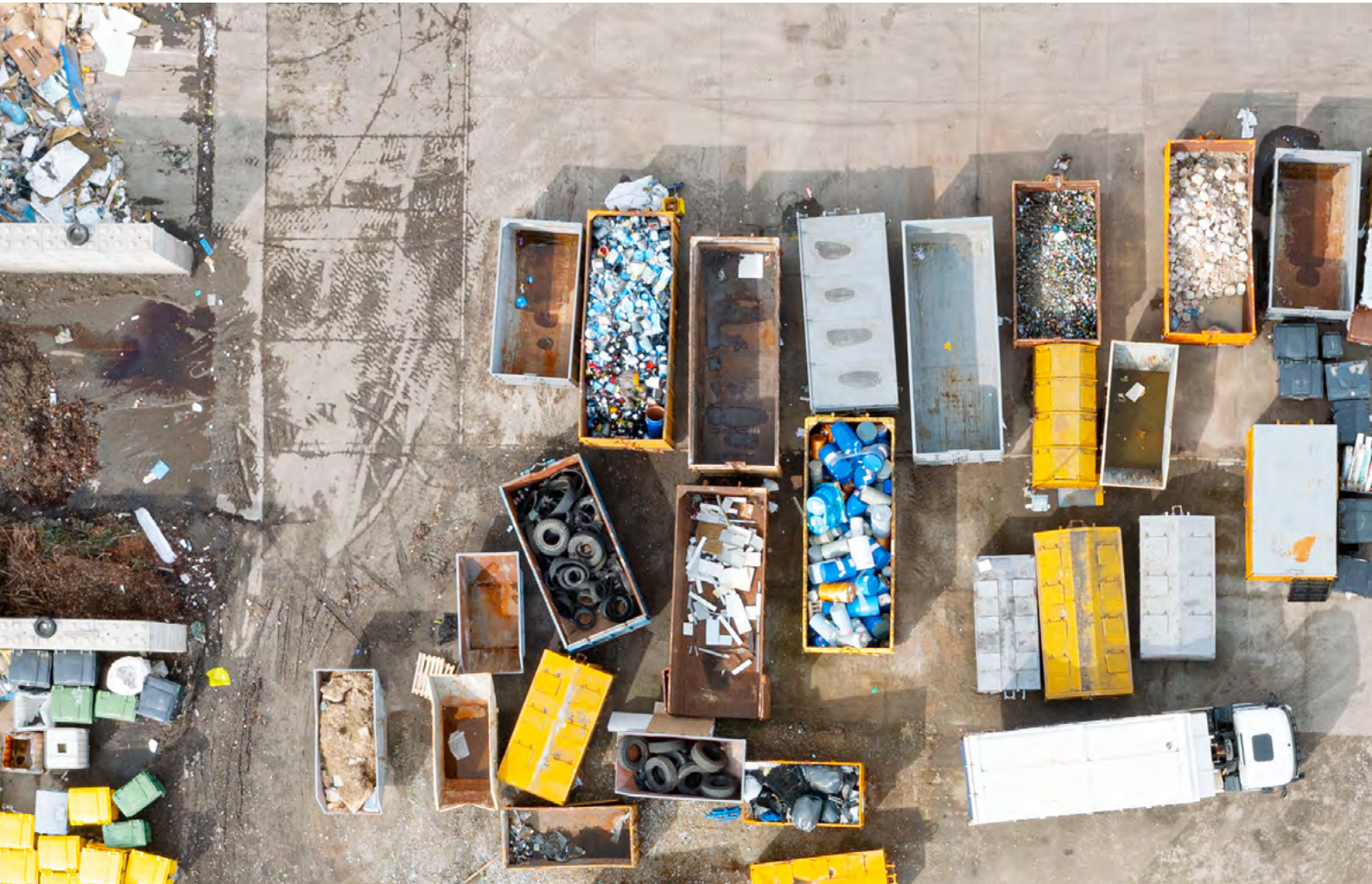




UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION



PAGE PARTNERSHIP FOR ACTION
ON GREEN ECONOMY



INDUSTRIAL WASTE MANAGEMENT - COST STRUCTURE REVIEW IN THE REPUBLIC OF MAURITIUS



The report is published as part of the Partnership for Action on Green Economy (PAGE) – an initiative by the United Nations Environment Programme (UNEP), the International Labour Organization (ILO), the United Nations Development Programme (UNDP), the United Nations Industrial Development Organization (UNIDO) and the United Nations Institute for Training and Research (UNITAR).

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INDUSTRIAL WASTE MANAGEMENT - COST STRUCTURE REVIEW

IN THE REPUBLIC OF MAURITIUS



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Vienna, May 2022

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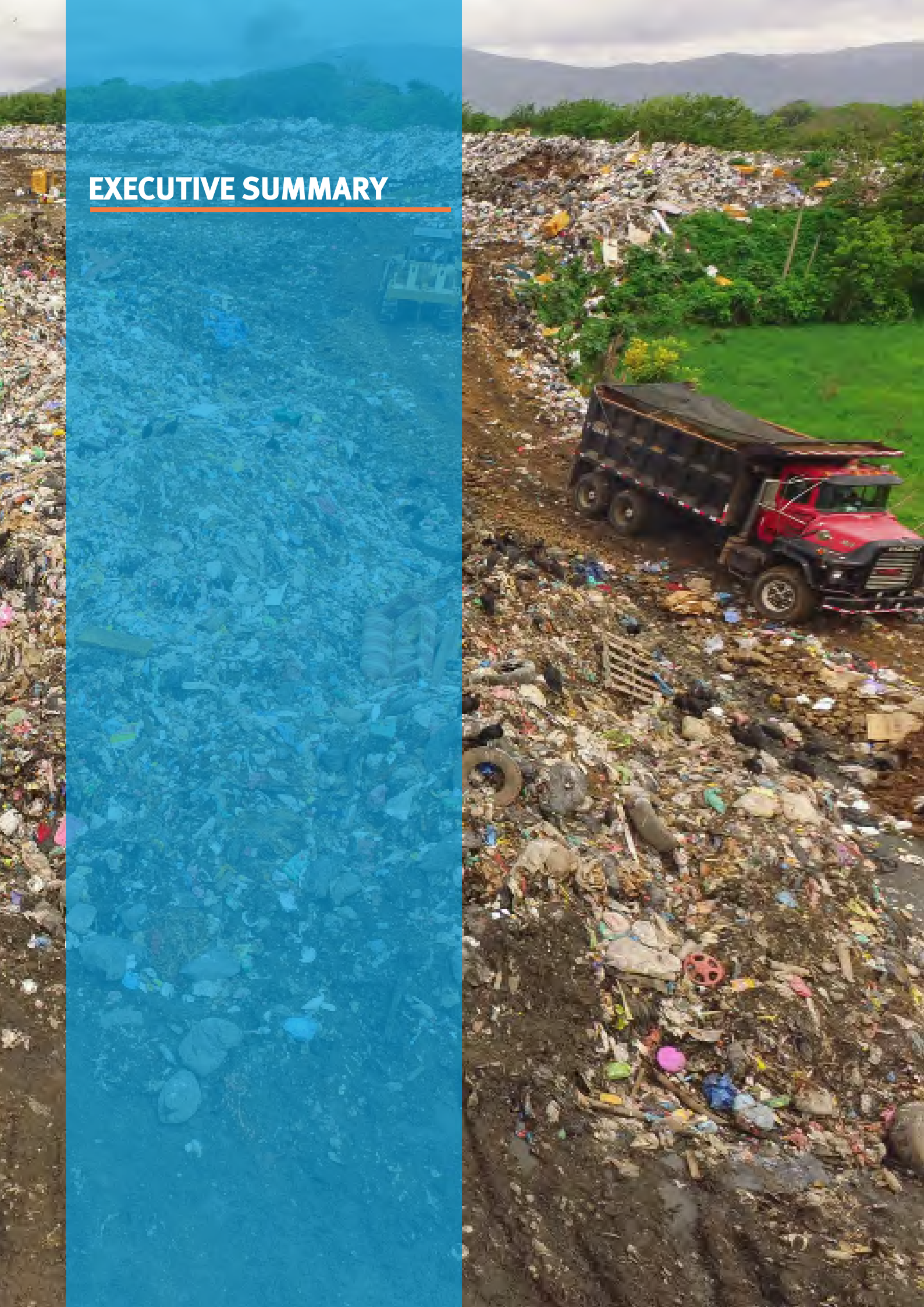
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ABBREVIATIONS

BM	Business Mauritius
EPA	Environment Protection Act
EPR	Extended Producer Responsibility
GEAP	Green Economy Action Plan
IGE	Inclusive Green Economy
ILO	International Labour Organization
IWA	Industrial Waste Assessment
IWM-CSR	Industrial Waste Management - Cost Structure Review
LA	Local Authority
LGA	Local Government Act
MoE	Ministry of Environment, Solid Waste Management and Climate Change
MoIDSC	Ministry of Industrial Development, SMEs and Cooperatives
MME¹	Mid-Market Enterprise
MRF	Material Recovery Facility
MSME	Micro, Small and Medium-Sized Enterprise
PAGE	Partnership for Action on Green Economy
PSC	Project Steering Committee
PRO	Producer Responsibility Organization
SC	Steering Committee
SDGs	Sustainable Development Goals
SWM	Solid Waste Management
SWMD	Solid Waste Management Division of the Ministry of Environment, Solid Waste Management and Climate Change
TS	Transfer Station
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
WEEE	Waste from Electrical and Electronic Equipment

¹ A **MME** is an enterprise generating a turnover greater than MUR 50 million but less than MUR 250 million. It is noted that a **MSME** is an enterprise generating a turnover less than MUR 50 million, and a **Large** enterprise is one that generates a turnover greater than MUR 250 million.

EXECUTIVE SUMMARY



OBJECTIVES AND CONTEXT OF THE STUDY

The activities of this Industrial Waste Management – Cost Structure Review (2021 IWM-CSR) respond to part of the recommendations of the ‘Industrial Waste Assessment in Mauritius’ that PAGE produced in 2017 (2017 IWA) with the collaboration of the Industry Division of the then Ministry of Industry, Commerce and Consumer Protection, UNIDO and Business Mauritius.

To enable effective industrial solid waste management, facilitate the development of a circular economy and enhance the competitiveness of the enterprises, the 2017 IWA recommended to integrate the management of industrial waste (IW) and municipal waste with similar characteristics and to proceed towards the definition of the cost structure and policy gaps in industrial waste management (IWM).

This study was thus undertaken, with the following objectives:

- 1. Understand the structure of SWM costs undertaken by selected industrial sectors** for Micro, Small and Medium-sized Enterprises (MSMEs), Mid-Market Enterprises (MMEs) and large companies.

In continuation with the 2017 IWA, the following sectors were included:

- Textile and wearing apparel
- Chemicals and chemical products
- Food products (poultry, seafood, beverages and bottling sub-sectors)
- Printing and reproduction of recorded media
- Construction materials

- 2. Assess the share of the SWM costs over the company’s turnover.**

- 3. Analyse the cost undertaken for SWM by the public sector.**

- 4. Provide a general overview advice on the introduction and implementation of EPR Schemes** and examine the main constraints to their applications in Mauritius.

In this context, this study focuses on:

- determining the **structure of the costs** for IWM within companies; and
- verifying if part of IWM costs constitute a **hidden cost** for the SWM carried out by the public sector.

METHODOLOGY APPLIED IN THE ANALYSIS

A direct survey of costs and structure of IWM was undertaken by use of two (2) questionnaires specifically formulated for this project:

- a questionnaire addressing each **industrial company** participating in the project: detailing the different costs incurred by each industrial site and to be filled by the individual company managers;
- a questionnaire addressing the structure of the costs incurred by the **public sector** for SWM in Mauritius: to be filled in by officers both of the Ministry of Environment, Solid Waste Management and Climate Change, and of the local authorities.

The two questionnaires¹ were formulated by following the approach called Waste Flow Analysis to describe:

- the SWM organisation adopted on each industrial site; and
- the overall SWM system controlled by the public sector.

The number of companies participating in the survey is given in the following table:

Companies Participating in the IWM-CSR Study	
Companies providing cost breakdown as required by the questionnaire	22
Companies providing only total sum of costs (via MoIDSC)	8
Total companies involved	30

The **objectives** of the questionnaire for the **private sector** were to:

- **identify the operations** that individual industries currently perform, to manage the waste they generate, and associate these operations **with a SWM phase**;
- **associate the cost of each management operation** – undertaken internally or paid to different external service providers - and indicate a **possible revenue** for the recovery of materials from industrial waste;
- organise the data in a general **flow diagram**, describing the overall SWM operations actually carried out by the industrial sectors; and
- define how the **IW flows interact with the SWM system** organised by the public sector.

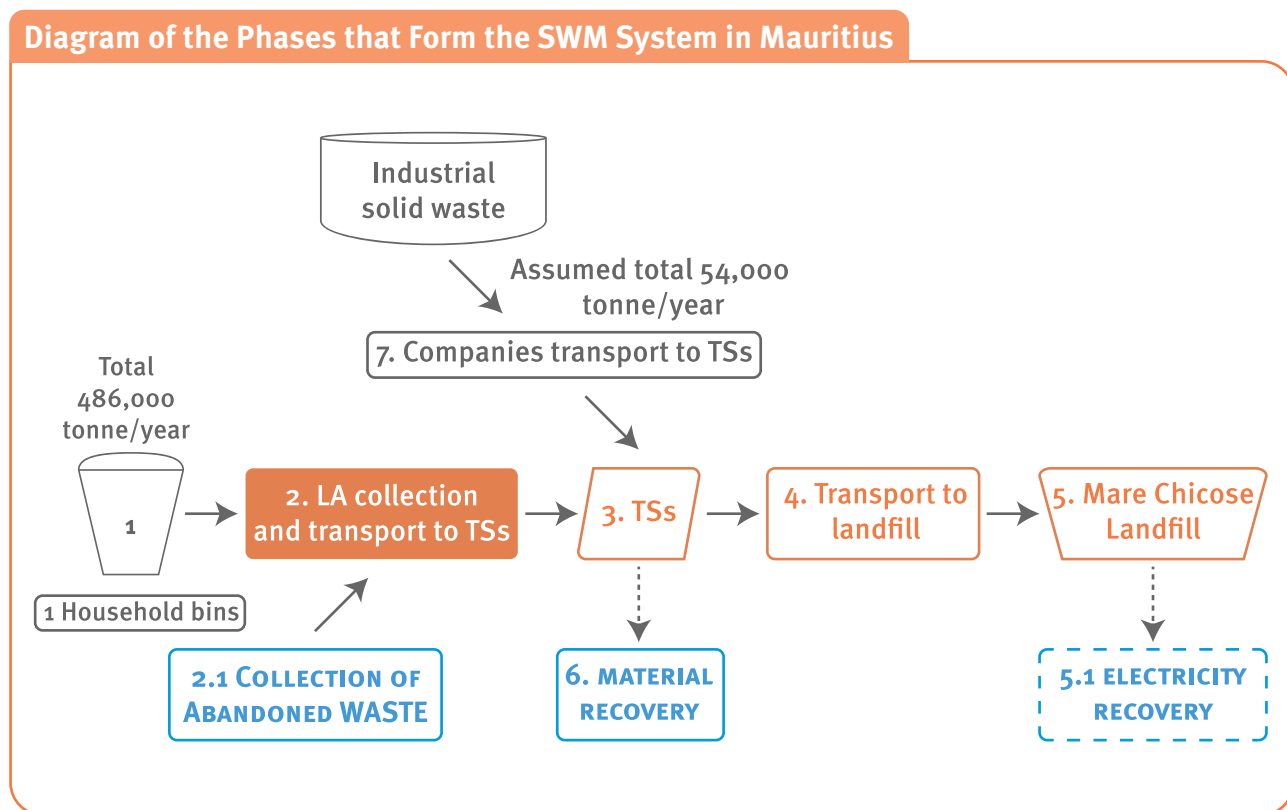
The **objectives** of the questionnaire addressing the **public sector**, namely local authorities (LA) and the Solid Waste Management Division (SWMD), were to:

- analyse at what level costs are known and **if a SWM budget** is separately kept by the Ministry of Environment, Solid Waste Management and Climate Change;
- formulate an **overall waste flow diagram** for the SWM system controlled by the public sector;
- include the **cost incurred by LAs** in collection and transportation of municipal solid waste to the transfer stations;
- include the cost incurred for each phase of **SWM** by the **SWMD**; define the **overall cost of SWM** and the potential specific cost contribution of industrial waste.

¹ The questionnaires are provided in Annex 1 and Annex 2 of this report.

ANALYSIS OF THE STRUCTURE OF THE COSTS FOR THE PUBLIC SECTOR

The following schematic diagram describes **the phases that form the SWM system** – for municipal, abandoned and industrial waste – run by the **public sector** in Mauritius: at present, waste is either recycled (at a very small percentage) or landfilled.



This study associated a cost to each phase of SWM in Mauritius, as summarised in the following table:

Cost of SWM for the Public Sector in Mauritius						
Population	Total SW (Estimated municipal and industrial waste)	Cost for Collection and Transport to TSs by LA (Estimated only for municipal waste)	Management of 5 TSs for Mixed Waste*** by Ministry of Environment	Transport to Landfill of Mixed Waste by Ministry of Environment	Landfill Management for Mixed Waste by Private Service Provider	TOTAL
1,266,000	tonne/year	MUR/year	MUR/year	MUR/year	MUR/year	MUR/year
	(486,000 + 54,000) 540,000*	1,100,000,000**	95,100,000	177,000,000	284,500,000	1,656,600,000
	MUR/tonne	2,263	176	328	527	3,294
	\$/tonne	52	4	7.5	12	76
	MUR/person					1,309
	Euro/person					26

*It is assumed that the 540,000 tonne/year of SW comprises 486,000 tonne/year municipal waste (90%) and 54,000 tonne/year industrial waste (10%).

**The cost of collection by LA was provided by SWMD of MoE

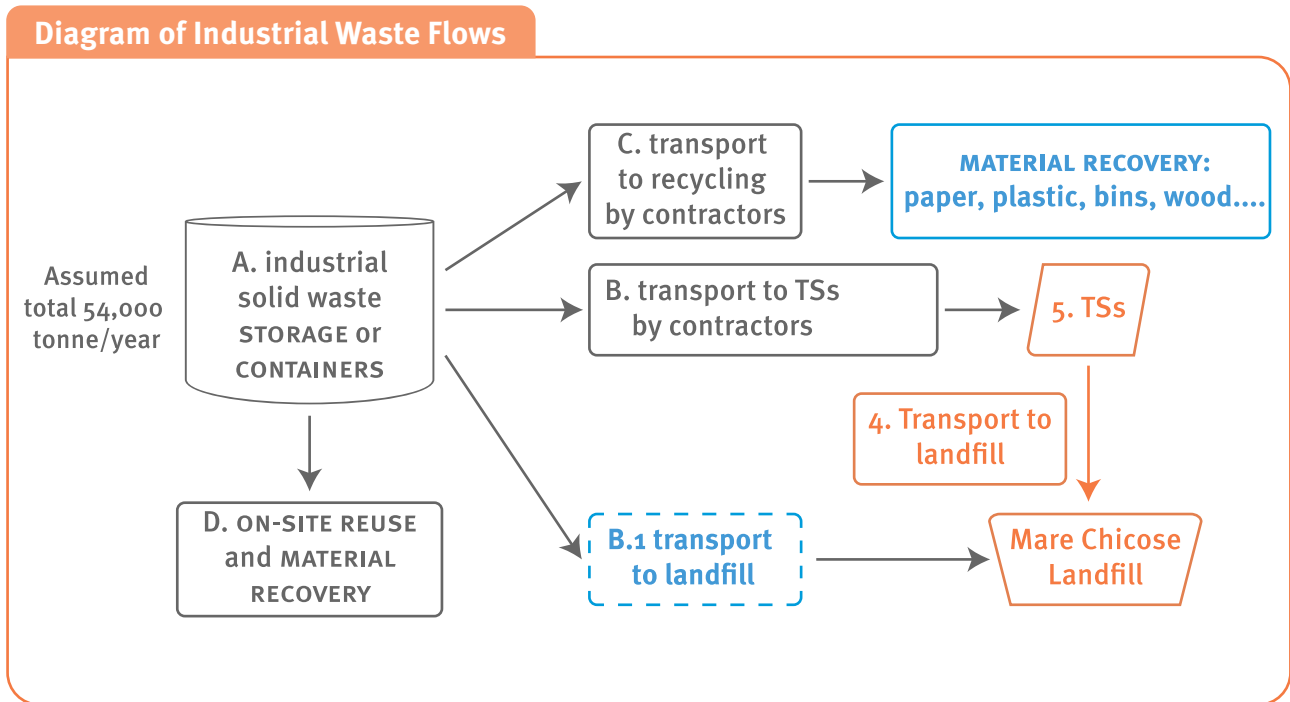
***Mixed Waste refers to municipal and industrial wastes.

(Exchange rate: 1\$ = MUR 43.5; 1 Euro = MUR 50)

STRUCTURE OF THE SWM ADOPTED BY INDUSTRIAL COMPANIES

As reconstructed from the data in the questionnaires, the phases of SWM carried out by the different industrial sectors are depicted in the following diagram:

The diagram shows that the enterprises' current engagement ends with organising the transport of waste to either a transfer station or a recycling facility (only a single company carries its waste directly to the landfill).



In the current legislative framework, what happens to industrial waste after it has been transported to the first destination is not part of enterprises' responsibilities.

Given that manufacturing companies only perform collection and transport to transfer stations, they incur only the costs associated with:

- storage on-site; and
- collection and transport to transfer stations.

The **range of the cost per tonne for 'general waste'** (not specific to each industrial sector) was determined to be:

'general waste' range of costs for collection and transport to a transfer station
 =
MUR/tonne 480 - 940.

The Cost of SWM with Respect to the Turnover

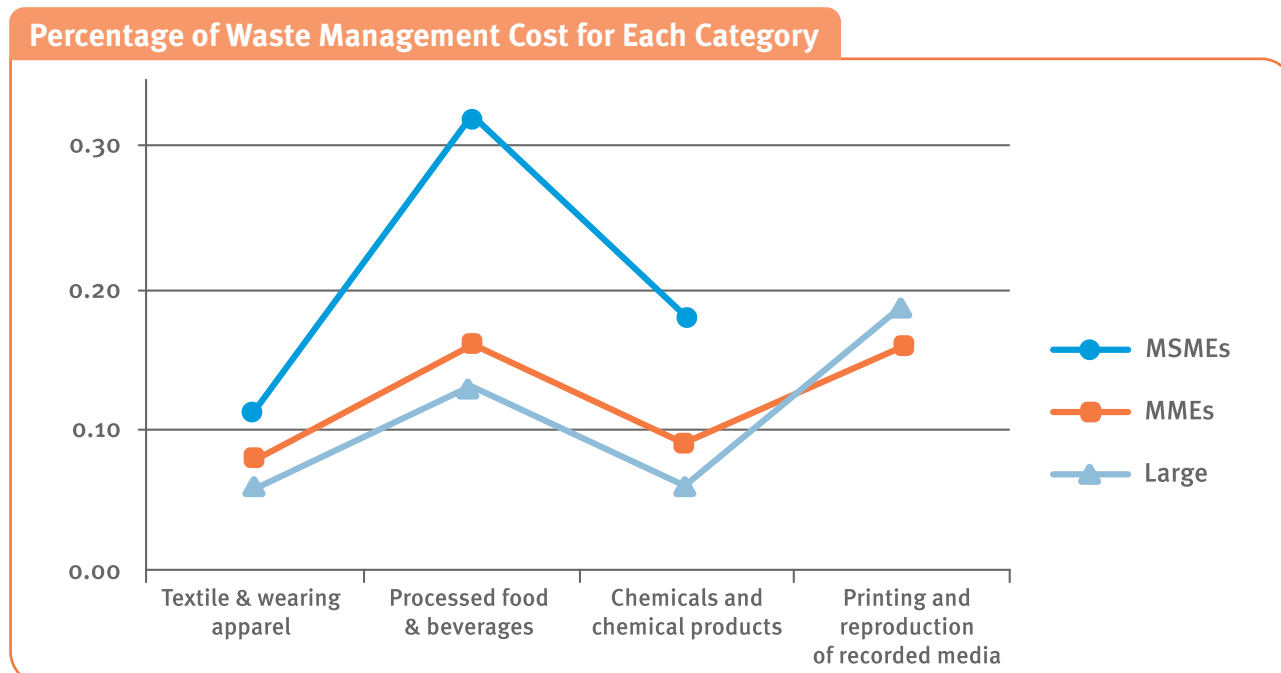
The results of the cost structure analysis can be summarised as:

1. For individual companies, the range of the incidence (given as percentage) of the cost for the management of 'general waste' (storage and transport to transfer stations) ranged in the interval **0.012% to 0.70%** of turnover.
2. When the incidence of cost over turnover was grouped per manufacturing sector and per enterprise size, as shown in the table below, the range narrows from **0.06% to 0.32%**, (with an outlier small company registering 1.71%).
3. the cost for the management of 'general waste' is on the low side as compared to turnover.

The following table shows the percentage of industrial waste management (IWM) over turnover per industry sector and size.

It is observed that large and MME enterprises show essentially the same incidence of the 'general industrial waste' management cost over turnover, whereas MSME companies show a slight increase.

Percentage of IWM Cost Over Turnover in Manufacturing Enterprises			
Sub Sectors	Average % Of Waste Management Cost		
	MSMEs	MMEs	Large
Textile & wearing apparel	0.11	0.08	0.06
Processed food & beverages	0.32	0.16	0.13
Chemicals and chemical products	0.18	0.09	0.06
Printing and reproduction of recorded media	1.71	0.16	0.19
Construction materials			0.04



The Cost for IWM is Mostly Undertaken by the Public Sector

When the range of the costs per tonne paid by the companies for 'general waste' collection and transportation to transfer stations - **MUR/tonne 480 – 940** - is compared to the collection and transportation cost per tonne paid by local authorities - **MUR/tonne 2,263** - it is to be expected that collection cost per tonne for industrial waste paid by the private sector is lower. In fact, local authorities' vehicles must haul municipal waste for longer distances at a much slower speed before getting completely filled with household waste and carrying the load to a transfer station.

Moreover, by looking at the diagram for the waste flows managed by the public sector in Mauritius, it appears that industries are not engaged in what happens to their waste once it is disposed of at the transfer stations.

This means that the public sector is undertaking the costs associated with:

1. the transportation of mixed waste (municipal and industrial) to the landfill: **MUR/tonne 328**,
2. the landfill management: **MUR/tonne 527**,
3. the management of 5 transfer stations for mixed waste streams by the Ministry of Environment, Solid Waste Management and Climate Change: **MUR/tonne 176**.

A **total cost of MUR/tonne 1,031** is estimated to be the **hidden cost incurred by** the public sector to sustain the management of industrial waste.

RECOMMENDATIONS

Recommendations to Private Sector and Recyclers

- Improve data collection and describe in detail the solid waste (SW) disposal operations undertaken within their premises;
- Express the unit of waste generated in cost per tonne;
- Assess the feasibility of using the structure of cost provided in this study;
- Private enterprises should be sensitised on the complete structure of the costs undertaken by the public sector for the management of their industrial waste; and
- Recycling companies or recycling activities need to be monitored and the critical elements highlighted

Recommendations to Policymakers

- Organise SWM system data under the responsibility of the public sector;
- Keep a full cost budget to allow for the selection of investments and the evolution of the current SWM system;
- Review the overall mechanism for the cost of management of industrial solid waste to encourage sustainable development;
- Support the industrial operators to keep their SWM budget by providing an appropriate method;
- Build a database from the Industrial Waste Audit; and
- Perform training on the method of SWM Full Cost Accounting

1.

INTRODUCTION



1.1 CONTEXT OF THE STUDY

PAGE was launched in Mauritius in April 2014 and was quickly followed by a joint inception mission in July of the same year. The inception meeting brought together key stakeholders of the Government. Since the inception of PAGE in Mauritius, the Government has demonstrated high-level support towards transitioning its economy to an Inclusive Green Economy (IGE). Working at the policy and strategic levels in Mauritius, PAGE has supported Government policy objectives in line with the Green Economy Action Plan (GEAP). PAGE activities in Mauritius are also in agreement with the Government Vision 2030, which addresses complementary dimensions of stimulating green investments and policy reforms to deliver sustainable growth, job creation and poverty annihilation. Interventions have focused on three principal areas so far: i) macroeconomic policy support, ii) sector programmes and iii) institutional capacity building. These interventions have contributed to several Sustainable Development Goals, including SDGs 1,4,8,9,12, 13 and 17.

During the inception phase of PAGE activities, the private sector voiced out the dire need of an industrial symbiosis project. In response to this request, UNIDO in partnership with the Industry Division of the then Ministry of Industry, Commerce and Consumer Protection, designed a study titled Industrial Waste Assessment (IWA) with the principal objective of determining the feasibility of a possible symbiosis of industrial waste management in Mauritius. To support this move, the Government of Mauritius, through the Cabinet, recognised the implementation of the IWA which was then launched in February 2016. In 2017 the IWA was completed, and the report made available. The recommendations of this report fuelled the need for a follow-up study to focus on the cost structure review of industrial waste in Mauritius.

The idea of the current Industrial Waste Management-Cost Structure Review (2021 IWM-CSR) is to build on the IWA and to provide a better understanding of the capacities of the various enterprises within the industrial sector and thus aid the symbiosis. The wider objective is to promote sound solid waste management in industries with a view to enhance their competitiveness and promote circular economy as per international best practices.

To attain the set objectives, the national Project Steering Committee (PSC), co-chaired by the Ministry of Industrial Development, SMEs and Cooperatives (MoIDSC) and Business Mauritius (BM), supervised the implementation of the IWM-CSR and endorsed the scope of the study.

The Project Steering Committee was composed of the:

- Ministry of Industrial Development, SMEs and Cooperatives (Industrial Development Division) (Co-Chair)
- Business Mauritius (Co-Chair)
- Ministry of Industrial Development, SMEs and Cooperatives (SMEs Division)
- Ministry of Finance, Economic Planning and Development
- Ministry of Environment, Solid Waste Management and Climate Change (Solid Waste Management Division and Department of Environment)
- Ministry of Local Government and Disaster Risk Management
- Ministry of Energy and Public Utilities
- Ministry of Health and Wellness
- Economic Development Board
- United Nations Resident Coordinator's Office
- Mauritius Research and Innovation Council
- University of Mauritius
- Mauritius Export Association
- Mauritius Chamber of Commerce and Industry
- Association of Mauritian Manufacturers

1.2 AIMS, OBJECTIVES AND SCOPE OF THIS STUDY

The activities of the IWM-CSR project were built on the recommendations of the Industrial Waste Assessment (2017 IWA) carried out by PAGE in Mauritius with the collaboration of the Industry Division of the then Ministry of Industry, Commerce and Consumer Protection, UNIDO and Business Mauritius. It was recommended in the IWA Report that industrial waste flows could be integrated with flows of municipal waste with similar characteristics. The advantage of this suggested

mergence was that this could boost the recovery and treatment processes, thus making recycling a viable option for those waste materials that did not require complex and costly treatment processes, particularly, those that could be reused on the island.

The 2017 IWA also recommended the achievement of a sound understanding of the cost structure and policy gaps in the industrial waste management sector with the primary goal of enabling the development of a circular economy within the sector and thus enhancing the competitiveness of the enterprises.

To fulfill these selected recommendations, the current study was undertaken, with a focus on the following objectives:

- 1. Understand the structure of solid waste management costs undertaken by selected industrial sectors** for Micro, Small and Medium-sized Enterprises (MSMEs), Mid-Market Enterprises (MMEs) and Large Enterprises.

In continuation from the 2017 IWA, the IWM-CSR addresses the following industrial sectors:

- Textile and wearing apparel
- Chemicals and chemical products
- Food products (poultry, seafood, beverages and bottling sub-sectors)
- Printing and reproduction of recorded media
- Construction materials (this sector was added to include data submitted by enterprises)

- 2. Assess the share of the SWM costs over the company's turnover.**

- 3. Analyse the cost undertaken for SWM by the public sector.** Identify potential hidden costs derived from the management of industrial waste.

- 4. Provide a general overview advice on the introduction and implementation of Extended Producer Responsibility (EPR) Schemes** and examine the main constraints to their applications in Mauritius.

To meet the objectives of this study, 30 companies participated from the selected industrial sectors.

The study aimed to quantify the structure of cost for industrial waste management (IWM) in Mauritius and the percentage of these costs with respect to the company's turnover.

1.3 GOVERNANCE OF THE PROJECT

This project was funded under the Partnership for Action on Green Economy (PAGE). Launched in 2013, PAGE represents a mechanism to coordinate UN actions on green economy and to put sustainability at the heart of economic policies and practices to advance the 2030 Agenda for Sustainable Development. It supports nations and regions in reframing economic policies and practices around sustainability to foster economic growth, create income and jobs, reduce poverty and inequality, and strengthen the ecological foundations of their economies.

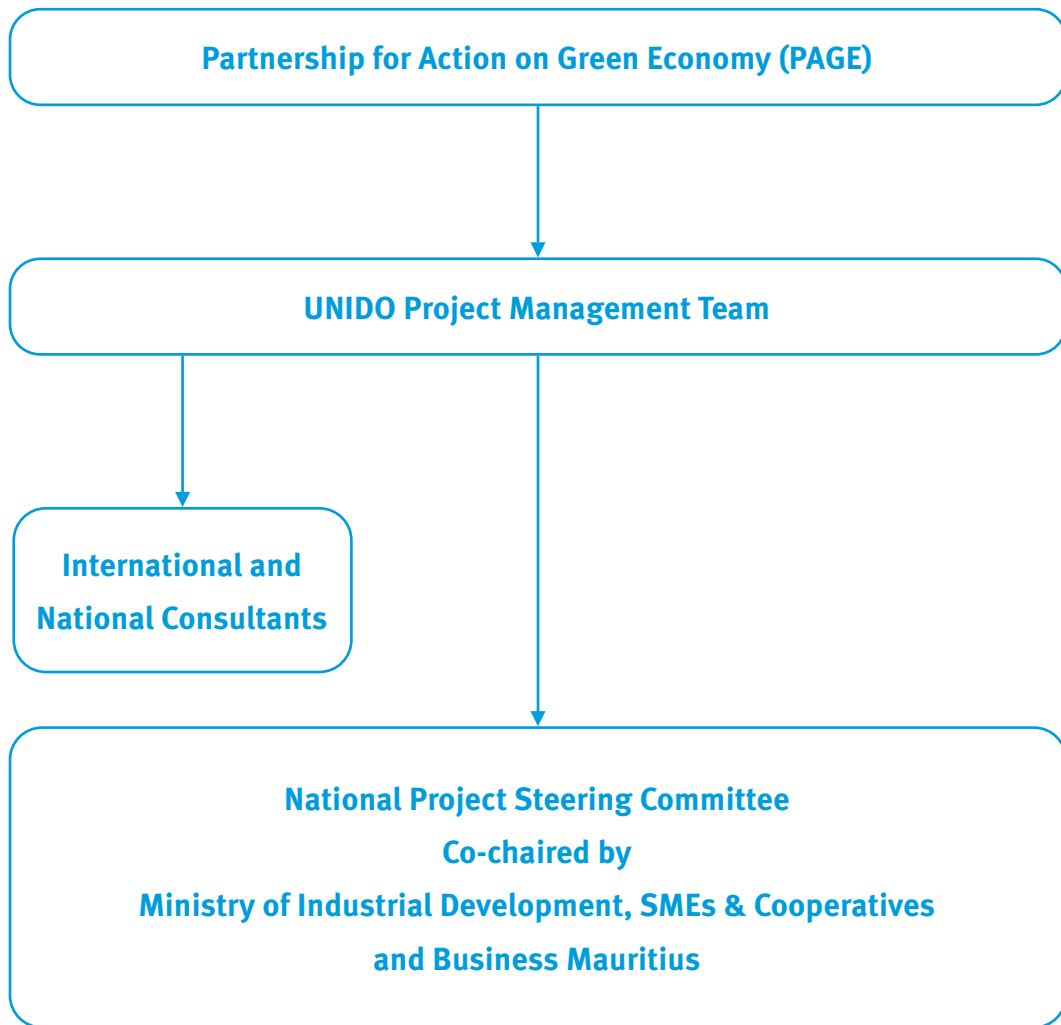
The United Nations Industrial Development Organization (UNIDO) was the implementing agency for the IWM-CSR. UNIDO is specialised in promoting industrial development for poverty reduction, inclusive globalization, and environmental sustainability. The mandate of UNIDO is to promote and accelerate inclusive and sustainable industrial development in developing countries and economies in transition.

The national Project Steering Committee (PSC), co-chaired by the then Ministry of Industry, Commerce and Consumer Protection and Business Mauritius (BM), was set up in January 2016 to supervise the implementation of the Industrial Waste Assessment (IWA) and to endorse the scope of the study, The PSC continued overseeing the implementation of the activities on the IWM-CSR study.

The roles and responsibilities of UNIDO, Ministry of Industrial Development, SMEs and Cooperatives, PSC, international and national consultants are illustrated in Figure 1.

- PAGE - Funding the project
- UNIDO/UNIDO Project Management Team - Overseeing planning and Implementation
- Consultants, International and National - Executing activities
- National Project Steering Committee - Implementation supervision and study scope endorsement

Figure 1. IWM-CSR Project - Roles and Responsibilities



2.

REGULATORY FRAMEWORK PERTAINING TO INDUSTRIAL SOLID WASTE MANAGEMENT



As this study stems from the 2017 IWA that performed a detailed analysis of the legislative and institutional frameworks, this report updates the review by assessing that these frameworks have not changed substantially.

2.1 INSTITUTIONAL SETTING AND COORDINATION

The **Solid Waste Management Division**, at the Ministry of Environment, Solid Waste Management and Climate Change is responsible for the main functions of SWM:

1. Devising policies and strategies and developing programmes;
2. Management, control and supervision of waste disposal sites (transfer stations and sanitary landfill) in Mauritius;
3. Enforcement of the legislations such as:
 - Environment Protection (Standards for Hazardous Wastes) Regulations 2001;
 - Local Government (Dumping and Waste Carriers) Regulations 2003;
 - Local Government (Registration of Scavenging Contractors) Regulations 2004;
 - Environment Protection (Collection, Storage, Treatment, Use and Disposal of Waste Oil) Regulations 2006; and
 - Local Government (Registration of Recycler and Exporter) Regulations 2013.
4. Registration of scavenging contractors, recyclers and exporters.

The local authorities play a pivotal function in SWM as they are responsible for the collection and transportation of waste from households and public places to disposal sites or waste management facilities.

It is noted, due to relevance for this study, that local authorities are not involved in the collection of **industrial waste**.

The **Ministry of Health and Wellness** is responsible for controlling health-related aspects of waste. The Public Health Act defines problems

and empowers Public Health and Food Safety Inspectors to issue sanitary notices for offences relating to solid waste and wastewater where they could prove injurious to health. The Ministry of Health and Wellness is also a member of the Industrial Waste Audit Committee at the Ministry of Environment, Solid Waste Management and Climate Change.

2.2 LEGAL FRAMEWORK

The main legal acts defining the framework for waste management in Mauritius are the Environment Protection Act (EPA) of 2002, amended in 2008, and the Local Government Act (LGA) of 2011. Specific regulations were made under EPA 2002 and LGA 2011.

Thus, the recommendations made in the 2017 IWA concerning the need to detail the legislation on solid waste management – addressing all types of waste – remain relevant.

The legislative innovations relate to two regulations with regard to banning plastic bags and mono-use plastic items.

2.2.1 Environmental Protection (Banning of Plastic Bags) Regulations 2020

The Environment Protection (Banning of Plastic Bags) Regulations 2020 is a more extensive and more stringent version of the Environment Protection (Banning of Plastic Bags) Regulations 2015.

As from 01 March 2021, the possession, use, distribution, selling, exportation, importation, manufacture, or supply of plastic bags is banned with certain exemptions.

The importation or manufacture of an exempt plastic bag or a biodegradable plastic bag or a compostable plastic bag is subject to registration with the Department of Environment. The issued Certificate of Registration is valid for a period of three years and can be renewed thereafter.

Furthermore, the importation or manufacturing of biodegradable plastic bags or compostable plastic bags is also subject to acquiring a clearance from the Department of Environment.

2.2.2 Environment Protection (Control of Single-Use Plastic Products) Regulations 2020

Salient features of the Regulations are that “no persons shall import for home consumption, manufacture, possess, sell, supply or use any non-biodegradable single use plastic product specified in Part I of the Second Schedule.”

Part I of the Second Schedule of the Regulations comprises the following single use plastics products: cutlery (forks, knives, spoons, chopsticks), plates, cups, bowls, trays, straws, beverage stirrers, hinged containers, plastic lids for single use plastic products and plastic receptacles of any shape, with or without lids used to contain food which is intended for immediate consumption, either on the spot or take away and supplied by a food service business.

As from 15 January 2021, the above-mentioned single-use plastic products have been banned. Three single use plastic products, namely, plastic trays, plastic hinged containers and sealed plastic straws forming an integral part of the packaging of another product have been banned as from 15 April 2021.

The First Schedule of the Regulations comprises all of the above listed products, but which are made of material other than plastic such as wood, paper, paper pulp, kraft paper, cellulose, bagasse, bamboo, palm, edible cutlery, and bio-based polymer such as poly (lactic) acid, crystallised poly (lactic) acid, polybutylene succinate. Importers and manufacturers of biodegradable single-use products are required to be registered at the Department of Environment prior to import or manufacture.

2.3 NATIONAL SWM STRATEGY

2.3.1 Ongoing Revision of Waste Management Strategy

The Solid Waste Management Strategy 2011-2015 is being updated in line with the Government of Mauritius’ aim to focus on waste reduction, recycling, and recovery.

To implement a more sustainable SWM system, the Solid Waste Management Division decided to develop a Strategy and Action Plan for a new SWM and Resource Recovery System for Mauritius, with the financial assistance of the Agence Française de Développement.

The Consultancy Study was awarded to Ecozem/Luxconsult (Mtius) Ltd on 14th March 2017 and the Consultancy Study consists of two phases:

Phase 1: has already been approved by the Government, it comprised the preparation of the Strategy and Action Plan, including a baseline review, and an analysis of strategic options and recommendations.

Phase 2: comprised a feasibility study of regional composting plants and sorting units; Phase 2 started in November 2020 and has been completed in June 2021.

After extensive consultations with all stakeholders, a new Solid Waste Management Strategy and Action Plan for the next five years has been developed, which aims at maximising resource recovery and recycling in the short to medium term, while also tapping the energy recovery potential from wastes in the long term.

The proposed strategy focuses on five key areas:

Strategic Area I: Prevention and Environmentally Responsible Consumption: actions include home composting, deposit of post-consumer products. The use of legal instruments and enforcement has also been recommended.

Strategic Area II: Increase in Resource Recovery: is the cornerstone of the Strategy. It aims to recover waste with intrinsic economic value, such as organic matter, wastepaper, plastic, glass and metal. Separation of waste at source is viewed to be of paramount importance for this initiative to succeed. It foresees the development of 2 pilot projects on Material Recovery Facilities (MRF) that would include a compost plant for source separated organic waste, a sorting unit and a Civic Amenity Centre.

Strategic Area III: Adequate Technologies for Energy Recovery: setting up waste-to-energy infrastructure can only be envisaged for implementation in the long-term after the successful implementation of resource recovery and recycling projects.

Strategic Area IV: Provision of Adequate Disposal Infrastructure: focuses on short- and medium-term extension or further optimisation of the existing Mare Chicose Landfill, while also considering the eventual option of a new landfill.

Strategic Area V: Information, Education and Communication.

2.4 EXTENDED PRODUCER RESPONSIBILITY

The National Environmental Policy 2007 established that the Government will:

“Provide a legal framework for establishing a recycling-based society to promote waste recycling measures”. Centred on this legislation, individual regulations will be established to include the following: effective utilisation of resources, container and packaging, **Extended Producer Responsibility**, construction material recycling, food recycling, green procurement, etc.

In the Budget Speech for the financial year 2020/2021, it was mentioned that the Environment Protection Act will be amended to set up an Extended Producer Responsibility on management of e-wastes, end-of-life vehicles, and waste batteries, in close partnership with the private sector.

The Solid Waste Management Division has drafted the key elements of an Extended Producer Responsibility Regulations for electrical and electronic equipment. The Regulations are being drafted by the State Law Office and once completed the Regulations will be promulgated. It is expected that the EPR system for electrical and electronic equipment would be in place in 2022.

2.5 OTHER TAX PAYMENTS/ CHARGES/DUTIES PAID BY MANUFACTURING ENTERPRISES

2.5.1 Industrial Tax Paid to Municipalities

Manufacturing enterprises currently pay industrial tax at the rate of 26% to Municipal Councils and is based on the company’s net annual value. Usually, the domestic and commercial tax rates are lower than the industrial tax rates. There is no industrial tax rate at the level of District Councils.

2.5.2 Charge on PET Bottles/Aluminium Cans

Manufacturers of beverages have to pay Rs 2 per unit on PET bottles or aluminium cans produced.

2.5.3 Excise Duty on Sugar Sweetened Products

It is to be noted that a tax of 6 cents per gram of sugar on locally manufactured and imported non-staple sweetened products (as announced in the Annex of the Budget Speech 2020-21) will be effective as from 01 July 2022.

2.5.4 Fee for Disposal of Hazardous Waste (also refer to Section 4.1.4)

Some manufacturing enterprises pay a disposal fee of Rs 100 per kilogram of hazardous wastes generated to the relevant Authority and an additional fee of Rs 2,500 (inclusive of VAT) for the quantity of hazardous wastes exceeding one tonne.

3.

CONTEXT AND METHODOLOGY



3.1 CONTEXT OF THE STUDY AND SECTORS SELECTED

This study originates from Recommendation no. 6 of the 2017 IWA Report: *"to better enable identification of the conditions that favour the recovery of materials and energy from waste, the SWM national strategy should investigate the feasibility of developing a framework supporting the **integrated management of municipal and industrial waste flows.**"*

In this context, this study focuses on:

- the determination of the structure of the costs for IWM within companies; and
- the possibility that part of these costs constitute a hidden cost for the activities for SWM carried out by the public sector.

Thus, to be able to integrate the information relating to both issues, the analysis was carried out in parallel for the private and the public sectors.

Continuing from the 2017 IWA, this study addresses the following industrial sectors:

- Textile and wearing apparel
- Chemicals and chemical products
- Food products (poultry, seafood, beverages and bottling sub-sectors)
- Printing and reproduction of recorded media
- Construction materials.

To represent the full spectrum of operating enterprises, companies were selected ranging from:

- Micro, Small and Medium-sized Enterprises (MSMEs)
- Mid-Market Enterprises (MMEs); and
- Large Enterprises.

3.2 REPRESENTATIVENESS OF THE SURVEY

Initially, the target number of enterprises expected to participate in the study was estimated to be in the range of 50. But due to the emergency of the COVID-19 pandemic in Mauritius, by June 2020 it had become clear that it was impossible to maintain the structure and the timeframe initially agreed upon.

A first effect was that the whole project timeline was delayed by more than a year. A second effect was that many of the companies that had initially expressed interest did not participate in the survey. This withdrawal was due to the fact that some companies encountered serious economic difficulties, and that all of them had to deal with the challenges of the pandemic, including safeguarding employment.

These difficulties prevented many companies from mobilising resources to participate in the survey.

As a result, 30 companies were involved in this study.

Table 1 summarises how the individual companies participated in the analysis of the costs for the management of solid industrial waste:

Companies providing a cost breakdown as required by the questionnaire	22
Companies only providing the total sum of costs (via MoIDSC)	8
Total companies involved	30

It is observed that, even if the number was reduced with respect to the initial forecast, the **sample of companies** providing data i) on the structure of the costs of industrial solid waste management (22) and ii) on the range of costs estimated (30) is **fully representative** of the current conditions in Mauritius- regarding companies of all sizes and across all sectors as initially forecasted in the study.

The study was the first of its kind conducted for Mauritius and the results provided **a clear and unique description of the structure of the costs for industrial waste management**, both by the private and public sectors.

3.3 INSTITUTIONAL PARTNERSHIP AND PROJECT STEERING COMMITTEE

Following the positive outcome of the 2017 IWA, the IWM-CSR confirmed the partnership between institutional actors and the private sector. A Project Steering Committee was set up to jointly formulate and approve the methodological tools applied in the course of the project.

In February 2020, the Project Steering Committee, in which both national and international consultants participated, underlined that the goals of the project were to understand:

- the structure of costs and (potential) revenues, if any, of IWM for the private and the public sectors, and
- how these costs were shared among the public and the private sectors.

The Ministry of Local Government and Disaster Risk Management, being a member of the Project Steering Committee, was also involved in preparatory meetings and trainings.

The relevance of UNIDO’s previous 2017 IWA was recognised in having established the awareness of the relevance of quantifying waste generation and of describing the flows of the several types of waste managed and the associated costs.

Subsequently, these aspects were emphasised by some of the industrial managers interviewed. It was agreed that data analysis and reporting would not disclose sensitive information or data about the private enterprises.

3.4 METHODOLOGY APPLIED IN THE ANALYSIS

Table 2 summarises the steps of the project.

3.4.1 Two Questionnaires Were Formulated Based on the Flow Analysis Approach

One of the methodological steps agreed was to undertake a direct survey of IWM costs by using two (2) questionnaires specifically formulated for this project:

- a questionnaire addressing the **industrial companies** participating in the project: to be filled in by the individual company’s managers detailing the different costs incurred by each industrial site;
- a questionnaire addressing the structure of the costs incurred by the **public sector** for the management of solid waste in Mauritius: to be filled in by officers/managers both of the Ministry of Environment, Solid Waste Management and Climate Change and local authorities.

Table 2. Activities, Tasks and Timeline of Project

Activities	Tasks	Timeline
Institutional partnership	<ul style="list-style-type: none"> • Partnership between institutional actors and the private sector. • Establishment of the Project Steering Committee. 	June – October 2019
Preparation of the two questionnaires	Preparation of questionnaires on survey of IWM costs both for the private and public sectors.	December 2019 – January 2020
Capacity building	Workshop / Capacity Building on Industrial Waste Management - Cost Structure Review.	February 2020
Preliminary on-site visits and data collection	Contacts established, site visits by the national consultant and questionnaires filled out by participating companies.	February 2020 – July 2021
Analysis of data available from the questionnaires	<ul style="list-style-type: none"> • Organisation of the data gathered with the questionnaires. • Validation of the quality of data provided by the participating companies. • Attribution of the different costs to the different SWM operations. • Estimation of a range of costs for the management of 'general waste' (waste that is similar to municipal waste). • Analysis of the costs undertaken by the public and private sectors. • Analysis of the costs incurred by the public sector on behalf of the industrial sector (hidden costs). 	July – September 2021
Draft report	Assessment and finalising of a draft report with institutional partners and the Project Steering Committee.	October – December 2021
Final report (edited)	<ul style="list-style-type: none"> • Including recommendations. • Editing by UNIDO 	April 2022

The two questionnaires were formulated by following the approach called Waste Flow Analysis² to describe:

- the SWM organisation adopted on each industrial site; and
- the overall SWM system controlled by the public sector.

The questionnaires are provided in Annex 1 and Annex 2 of this report.

The Waste Flow Analysis approach provides a unique method to describe a SWM system and to put in place the different activities that are conducted as part of waste management.

This method answers Recommendation no. 4 from the 2017 IWA: “A clear legislative framework is essential for providing each actor of a WM system with a clear indication of his/her functions and the understanding of his/her relationship with institutions and enforcing agencies. **Clearly defining different waste management phases in legislation is of high relevance.**”

The Waste Flow Analysis approach requires quantifying the flow of all waste as it goes through the different phases of management, allowing **full traceability** of the waste generated.

This approach describes how SWM is carried out by highlighting the quantity of waste that passes from one **management phase** to the next, until the final destination is reached (further details in the following sections).

The waste flow approach, adopted to define the SWM phases taking place in Mauritius, was illustrated in a specific training meeting held in February 2020 with the local authorities and the Ministry of Environment, Solid Waste Management and Climate Change.

With the awareness that the issues being dealt with would be perceived as new by the companies, particular effort was made to simplify the questionnaires and make them ‘user friendly’.

² S. Tunesi, J. Gorelick. 2018. “Solutions design for Solid Waste management - A Guidebook to an effective method for low and middle-income Countries and Cities”. Pag. 260. CreateSpace.

The **objectives** of the questionnaire for the **private sector** were to:

- **identify the operations** that individual industries currently perform, to manage the waste they generate, and associate these operations **with a SWM phase**;
- **associate the cost of each management operation** – undertaken internally or paid to different external service providers - and indicate a **possible revenue** for the recovery of materials from industrial waste;
- organise the data in a general **flow diagram**, describing the SWM operations carried out by the industrial sectors; and
- define how the **industrial waste flow interacts with the SWM system** organised by the public sector.

The **objectives** of the questionnaire addressing the public sector, namely local authorities (LA) and the Solid Waste Management Division (SWMD), were to:

- analyse at what level costs are known and **if a SWM budget** is kept by the Ministry of Environment, Solid Waste Management and Climate Change;
- formulate an overall waste flow diagram for the SWM system controlled by the public sector;
- include the **costs incurred by LA** for the collection and transportation of municipal solid waste to the transfer stations;
- include the costs incurred for each phase of SWM by the **SWMD**;
- define the **overall cost of SWM** and the potential specific cost contribution of industrial waste.

Several meetings were held in preparation, including a discussion on the format of the questionnaires, in the months preceding the Inception Workshop between UNIDO’s Project Manager, the Ministry of Industrial Development, SMEs and Cooperatives, the Ministry of Environment, Solid Waste Management and Climate Change, and the national and international consultants.

3.4.2 Capacity Building – Inception Workshop

To introduce and present the UNIDO IWM-CSR project to a vast number of enterprises and stakeholders, a one-day Inception Workshop was held on 04 February 2020 at the National Co-operative College

in Terre Rouge. The Honourable, S. Bholah, Minister of Industrial Development, SMEs and Cooperatives; Mrs C. Umutoni, the United Nations Resident Coordinator; Mr K. Ramkaloan, the Chief Executive Officer of Business Mauritius; and other personalities were present at the Opening Ceremony.

The workshop, organised by the Ministry of Industrial Development, SMEs, and Cooperatives, in collaboration with UNIDO, under the Partnership for Action on Green Economy and Business Mauritius, was conducted by a team of UNIDO consultants, namely, Dr S. Tunesi, International Consultant and Dr D. Surroop, National Consultant.

The workshop was attended by 70 participants, including personnel from 39 manufacturing enterprises and 6 recycling companies, as well as members of the Project Steering Committee and representatives of relevant Ministries/institutions.

The training and capacity building of the participating companies focused on the following aspects:

- Review of goals and scope of the IWM-CSR. A brief overview was also made on international best practices with respect to industrial waste management, industrial symbiosis and circular economy;
- Principles of the Waste Flow Analysis approach (including solid waste management cost structure for the public sector);
- Principles of industrial waste management, industrial symbiosis and circular economy;
- Methodology for data collection of a cost structure review: the questionnaires were described in detail and;
- Principles of the Extended Producer Responsibility (EPR) approach.

3.4.3 Preliminary On-Site Visits

Eight companies were preliminarily visited by both national and international consultants in February 2020. These initial visits to industries of different sectors and sizes enabled the consultants to:

- get a first set of observations used to finalise the questionnaire for the private sector, and
- add a section for comments and recommendations where the industrial management could indicate specific measures they considered relevant.

As a result of this consultation, **the questionnaire for private industries** describes the operations carried out within each industrial site:

- quantification of the amount of waste generated per type;
- description of waste collection and its cost;
- description of waste storage and its cost;
- description of transportation of waste to transfer stations and its cost;
- possibility of recovery of materials; and
- description of transportation to disposal in a landfill.

The questionnaire for the public sector describes the steps carried out under public responsibility:

- quantification of the amount of the municipal waste generated;
- description of transportation of waste to transfer stations and its cost;
- management of transfer stations and its cost;
- description of transport to final disposal in a landfill; and
- management of landfill and its cost and revenues from biogas sales.

In Mauritius, the recovery of material is very limited, there is no recovery of energy and the final destination of all the waste is the Mare Chicose Landfill, where landfill gas is recovered for power generation in engines.

3.4.4 Data Acquisition

The remaining on-site visits to each participating company were carried out by the national consultant. Assistance was provided for the filling in of questionnaires during on-site visits.

In some cases, more than one visit was conducted, while in other cases assistance was provided through virtual meetings, phone calls and emails. In most cases, the data provided were not complete and the company's managers had to be contacted for additional information and clarifications. Subsequently, 22 questionnaires were then filled in by the companies in the following months and submitted to the ministries and UNIDO team by the end of July 2021.

The Ministry of Industrial Development, SMEs and Cooperatives contacted 8 additional companies, whose data were used to quantify the cost percentage over turnover.

3.5 DATA ANALYSIS AND MAIN OUTCOMES

3.5.1 Costs Undertaken by Individual Companies for the Management of Industrial Waste

The data provided in the questionnaire for private companies were assessed and validated by the national and international consultants to verify if they could support the required analysis.

The types of industrial waste generated vary with each industrial sub-sector and with each company, for instance, industrial waste from textile can be fabric or carton, while waste from the food industry is richer in organic fractions.

To allow a comparison of the costs between the several companies, the cost of different characteristics could not be compared and a waste type that could be classified as having **common characteristics was identified** and named '**general waste**' (solely for the purpose of this study).

- The different waste types that were (for the purpose of this study) classified as 'general waste', have characteristics similar to municipal waste, in terms of:
 - composition (because for instance they include paper, plastic, organic waste...) and
 - the possibility of undergoing the same type of management and/or treatment.

With respect to the specific type of waste identified in the 2017 IWA - fabric, organic food and pellets - the companies' answers to the questionnaire did not provide sufficient data to formulate a comparison in the management of their costs for the following reasons:

- very few companies listed cost for waste specific to their production; and
- specific waste was only listed by a few companies, thus data were insufficient to obtain a statistically significant comparison.

Therefore, only the **costs per tonne for the 'general waste' category could be determined and compared** among the different industrial sites.

3.5.2 Costs Undertaken by the Public Sector for SWM

The questionnaires for the cost incurred by the public sector were filled out in collaboration with the:

- Ministry of Environment, Solid Waste Management and Climate Change – Solid Waste Management Division.

The costs incurred by the Solid Waste Management Division for the management of solid waste were based on contractual obligations with the operators of the transfer stations and the Mare Chicose Landfill. As such, the yearly amount dedicated for the operation and maintenance of the:

- transfer stations
 - the transfer of wastes from transfer stations to landfill, and
 - the operation and maintenance of the landfill,
 - are known figures obtained from the National Budget.
- Local authorities (LAs)

Given that only 6 LAs contributed to the definition of the cost of municipal solid waste collection, the total cost for municipal solid waste collection for the island of Mauritius had to be estimated.

All LAs collect municipal solid waste and transport it to the transfer stations except for waste from the southern part of the island, which is sent directly to Mare Chicose Landfill.

The Solid Waste Management Division of the Ministry of Environment, Solid Waste Management and Climate Change oversees the costs for:

- managing the waste at transfer stations,
- transporting the waste to landfill and
- managing the waste at the landfill.

3.6 REPORTING

This final report was assembled with the contribution and comments of all stakeholders participating in the Project Steering Committee.

4.

SOLID WASTE MANAGEMENT (SWM) IN MAURITIUS³



³ PAGE (2017), Industrial Waste Assessment in the Republic of Mauritius: Opportunities for Industrial Symbiosis.

The 2017 IWA conducted for the Republic of Mauritius⁴ suggested that the SWM carried out by the industrial sector intersects with the management of municipal waste carried out under the responsibility of the Ministry of Environment, Solid Waste Management and Climate Change and the local authorities, which operate under the aegis of the Ministry of Local Government and Disaster Risk Management.

For the purpose of this study, the public sector comprises the Ministry of Environment, Solid Waste Management and Climate Change and the local authorities.

The recommendations of the 2017 IWA, therefore, were to:

- analyse the costs incurred by the private sector for the management of industrial waste; and
- integrate the analysis with a more detailed study of the structure of solid waste management of municipal waste and of the costs undertaken by the public sector.

4.1 OVERVIEW OF SOLID WASTE MANAGEMENT

Over the past 10 years, waste generation has been growing at an average rate of 2% annually, and, in 2018, more than 540,000 tonnes of solid wastes were generated in Mauritius. Whilst waste is continuously increasing and the available disposal capacity at the Mare Chicose Landfill will eventually decrease (despite its vertical expansion), land scarcity in Mauritius drastically limits the possibility of developing new disposal infrastructures.

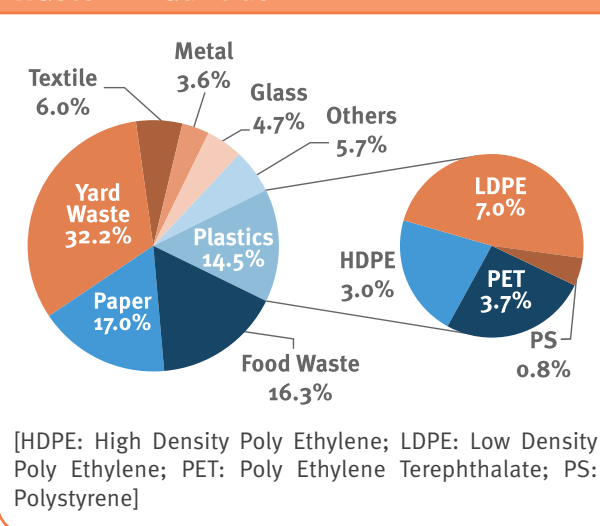
The composition of the waste generated in Mauritius is shown in Figure 2 below (from the National Waste Characterisation Study).

4.1.1 The 5 Transfer Stations

Collection of municipal solid waste is carried out by the 12 local authorities, and it is arranged either by an in-house format or it is outsourced to a private contractor.

⁴ Executive Summary "Strategy and Action Plan for a new SWM and re source recovery system for Mauritius and project preparation support for the implementation of the strategy" downloaded from <<https://environment.govmu.org/Pages/swmd/SWMD-Strategy-and-Action-Plan.aspx>>

Figure 2. Composition of Municipal Solid Waste in Mauritius



The collected waste transits through 5 strategically located transfer stations as detailed in Table 3:

Table 3. Details of Transfer Stations

	Transfer stations	Starting year of operation	Approved capacity / tonnes / day
1	La Brasserie	1991	150 to 300
2	Roche Bois	1992	300 to 400
3	Poudre D'Or	2000	150 to 180
4	La Laura	2005	100 to 150
5	La Chaumiere	2011	350 to 450

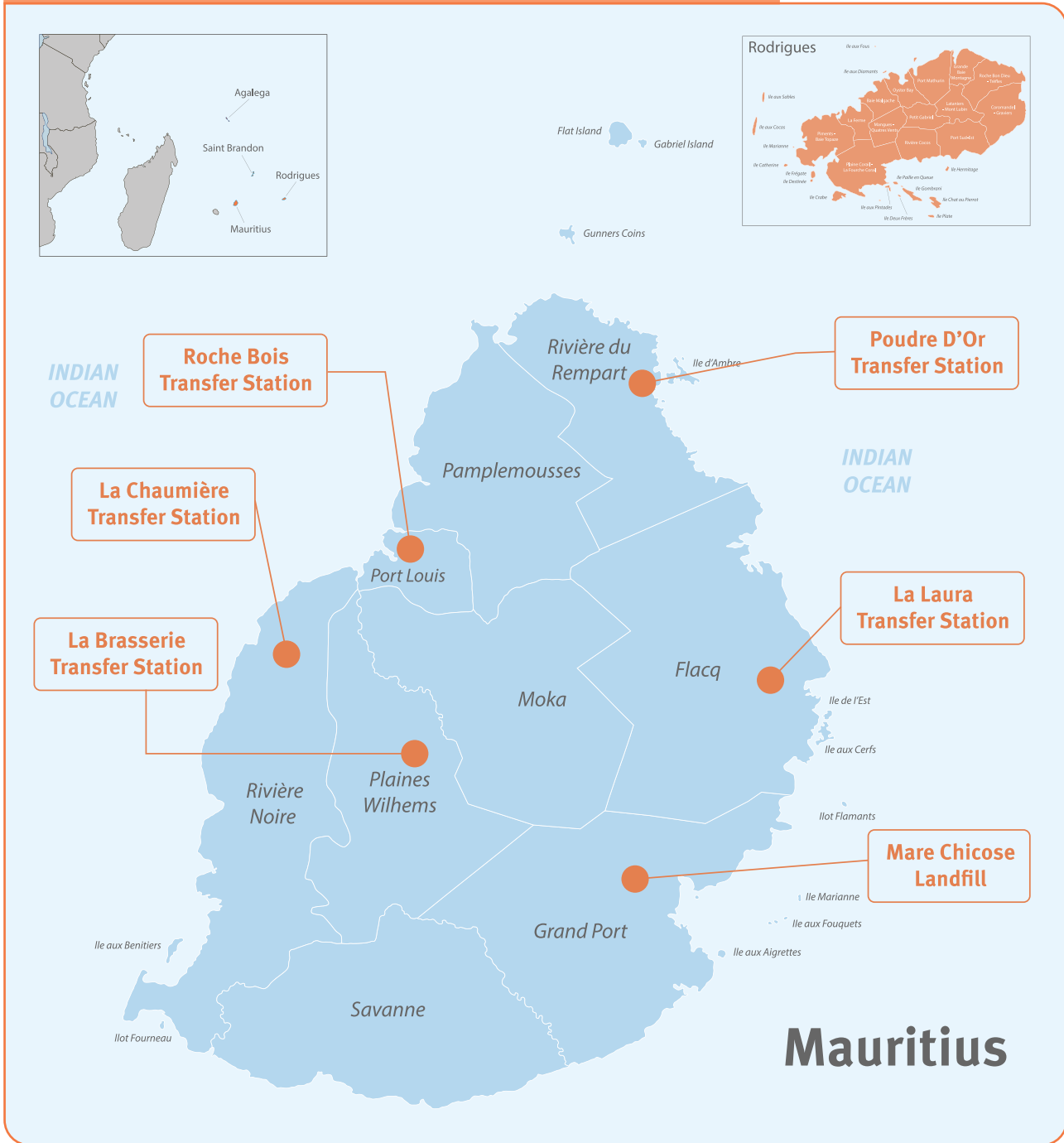
Waste collected by local authorities (except for Grand Port and Savanne District Councils) and other waste generators transit through the 5 transfer stations where municipal and industrial wastes are bulked. Large capacity trucks thus collect the mixed waste and haul it to the Mare Chicose Landfill.

4.1.2 The Mare Chicose Landfill Site

The Mare Chicose Landfill has been in operation since 1997. The landfill cells have been developed and filled in a progressive manner and numbered sequentially. With the construction of Cell 7, the total landfill area is about 48 hectares.

Approximately 540,000 tonnes are landfilled annually and the amount of waste landfilled to date is about 8 million tonnes.

Figure 3. Geographical Location of Transfer Stations and Landfill



Environmental monitoring is an ongoing feature. The engineered landfill at Mare Chicose has been designed for the disposal of waste in an environmentally safe manner. The essential elements providing these safety measures are:

- suitable composite soil and geo-membrane lining at the bottom of the landfill and leachate collection and carting away to prevent contamination of the ground water, and
- abstraction of gas from the landfill to control the emission of methane, through combustion and power generation.

In view of the saturation of the Mare Chicose Landfill and to prevent a major waste management crisis in Mauritius post 2019, the idea of raising the Mare Chicose Landfill to increase disposal capacity was put forward. The vertical expansion works were expected to start by October 2021.

4.1.3 Disposal of Condemned Goods

Condemned goods are goods found unfit for use/ consumption and are also disposed of at the Mare Chicose Landfill. The generators of condemned goods as well as the Ministry of Health and Wellness may declare food items as condemned and unsuitable for consumption/use and a licensed waste carrier is used to transport the goods to the landfill.

4.1.4 Hazardous Waste Management and Procedures for Disposal

It is estimated that an average of 17,000 tonnes of hazardous wastes are generated annually (*out of which around 10% comprising laboratory and industrial chemical wastes, paint wastes, obsolete pesticides, pharmaceutical wastes, gas cylinders and waste aerosols*), cannot be disposed of locally.

Mauritius, being party to both the Basel and Bamako Conventions since 1992, is obliged to take all practicable steps so that hazardous wastes generated on the island are managed in such a way to protect human health and the environment against adverse effects.

In view of ensuring compliance to the international obligations and ensuring safe management of hazardous waste within the country, an interim hazardous waste storage facility at La Chaumière was set up and is operational since April 2017.

Hazardous wastes that cannot be treated and disposed of on the island are tested, collected, sorted, pre-treated (if possible), regrouped, re-packaged, labelled, stored, and exported to licensed recovery/treatment/ disposal facilities.

The Government of Mauritius has approved the payment of a disposal fee of Rs 100 per kilogram of hazardous wastes and an additional fee of Rs 2,500 (inclusive of VAT) for the quantity of hazardous wastes exceeding one tonne by hazardous waste generators. Upon commitment from generators to pay for the disposal of their hazardous wastes, an assessment visit is scheduled; following the assessment visit, the generator is informed of the fee to be paid to the Ministry of Environment, Solid Waste Management and Climate Change for the disposal of hazardous wastes based on an estimated weight of the wastes assessed. Once the disposal fee is received by the Ministry, collection of the hazardous wastes is scheduled.

4.2 ROLES AND RESPONSIBILITIES

In the Republic of Mauritius, municipal solid waste management is under the responsibility of local authorities and of the Ministry of Environment, Solid Waste Management and Climate Change (*as confirmed by information and data acquired during the study*). The outcomes of this study also show that all the industrial waste (*after the operations of storage and collection carried out at the industrial sites*) are not reused (*such as drums or plastic cones*), donated or sold for recycling. They are transported, at the cost of each enterprise, to a transfer station.

Transfer station management is under the responsibility of the Ministry of Environment, Solid Waste Management and Climate Change. Therefore, once it reaches the transfer stations, the management of the industrial waste and the associated costs fall under the responsibility of the public sector.

5.

STRUCTURE OF COSTS OF THE SWM UNDER THE RESPONSIBILITY OF THE PUBLIC SECTOR



5.1 THE SWM UNDER THE RESPONSIBILITY OF THE PUBLIC SECTOR

Given that the industrial waste flows merge with in the larger waste management undertaken by the public sector, and in order to understand the whole system, this section describes the organisation of municipal solid waste management (SWM) in Mauritius and illustrates where industrial waste merges.

Figure 4 describes **the phases that form the SWM system** – for municipal, abandoned and industrial waste – run by the **public sector** in Mauritius. It illustrates the flows of household and industrial waste from generation to the final destination, summarising how SWM is organised in Mauritius; the diagram highlights that, at present, waste is either recycled (at a very small percentage) or landfilled.

- This diagram, formulated on the basis of recently collected data, summarises the whole waste flow currently in operation on the island of Mauritius for the management of municipal solid waste and industrial waste.

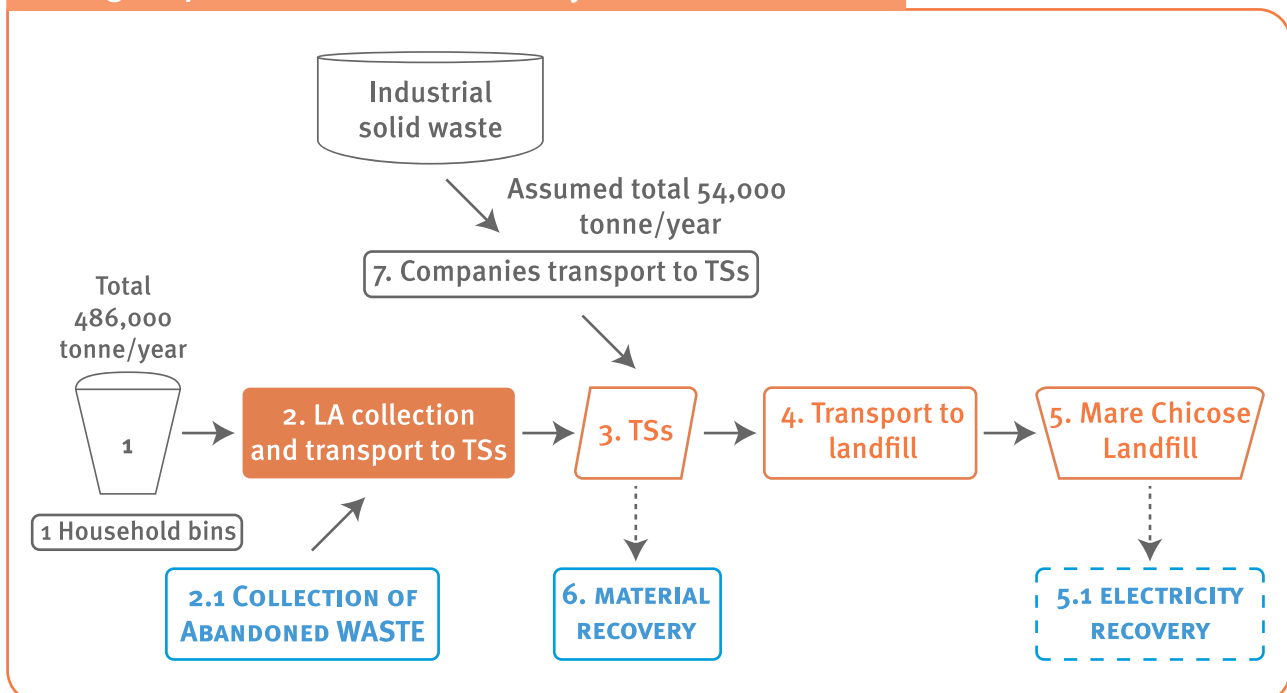
The SWM phases which are currently active in Mauritius are the:

1. disposal of municipal and commercial waste in a single bin at point of origin: no cost was associated with the distribution of the bins;

2. collection from households and commercial units and transportation to transfer stations (TS) by local authorities, which also collect abandoned waste;
3. management of five (5) TSs: operation and maintenance of TSs is contracted to private operators;
4. transportation from the TSs to the landfill;
5. management of the Mare Chicose Landfill by a private company (energy is recovered from the biogas in the landfill);
6. some material recovery by SMEs or informal actors is carried out at TSs; and
7. industrial waste from individual companies is hauled by private contractors to a TS.

The diagram was formulated on the basis of the answers provided in the questionnaires filled out by the Ministry of Environment, Solid Waste Management and Climate Change, it also includes data from the local authorities, and the information on the structure of industrial waste management derived from questionnaires filled out by the participating industries (discussed in the following section).

Figure 4. The Phases of the SWM System in Mauritius



The collection of abandoned waste is included in the diagram among the activities performed by local authorities. Collection campaigns for bulky wastes (excluding electric and electronic waste) are organised once or twice per year by local authorities. Municipal waste from households is collected in a single bin. Bins are provided by the local authorities during periodical communication and information events. Local authorities collect municipal solid waste from households and commercial units and transport it to the 5 transfer stations.

It must be noted that obtaining a waste fraction of good quality (with homogeneity and cleanliness attributes) is the first step to set up an economically sustainable recycling industrial chain. As underlined in the 2017 IWA, the organisation of the collection of municipal waste by a single bin makes it impossible to segregate different fractions of waste from the undifferentiated waste. The lack of segregation at the source reduces the quality of the few waste fractions that get separated by hand by informal workers at transfer stations, because the potentially recyclable fractions get soiled and contaminated by the rest of the waste, in particular by food waste.

The Ministry of Environment, Solid Waste Management and Climate Change contracts the management of the transfer stations to private parties. Contractors have the obligation to reach a minimal percentage (2%) of waste sent to recycling. This task is carried out by a number of actors, working under informal conditions or as formal SMEs, depending on the waste fraction being recovered.

At transfer stations, where municipal and industrial solid wastes are mixed, waste gets labelled as “Mixed”. The Ministry of Environment, Solid Waste Management and Climate Change contracts private parties to transport “Mixed Waste” from the transfer stations to the Mare Chicose Landfill.

A private company manages the landfill and has not disclosed the terms of the contract established several years ago with the Central Electricity Board (CEB) for the sale of the electricity which is produced by burning the landfill gas. A compost plant with a capacity of 300 tonnes of waste daily, was set up by a private promoter, at La Chaumiere. However, it ceased operation in 2017.

5.2 ANALYSIS OF THE STRUCTURE OF THE COSTS FOR THE PUBLIC SECTOR

The results of the analysis of the data on costs acquired from the questionnaires filled out by the Ministry of Environment, Solid Waste Management and Climate Change and 6 local authorities are summarised in Table 4 below. Costs undertaken by the Government of Mauritius for the management of municipal and industrial waste are split according to the waste flow diagram described in Figure 4 above. The ‘Total’ cost is calculated for the total amount of waste (municipal and industrial) estimated to be **540,000 tonnes per year**. No cost was associated with the periodically distributed bins for families and commercial units.

The cost for the transport from transfer stations to the Mare Chicose Landfill is MUR/year 177 million. The Government pays for the management of the landfill by a private contractor at the total cost of MUR/year 284.5 million. The revenues to the service provider for the sale of electrical energy to the national grid were not disclosed, so this data could not be added to the overall budget.

The cost for the transport from transfer stations to the Mare Chicose Landfill is MUR/y 177 million. The Government pays for the management of the landfill by a private contractor at a the total cost of MUR/y 284.5 million. The revenues to the service provider for the sale of electrical energy to the national grid were not disclosed, so this data could not be added to the overall budget.

The reconstruction of the waste flow and the data made available for this study document indicated that a total of around MUR/year 1,656.6 million was incurred annually by the public sector for the management of all solid waste generated on the island of Mauritius.

The analysis shows that a majority of the cost (MUR/year 1,100 million) is undertaken by the local authorities: 66% of the total cost goes towards collection and transport to transfer stations.

The costs incurred by the Solid Waste Management Division (SWMD) are associated with the management of the 5 transfer stations (TS) and the transportation of waste from the TSs to the landfill at a total of MUR/year 272.1 million.

This structure of cost, with collection being the main expense, is typical for a simplified solid waste management system: in countries where the recovery plants for material or energy are lacking, the main cost is incurred by the collection and transportation to first destination sites.

5.3 COMMENTS ON THE RESULTS FOR THE COSTS OF SOLID WASTE MANAGEMENT (SWM) BY THE PUBLIC SECTOR

Table 4 shows that for SWM in Mauritius, the costs undertaken by the public sector are:

- MUR 3,294 per tonne of mixed waste
- MUR 1,309 per inhabitant - an equivalent of about 26 €/person.

The cost per person of a fully integrated SWM system in a European city can reach up to 200 €/person. Thus, the cost per person in Mauritius is representative of the simplified waste management situation currently in operation.

Table 5⁵ below shows an overview of international SWM costs for different waste management options as recorded by the World Bank for countries at different national income levels. The cost of 76 US\$/tonne, shown in Table 4, is lower than what was reported for an upper-middle income country such as Mauritius⁶ where the higher range is 65-100 US\$/tonne.

The difference could be due to the effect of the electrical energy recovery from the landfill which diminishes the cost for the management of the landfill or it could also be due to difficulties in accounting for all the costs incurred by the public sector.

⁵ Kaza, Silpa, Lisa Yao, Perinaz Bhada-Tata, and Frank Van Woerden. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development Series. Washington, DC: World Bank. doi:10.1596/978-1-4648-1329-0. License: Creative Commons Attribution CC BY 3.0 IGO
⁶ Actually, in 2020 the World bank classified Mauritius as a high income Country. <<https://data.worldbank.org/country/MU>>

Table 4. Cost of SWM for the Public Sector in Mauritius

Population	Total SW (Estimated municipal and industrial waste)	Cost for Collection and Transport to TSs by LA (Estimated only for municipal waste)	Management of 5 TSs for Mixed Waste*** by Ministry of Environment	Transport to Landfill of Mixed Waste by Ministry of Environment	Landfill Management for Mixed Waste by Private Service Provider	Revenues for Landfill Management from Electricity Sold to Grid	TOTAL
1,266,000	tonne/year (486,000 + 54,000) 540,000*	MUR/year 1,100,000,000**	MUR/year 95,100,000	MUR/year 177,000,000	MUR/year 284,500,000	MUR/year 284,500,000	MUR/year 1,656,600,000
	MUR/tonne	2,263	176	328	527		3,294
	US\$/tonne	52	4	7.5	12		76
	MUR/person						1,309
	Euro/person						26

* Of the 540,000 tonne/year: It is assumed that the 540,000 tonne/year of SW comprises 486,000 tonne/year municipal waste (90%) and 54,000 tonne/year industrial waste (10%).

**The cost of collection by LA was provided by SWMD of MoE

***Mixed Waste refers to municipal and industrial wastes.

(Exchange rate: 1\$ = MUR 43.5; 1 Euro = MUR 50)

Table 5. Typical Waste Management Costs by Disposal Type

	Low income Countries	Lower-middle income countries	Upper-middle income countries	High income countries	Mauritius
	US\$/tonne				
Collection and transfer	20-50	30-75	50-100	90-200	52
Controlled landfill to sanitary landfill	10-20	15-40	20-65	40-100	12
Open dumping	2-8	3-10	N/A	N/A	
Recycling	0-25	5-30	5-50	30-80	
Composting	5-30	10-40	20-75	35-90	

Source: World Bank Solid Waste Community of Practice and Climate and Clean Air Coalition (N/A: Not available)

With respect to the initial objectives, the analysis of the data collected for the public sector allowed the following conclusions:

- only an estimate of the overall cost of SWM for municipal waste was achieved:
 - the incidence of industrial waste on the total amount stored at transfer stations is not known, it was assumed to be 10%,
 - o the total cost for collection was provided by the SWM Division of Ministry of Environment, Solid Waste Management and Climate Change.
 - the revenues from the sale of electricity for the private company managing the landfill – which should be part of a full accounting budget – are not known;
- the analysis of the cost incurred by local authorities allows an estimate of a cost of:
 - MUR 2,263 / tonne (52 US\$/tonne) for the collection and transport of municipal waste to TSs,
 - MUR 3,294 / tonne (76 US\$/tonne) for the whole SWM system;
- Given that the total amount of industrial waste deposited at transfer stations is not known, it is not possible to extrapolate a precise cost associated with the management of industrial waste after they are deposited at transfer stations: a single estimate of cost per tonne is provided for the mixed waste;

- it is apparent that the **definition of the structure of the full cost for solid waste management** (which is one of the recommendations of the 2017 IWA) has **not yet been reached** by relevant authorities at the national level; and
- it is observed that in the urban areas, most of the manufacturing enterprises are entitled to pay an industrial tax rate of 26% to the Municipal Councils for services including waste disposal. The industrial tax rate is usually higher than the domestic and commercial rates.

5.3.1 Difficulties in Defining a Single Budget

The data to reconstruct the whole budget for the solid waste management in Mauritius by the public sector was not easily available as it required information from both local authorities regarding the collection and transportation costs as well as the Ministry of Environment, Solid Waste Management and Climate Change regarding the management of transfer stations and the following management phases.

Overall, the data are associated with a high uncertainty, and the recommendations issued in the previous 2017 IWA are still relevant.



6.

COST STRUCTURE OF INDUSTRIAL WASTE MANAGEMENT IN MANUFACTURING ENTERPRISES



As detailed in Table 1, 30 companies were able to participate in this study notwithstanding the operational and economic difficulties generated by the COVID-19 pandemic.

Table 6 below highlights the number and proportion of participating companies within the sub-sectors of the manufacturing sector.

The 22 companies which filled the questionnaire comprised:

- 18 Large Enterprises,
- 1 Mid-Market Enterprise (MME), and
- 3 Micro, Small, Medium Enterprises (MSMEs).

Additionally, the MoIDSC provided additional data from 8 companies consisting of:

- 4 Mid-Market Enterprises (MMEs), and
- 4 Micro, Small, Medium Enterprises (MSMEs).

The predominance of large companies can be the result of 2 factors:

1. Small companies had more difficulties in overcoming the obstacles created by the pandemic.
2. Companies are large in size given that they belong to the sectors that are most relevant to the Mauritian economy.

Even if the number of companies was reduced with respect to the initial forecast, the **sample of companies** providing data on the structure of the management of industrial waste and the range of costs estimated was **representative** of the current industrial waste management situation in Mauritius.

Many companies that answered the questionnaire have an internal environmental policy and perform waste management according to their respective environmental policy.

In general, the participating companies demonstrated attention to reducing their environmental impact and to performing sound solid waste management.

Table 6. Manufacturing Sector

Sub-Sectors	Number	%
Textile & wearing apparel	10 (7*)	33
Processed food & beverages	9 (9*)	30
Chemicals and chemical products	6 (3*)	20
Printing and reproduction of recorded media	4 (2*)	13
Construction materials	1*	3
Total	30	100

*Companies providing filled out questionnaires

6.1 STRUCTURE OF THE SWM ADOPTED BY INDUSTRIAL COMPANIES

In Mauritius, companies hold the responsibility for disposing of their waste without causing health or environmental harm; they also bear the obligation to respond to the Industrial Waste Audit where the amount and type of waste generated is recorded and reported to the Ministry of Environment, Solid Waste Management and Climate Change.

All the enterprises participating in this survey comply with these requirements but the current legislation does not require them to ensure the complete management of their waste nor, as this study demonstrates (and discusses further in the following sections) to pay for the full cost of the SWM service, as to be expected according to the Polluter Pays Principle.

This IWM-CSR shows that, with respect to the several phases of the overall solid waste management system currently operated in Mauritius (and described in the previous section), the management of industrial waste, described in Figure 5, only addresses the initial phases:

- storage (for large companies),
- collection, and
- transportation to a transfer station/landfill.

As reconstructed from the data in the questionnaires, the phases of SWM carried out by the different industrial sectors are depicted in Figure 5.

6.1.1 The Operations Undertaken by the Private Companies

The **operations describing the structure of the industrial waste management** were reconstructed from the data acquired by the questionnaires as follows (refer to Figure 5):

- A.** In the majority of cases, industrial waste of various types is non-hazardous and can be safely stored either within the premises, in small bins near the point of generation, or in larger containers such as skips (often provided by contractors) located in storage areas, covered or open air;
- B.** Waste is collected at regular intervals. For the majority of companies, this phase is carried out by an external service provider who then carries the waste to one of the 5 transfer stations operating on the island;
 - B.1.** Only one (1) large company carries its waste directly to the landfill;
- C.** For large companies where sufficient waste flows are generated a small quantity of waste may be transported to recycling facilities; and
- D.** Some waste, such as plastic bins and cartons, are reused on the premises or given/sold to employees.

Figure 5, which reproduces the SWM operations carried out by the manufacturing enterprises, makes it clear that the enterprises' current engagement ends with organising the transport of waste to either a transfer station or a recycling facility (only a single company carries its waste directly to the landfill).

In the current legislative framework, what happens to industrial waste after it has been transported to the first destination is not an enterprise's responsibility.

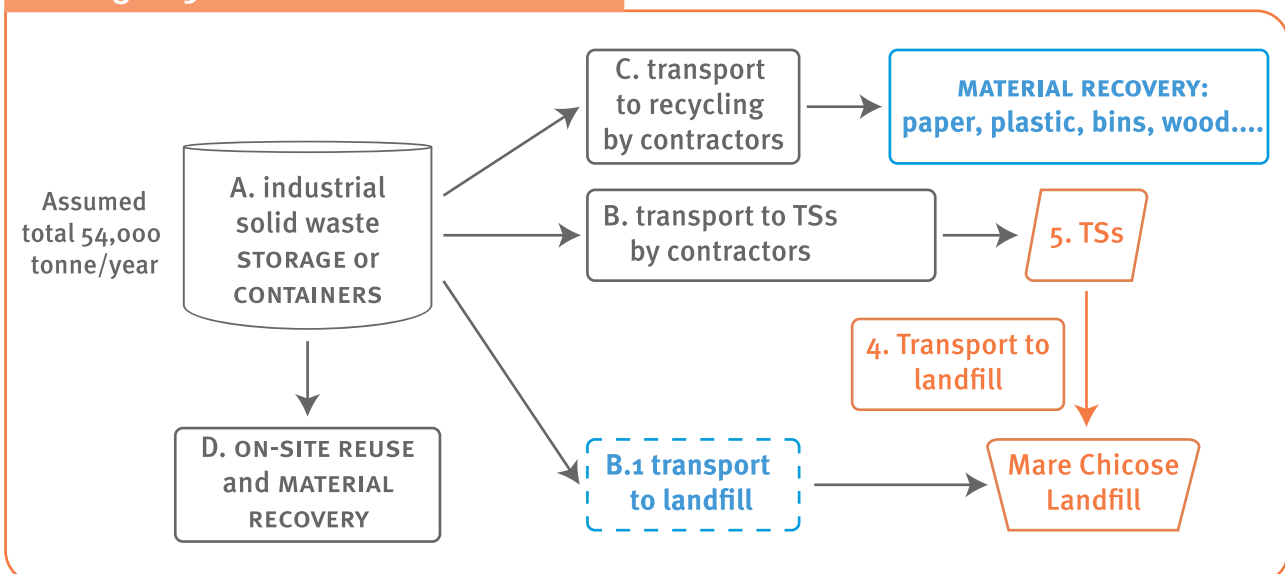
Given that manufacturing companies only perform collection and transportation to transfer stations, they only incur the costs associated with:

- storage on-site; and
- collection and transport to transfer stations.

It can be underlined that this approach (referring to the storage, collection and transportation) does not fulfil the criteria considered to be the pillars of safe and fair environmental management (i.e., responsible production and safe disposal), that can be summarised by:

- the Polluter Pays Principle; and
- the Extended Producer Responsibility principle.

Figure 5. Industrial Waste Flows



6.2 OUTCOMES OF QUESTIONNAIRES USED TO DETERMINE THE STRUCTURE OF SOLID WASTE MANAGEMENT (SWM) COSTS FOR THE PRIVATE SECTOR

As shown in the schematic reconstructed in Figure 5, to quantify the full cost of the industrial solid waste management, the questionnaire required companies to separate and detail two (2) types of costs:

- costs associated with the operations taking place within the production premises; and
- costs associated with the operations of SWM taking place outside the industrial premises.

6.2.1 Difficulties Encountered in Expressing the Cost for On-Site Operations: Storage and Waste Management on the Premises

In general, only large companies estimated costs for buying waste **containers**. Few companies indicated the cost associated to the time dedicated by their **personnel** to waste management on the premises. For the medium- and large-sized companies, calculating the cost of solid waste management within the premises proved difficult. In fact, only one large company provided reasonable estimates of the cost for **storage within** the premises.

The methods adopted for estimating the cost for storage – containers, personnel, maintenance - varied from company to company.

In particular:

- it could not be clearly ascertained how the cost for the personnel was calculated in some cases;
- no depreciation was considered for the lifetime of the containers or for the building of a storage area; and
- in one case, cost was calculated by square meter of the storage area occupied.

As a result, the costs per year associated with the bins/skips and with the storage operations cannot be correctly compared to the other annual costs.

6.2.2 Constraints Encountered in Expressing the Cost of the External SWM Phases: Collection and Transport to TSs or Recycling Facilities.

All companies participating in the survey, pay an external carrier to deliver the waste to the transfer stations or for recycling. Only one company has the main portion of its waste (the organic fraction) hauled directly to the landfill. In the questionnaire, the cost of transportation to transfer stations was always provided as a lump sum amount.

With respect to the possibility of enforcing the Polluter Pays Principle, it must be noted that **transport is paid to contractors 'per trip', and that only 2 companies provided the actual value for cost/trip.**

Only 3 companies provided data for the cost/revenues from the **recycling** of their industrial waste. Out of these 3 companies only one (1) seems to have provided a sum consistent with the expenses for collection and transportation; the other 2 companies provided an amount, which is judged to be too high to be considered realistic, with respect to the costs for collection and storage.

6.2.3 Constraints in Expressing the Total Cost of SWM

It needs to be observed that the results of the survey show a general difficulty for the enterprises in formulating a complete SWM budget and in providing a single total cost amount.

This difficulty is to be expected given the novelty of this project to which the companies agreed to take part in and positively contribute to.

This project is **innovative** not only for Mauritius but for medium-income countries in general, where the sector of SWM is often not fully regulated by the legislation and knowledge of the cost structure is not required.

In particular, it was observed (from Table 1.2 of the questionnaire as per Annex) that the total cost provided often did not correspond to the sum of costs associated with the individual operations specified in the following tables. In fact,

only 1 company correctly recorded the total cost resulting from the **sum of all the costs** incurred within the premises.

All other companies reported only the cost of transportation as the 'Total Cost' (even the companies that estimated the costs for containers, storage and collection did not add those costs in Table 1.2 to obtain a 'Total Cost'). It is observed that the **revenues from recycling were never considered** in calculating the 'Total Cost' of industrial waste management.

6.3 THE COST FOR 'GENERAL' INDUSTRIAL WASTE MANAGEMENT AS DERIVED FROM THE QUESTIONNAIRES

The waste listed by participating companies were highly heterogeneous in composition (different waste fractions were listed for the different industries) and often did not include industrial waste that could be associated with the specific sector.

This is a relevant difference with the 2017 IWA previously performed, where specific flows of waste were investigated. In fact, in the answers from the questionnaire, even surplus textile waste was included in 'general waste' and sent to landfill; probably indicating a difficulty in performing recycling activities due to a worsened recyclables market.

The classification by industries of the main quantity of waste as 'general waste' prevented the possibility of identifying costs attributable to the types of waste characteristic of each sector.

For the cases in which an amount of 'general waste' was listed in the questionnaire, the range of the cost per tonne for collection and transportation to transfer stations⁷ is:

MUR/tonne 480-940.

The company that has its industrial waste transported directly to the landfill allows for a cost estimate for the management of 'general waste' of around MUR/tonne 3,300; but this cost cannot be compared with the range given because it also includes the renting of the skips and of the personnel working on-site from the service provider.

⁷ Some of the questionnaires were incomplete and sometimes reported a cost for a type of waste without an indication of the amount.

It is pointed out that the cost is paid by companies **'per trip' and not 'per tonne of waste'**: this way of reporting does not allow for an effective analysis of the costs because **it does not associate the cost to the actual waste production.**

6.4 THE COST OF SWM WITH RESPECT TO THE TURNOVER

The Project Steering Committee was instrumental in providing⁸ the data regarding the turnover of each company participating in the survey, thus allowing to calculate the percentage of the SWM cost for industrial waste with respect to the individual turnover.

Given the constraints discussed in the previous sections, only the total cost of SWM (vs. the cost of each operation) as a percentage of turnover was calculated. The findings are listed below.

General Findings:

1. For individual companies, the range of the incidence (given as a percentage) of the cost for the management of 'general waste' (storage and transport to transfer stations) ranged in the interval **0.012 % to 0.70 %** of the turnover.
2. When the incidence of cost over turnover was grouped per manufacturing sector and per size of enterprise (as shown in Table 7 below) the range narrows from **0.06% to 0.32%**, with an outlier small company registering 1.71%.
3. It can be observed that the cost for the management of 'general waste' is very small compared to turnover.

(This study only addresses solid waste management. However, the cost of disposing wastewater, which is significant for many industrial sites, was not considered.)

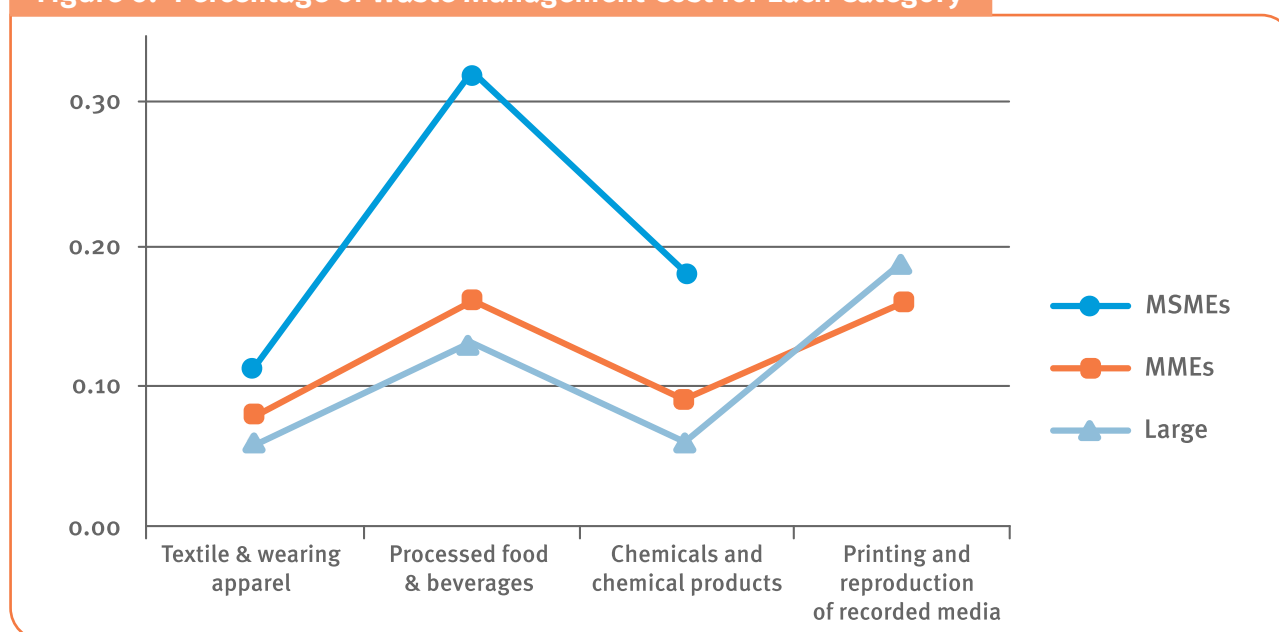
Figure 6 shows the average percentage of waste management cost per industry sector and size (to facilitate visualisation of differences, the graph does not include the outlier value of 1.71%).

⁸ Under the clause of confidentiality.

Table 7. Percentage of IWM Cost Over Turnover in Manufacturing Enterprises

Sub-Sectors	Average % Of Waste Management Cost		
	MSMEs	MMEs	Large
Textile & wearing apparel	0.11	0.08	0.06
Processed food & beverages	0.32	0.16	0.13
Chemicals and chemical products	0.18	0.09	0.06
Printing and reproduction of recorded media	1.71	0.16	0.19
Construction materials			0.04

Figure 6. Percentage of Waste Management Cost for Each Category



It is observed that large enterprises and MMEs show essentially the same incidence of the 'general industrial waste' management cost over turnover, while MSMEs show a slight increase.

The higher incidence for MSMEs could be real or it could be an effect of the non-homogeneous treatment of cost data for the questionnaires for which the detailed analysis of cost could not be performed (7 companies over 30).

Sectoral Findings:

Textile & wearing apparel

1. As indicated in Table 7, the cost of managing solid waste in the 'Textile and wearing apparel' sub-sector varies between 0.06% and 0.11 %.

2. For large enterprises, it stands at 0.06%; while for the MMEs, the cost increases to 0.08% and further rises to 0.11% in the case of MSMEs.

Processed food & beverages

1. The cost of managing solid waste by enterprises in the 'Processed food & beverages' sub-sector varies between 0.13% and 0.32% in the categories of large to MSMEs.
2. The cost in the 'Processed food & beverages' sub-sector stands slightly higher than the 'Textile and wearing apparel' sub-sector, but this difference may not be statistically significant given the constrained number of questionnaires collected.

Chemicals and chemical products

1. For enterprises in the 'Chemicals and chemical products' sub-sector, the cost of managing solid waste is 0.06% for large enterprises, 0.09% for MMEs and 0.18% for MSMEs.

Printing and reproduction of recorded media

1. The cost of managing solid waste by enterprises in the 'Printing and reproduction of recorded media' sub-sector ranges from 0.19% for large enterprises, 0.16% for MMEs and 1.71% for MSMEs.

6.4.1 An International Comparison

To provide a term of comparison, an international case study was obtained for an electro-mechanical company (medium-sized) in Italy.

The following table summarises the data obtained⁹.

General Waste	Industrial Waste	National Industrial Waste Tax
0.01%	0.03%	0.09%

It can be seen that the cost for the collection of the 'general waste' by a service provider is 0.01%: it compares well with the percentage calculated for the category 'General waste' for the industries in Mauritius. The value increases to 0.03% for the management of 'Industrial waste' of a type more specific to the production. The percentage of the cost over turnover increases significantly only when the 'National Waste Tax' is included (paid to the local authority), reaching 0.09% of turnover. The overall cost over turnover is thus 0.13%, however, it should be noted that this cost does not include the cost that could be allocated to the personnel handling the waste and dealing with the service provider. Furthermore, the sales of metal scraps, such as iron, aluminium, copper and bronze, that result in a revenue for the company, were not provided.

⁹ S. Tunesi data collected in the form of a personal communication.

6.5 THE COST FOR INDUSTRIAL WASTE MANAGEMENT IS MOSTLY UNDERTAKEN BY THE PUBLIC SECTOR

When the range of the costs per tonne paid by the companies for 'general waste' collection and transport to transfer stations - **MUR/tonne 480–940** – is compared to the collection and transport cost per tonne paid by local authorities - **MUR/tonne 2,263** – it is observed that collection cost per tonne for industrial waste paid by the private sector is lower.

In fact, local authority vehicles must haul municipal waste for longer distances at a much slower speed before getting completely filled with household waste before carrying the load to a transfer station.

Moreover, by looking at the schematic diagram in Figure 4, illustrating the overall SWM system operating in Mauritius, it is clear that the industries are not engaged in what happens to their waste once it is disposed of at the transfer stations.

This means that the public sector is undertaking the costs associated with:

1. the transport of mixed waste (municipal & industrial) to the landfill: MUR/tonne 328;
2. the landfill management: MUR/tonne 527;
3. the management of 5 transfer stations for mixed waste streams by the Ministry of Environment, Solid Waste Management and Climate Change: MUR/tonne 176.

The total cost of **MUR/tonne 1,031** is estimated to be the **hidden cost** the public sector sustains to manage industrial waste.

The total cost for the management of IW, when all the SWM phases undertaken by the public sector are considered, is in the range MUR/tonne 1,511 – 1,971 (given by the sum of all phases listed in Table 4: *Lower range* MUR/tonne 480 + 328 + 527 + 176 = 1,511; and *Upper range* MUR/tonne 940 + 328 + 527 + 176 = 1,971).

Another relevant question resulting from the 2017 IWA related to the payment of a municipal tax by the companies for industrial waste management. The companies that responded to the questionnaire indicated that they do not pay a municipal fee but they pay a licence (trade) fee to the local authorities.

This again demonstrates that all solid waste management costs after the transportation of industrial wastes to transfer stations are undertaken by the public sector.

6.6 THERE IS A NEED TO ACCOUNT FOR THE FULL COST OF WASTE MANAGEMENT

This study has the objectives of:

1. defining the cost structure of the management of industrial waste;
2. assessing the feasibility of expressing the costs undertaken by the different industrial sectors;
3. assessing the relevance of SWM costs on the overall turnover of the companies; and
4. estimating the hidden costs of industrial waste management paid by the public sector.

This report can highlight the following outcomes:

- The first objective was achieved and the structure of the costs for industrial waste management is summarised in Figure 5.
- The second objective was achieved by estimating the cost for the storage of 'general waste' and transportation to transfer stations to be MUR/tonne 480 – 940. It needs to be underlined that this objective could be reached only partially because the way the questionnaires were filled in shows that the majority of companies (except one) were not used to considering costs for industrial waste management in a specific budget.
- For companies of all sizes, it was found that the cost of waste management was in general, significantly lower than 0.2% of the annual turnover except for one company where it was 1.71%.

- The total cost for the management of IW, when all the SWM phases undertaken by the public sector are considered, is in the range MUR/tonne 1,511 – 1,971. (Given by the sum of all phases listed in Table 4: Lower range MUR/tonne $480 + 328 + 527 + 176 = 1,511$; and Upper range MUR/tonne $940 + 328 + 527 + 176 = 1,971$).
- The hidden cost is estimated at MUR/tonne 1,031. (The sum of costs associated with transport of mixed waste [MUR/tonne 328], landfill management [MUR/tonne 527] and management of transfer stations [MUR/tonne 176]).

It must be stated that the lack of clarity on how to calculate a budget specific to industrial solid waste management is not related to the capability of companies to fulfil the obligations of a safe management of waste: all companies properly collect and dispose of their waste. A relevant difficulty encountered by this study in estimating the cost of industrial waste management was given, as previously highlighted, by the fact that the cost of transportation to transfer stations by service providers is paid by the trip and not by the tonne. From the analysis of the data provided, this study was only able to estimate a cost for the transport of the so-called 'general waste' at MUR/tonne 480 - 940.

The overall outcome of the survey showed that it was not clear to the participating companies that the total cost of dealing with their waste had to be calculated as the sum of all activities they perform within and outside their premises:

- Cost of storage;
- Cost of collection;
- Cost of transport; and
- Revenues from recycling.

To support the expression of the full cost accounting the questionnaire specified - under Table 1.2 – that "The total is given by the sums of the cost detailed in sections 2 and 3" of the questionnaire.

Another accounting aspect needs to be underlined: Even if the questionnaire (provided in the Annex) supporting the detailed expression for the calculation of the cost of storage, when the cost incurred by each company for collection containers, storage area and personnel were provided, it was not clear how the cost was allocated to the

specific operation of waste management. For instance, the cost was provided as a bulk sum and was not allocated by year using a depreciation/amortization calculation; also, the method used to allocate a certain amount of time for the personnel dedicated to the collection task was not explained in detail.

As a further outcome of this project, the methodology adopted for reconstructing the waste flows and to collect data provides a method that could be used in the future by both the private companies and the public sector to:

- expand the analysis of the SWM operations carried out to other companies or sectors;
- improve the understanding of the cost undertaken for each operation and SWM phase;
- formulate a complete SWM budget; and
- overcome the hidden costs currently incurred by the public sector.



7.

REQUIREMENTS AND LIMITATIONS FOR SETTING EPR SCHEMES FOR SELECTED WASTES IN MAURITIUS



In the context of the study concerning the cost structure for the management of industrial waste, a reflection on the possibility of establishing EPR schemes for selected waste types can be useful.

Internationally, over 400 Extended Producer Responsibility (EPR) schemes have been established by different governments since the late 1980s and with strong impulse since 2001, with the aim of making producers responsible (*both from organisational and financial perspectives*) for the environmental impacts of their products along the whole product chain, from design to the post-consumer stage.

EPR systems provide a dedicated stable financial source to improve the collection, sorting and recycling infrastructure for the selected waste types. In general the EPR costs are incorporated into the final product's cost.

Several choices need to be made when setting the regulatory framework for the implementation of EPR schemes^{10, 11} (Table 9).

¹⁰ OECD "Extended producer responsibility – policy highlights – Guidance for efficient waste management". 2016.

¹¹ WWF – 2020 "How to implement EPR – A briefing for government and businesses".

Table 9. Choices of EPR Schemes

Actors involved	<ul style="list-style-type: none"> • Producers and importers (should be registered); • Distributors; • Retailers • WM operators (may receive funds from PRO to run dedicated recovery facilities); • Local authorities: responsible for collection from households and business premises; • Informal workers currently engaged in recycling activities; • Citizens: their behaviour is essential in returning segregated streams of waste in the collection bins provided or at dedicated centers.
The national regulation must involve and give specific responsibilities to	
Voluntary or mandatory	Most schemes adopted internationally are mandatory , rather than voluntary.
Types of waste covered by EPR	Small consumer electronic equipment (WEEE) account for more than 35% of EPR schemes established, followed by packaging (17%), tyres (17%), end-of-life vehicles, lead-acid batteries, and other products.
The numerical targets for each type of waste recovery and timeline	<p>The regulatory framework must outline the:</p> <ul style="list-style-type: none"> • objectives for the materials and/or energy recovery from waste; • responsibilities of each actor in reaching the targets; • enforcement mechanisms, and • a timeline for implementation.
Method of waste recuperation	<p>Various forms of take-back requirements are the most commonly used instrument, accounting for nearly three-quarters of the schemes implemented.</p> <p>It must be underlined that take-back schemes require the organisation of the segregated collection for each of the wastes targeted. The segregated collection could also be the result of the drop-off by the final users in collection centers (this is usually the option for larger waste types).</p> <p>Another widely used method is to issue advance disposal fees and deposit/refund mechanisms.</p>
Architecture of the scheme	<p>In most cases, producers have established collective EPR systems managed by specifically formed Producer Responsibility Organizations (PROs). PROs manage the EPR fees, engage obliged companies, and issue contracts with WM operators and municipalities.</p> <p>PROs can be operated by the producers themselves, by third party contractors, by a hand-over to the government or a mix.</p> <p>EPR fees are collected and managed by PROs.</p> <p>In Europe, the EPR architecture of the scheme adopted can be a mix, allowing for individual EPR systems to coexist with collective systems.</p>
Fees to be paid by involved actors	<p>Involved companies pay an EPR fee on the basis of the type and amount of waste they put on the market.</p> <p>The contribution paid by each producer and importer and the contribution given to interested local authorities for each type of waste must be defined by transparent accords.</p> <p>The collected fee can cover all or just a part of the cost for collecting, sorting, recovery and awareness-raising campaigns.</p>
Data registers	An EPR system requires transparent registers and data management systems for obliged companies and approved waste management operators.

Assessing the impacts of EPR systems is difficult due to a considerable lack of data, analytical difficulties in distinguishing the impact of EPR from other factors, and the wide variety of EPR systems. Notwithstanding, there is evidence that in some countries, EPRs have helped to shift some of the financial burden for waste management from municipalities and taxpayers to producers, and to reduce the public costs of waste management.

It is important to note that “on the other hand, the consensus appears to be that while EPR systems have contributed to waste prevention (e.g. eco-design) in some countries and some sectors, they are seldom sufficient to serve as the triggering factor”. This observation is particularly relevant for a country like Mauritius where the legislation concerning SWM does not establish targets for recovery of materials and energy from waste.

Moreover, the functioning of EPR schemes is, to a certain extent, reliant on the available waste management infrastructure as the latter determines end-of-life treatment. On the one hand, EPR can provide financial support for developing and improving waste management infrastructure, especially the recycling industry. However, an absence of suitable infrastructure or technology for waste collection, sorting and recycling may result in EPR schemes proving ineffective in delivering their objectives¹².

It is necessary to notice that in Mauritius, at the initial stage of waste collection, the segregation of different fractions of waste is not adequately organised. Thus, the establishment of an effective waste collection system (including modern infrastructure) would have to be undertaken from scratch by any interested party, willing to undertake the full cost of this activity.

A close partnership between local authorities and the industry-owned EPR organization, based on mutual trust, is a necessary condition for the success as well as the economic and environmental sustainability of the EPR scheme. Local authorities and the EPR organization have to agree on the most appropriate collection system, taking into account local particularities and complying with both national and European requirements¹³.

¹² OECD. 2018. “Policy Approaches to Incentivise Sustainable Plastic Design”. <www.oecd.org/environment/waste/background-paper-policy-approaches-to-incentivise-sustainable-plastic-design.pdf>

¹³ EXPRA 2016 “Extended Producer Responsibility at a glance”.

The outcome of this study on the structure of costs for industrial waste management highlights the difficulties in establishing an EPR scheme associated with the current Mauritius SWM system; in fact, the **overall structure of the SWM system in operation and its costs are not fully known and are not properly organised in a separate budget.**

Similarly, the involvement of local authorities in an EPR financial distribution scheme could be difficult given that the costs they undertake for collection and transport **were not readily available** to the Ministry of Environment, Solid Waste Management and Climate Change.

These organisational, administrative and financial conditions indicate the relevance for Mauritius to concentrate on establishing of a fully developed framework legislation for SWM management. This would support the development of an effective SWM National Strategy, before engaging in issuing regulatory acts for EPR schemes which would result in un-coordinated pieces of legislation.

7.1 BEST PRACTICES

7.1.1 Voluntary Commitments

Industries are increasingly introducing voluntary actions, with the objective of minimizing the environmental impacts of their products and services. While not as powerful as mandatory measures, voluntary commitments can also trigger significant changes across the value chain (see Table 10).

7.1.2 Fee Levels

CITEO is the collective EPR scheme for household packaging waste in France.

CONAI is the Italian scheme covering both household and commercial/industrial packaging.

They are amongst the more advanced schemes with regards to fee modulation; their approaches are described below (see Table 11).

Table 10. Voluntary Actions¹²

Company	Commitments
IKEA	All plastics used in IKEA Products are 100% renewable and/or recycled by august 2020
Lego	Only use sustainable materials in Lego products by 2030
Unilever	All plastic packaging designed to be reusable, recyclable or compostable by 2025
McDonalds	Source 100% of packaging from renewable, recycled or certified sources by 2025
Nestle & Danone	Develop a 100% bio-based plastic bottle

Table 11. Example of EPR in France and Italy¹²

	CITEO	Consorzio Nazionale Imballaggi (CONAI)
Basic fee modulation	<p>Based on weight and type of packaging material: Plastic, glass, paper/cardboard, steel, aluminium, cartons, and other materials. +fee based on number of packaging units</p>	<p>Based on weight and type of packaging material: Plastic, glass, paper/cardboard, steel, aluminium, wood, and glass</p>
Eco-modulation	<p>Bonus/malus system for all packaging: Total fee = (weight fee + units fee) x bonus/malus</p> <p>Bonus: fee can be reduced by between 4% and 24%; and 50% for PE packaging with at least 50% recycled material content</p> <p>Malus: fee can be increased by between 10% and 100%</p>	<p>Differentiated fees for plastic packaging:</p> <p>A. Sortable/recyclable commercial/industrial: €150/tonne</p> <p>B1. Household, with established sorting/recycling infrastructure: €208/t</p> <p>B2. Other sortable/recyclable: €263/tonne</p> <p>C. Non-sortable/recyclable: €369/tonne</p>

7.1.3 The Recent Viet Nam Case Study

As a comparison with an emerging economy, the analysis of the Viet Nam SWM situations suggested the following choices¹⁴:

- Mandatory EPR scheme
- EPR scheme for all consumer packaging materials and specified non-packaging plastic items
- Joint management of government and industry-led PROs
- Modulates fees
- Mandatory segregated waste collection
- Focus on setting up the infrastructure
- Recycling standards and funds for WM operators
- Green public procurement
- Informal sectors inclusion
- Register for producers and importers
- Register waste management operators
- Regular and enforced monitoring and inspections
- Reporting scheme

¹⁴ WWF February 2021 “EXECUTIVE POLICY BRIEF ASSESSMENT OF EPR FOR PLASTIC PACKAGING WASTE IN VIET NAM”.

7.2 DIFFERENT EPR MODELS IN THE WORLD

Below are a few examples of the models adopted in Europe.

PROs in hands of obliged industry (Belgium, Czech Republic, Ireland, Italy, France, Netherlands, Norway, Portugal, Spain): Obligated industry creates one common non-profit entity that collects the necessary funding, cooperates with local authorities and ensures recycling in the most cost-efficient and environmental way.

Dual model (Austria, Germany, Sweden): Industry has full operational and financial responsibility for collection, sorting and recycling. There is a separate collection system designated to local authorities, but their influence is minimal.

Shared model (France, Spain, Belgium, Netherlands, Italy, Czech Republic, Slovenia): the responsibility is shared between industry and the local authorities based on common agreements regarding collection. Municipalities are responsible for collection, and often for the sorting of packaging waste, arising on the municipal level, while industry’s financial responsibility differs from country to country.

Tradable Credits Model (UK, partly Poland): there is neither a link between industry and municipalities nor differentiation between commercial and packaging arising at the municipal level.

Vertical integrated systems (Germany, Poland, Slovenia, Romania, Bulgaria): Several, usually profit-oriented entities compete to attract obliged companies.

Sharing the collection infrastructure (Germany and recently introduced in Italy): Inhabitants have access to a common container and the collected packaging waste is split between the various PROs prior to being sorted..

PROs only responsible for packaging arising at the municipal level (Belgium, Germany, France, Spain), for commercial packaging (Belgium), or for integrated packaging waste streams (Netherlands, Italy, Czech Republic).

7.3 RECOMMENDATIONS IN THE CONTEXT OF THE REPUBLIC OF MAURITIUS

In relation to the several choices that need to be made when setting the regulatory framework for the implementation of EPR schemes, some observations could be made for the Mauritian context and are summarised in the following table.

- It is to be noted that these recommendations are complementary to the latest developments with regards to EPR at the level of the Ministry of Environment, Solid Waste Management and Climate Change.

Table 12. EPR in the Mauritian Context

<p>Actors the national regulation must involve and give specific responsibilities to</p>	<p>The following actors must be considered and a full database of their presence in the country must be made before considering establishing an EPR scheme:</p> <ul style="list-style-type: none"> • Producers and importers: all affected producers/importers should be registered • Distributors • Retailers • Exporters <p>Exporters could be relevant to the Mauritian context, given the lack of a domestic industrial chain for the recovery of materials, therefore export could be the destination of the waste collected by the EPR scheme.</p> <p>All participants must be registered upon verification of their requisites.</p>
<p>Voluntary or mandatory</p>	<p>It is suggested that EPR schemes be made mandatory by legislation.</p>
<p>Types of waste covered by EPR</p>	<p>Given that at present, in Mauritius, recycling activities are minimal and that segregated collection of household waste is not organised, the choice of which types of waste to make the object of an EPR scheme depends directly on the National SWM Strategy.</p> <p>The strategy has probably already indicated which types of waste are a priority for the setting up of segregated collection schemes.</p>
<p>The numerical targets for each type of waste recovery and timeline</p>	<p>Targets should be defined nationally, considering the current reality of very minimal recycling activities.</p> <p>It is extremely difficult to set up collection schemes by private operators, as required by EPR, when the industrial chain for the recovery of material is not present in a country.</p>
<p>Method of waste recuperation</p>	<p>National take-back schemes or advance disposal fees and deposit/refund mechanisms could be organised for specific packaging (such as glass bottles) from local producers.</p> <p>Collection centers for larger waste types could be set up to make citizens aware of the possibility of recycling large waste and educating them on future EPR schemes.</p>
<p>Architecture of the scheme</p>	<p>This is the most difficult element to set up in an EPR scheme.</p> <p>Given the need to reach a large level of organisation and technical expertise, it could be suggested that Mauritius' producers establish collective EPR systems managed by specifically formed PROs. Or the scheme adopted could be a mix, allowing for individual EPR systems to coexist with collective systems.</p> <p>The form of the PROs operations must be decided by the Government after consultation with the relevant participants.</p>
<p>Fees to be paid by involved actors</p>	<p>The decision on the level of the fees to be paid by the responsible participants (see choice of actors-producer, importer, retailer, ...) is extremely relevant. In the initial stage, the Government needs to intervene to monitor the cost of the PROs and regulate the fees.</p> <p>Also relevant is the decision on the amount of the fees that are assigned to local authorities for their contribution to the segregated collection of the selected waste types.</p> <p>In Mauritius, at present, local authorities are not involved in the segregated collection of waste, thus it is difficult to ascertain their specific roles.</p>
<p>Data registers</p>	<p>For an EPR scheme to be assessed the whole system must be periodically monitored and a detailed set of data needs to be collected and made available to the public.</p>

8.

RECOMMENDATIONS



8.1 RECOMMENDATIONS TO PRIVATE SECTOR AND RECYCLERS

8.1.1 Improve Data Collection and Describe in Detail the SW Disposal Operations Undertaken within the Premises

This study demonstrates the need to improve the capability of individual enterprises to understand the structure of SWM costs as well as to record and calculate its full cost.

It is suggested that the Mauritius Chamber of Commerce and Industry / Business Mauritius could provide local enterprises with a single homogenous method to:

- describe the waste management operations carried out within the premises; and
- calculate the total costs undertaken by an individual industry for waste disposal.

The flow analysis used in the survey and in the analysis of data provides a tool that could be used in the future by the private companies to:

- describe the operations carried out internally; and
 - associate a cost to each operation.
- The large companies produce more waste and thus present a larger range of operations they perform for waste management: **their experience could be the starting point** for setting a protocol for the calculation of the detailed costs.
 - It is recommended that waste types need to be clearly distinguished and quantified.

8.1.2 Express the Unit of Waste Generated in Cost Per Tonne

Highlighted in the analysis of the data collected from the questionnaires, the cost was often expressed as a bulk number (*the main example being the cost of transport by trip to the transfer stations*). It is thus recommended that companies express the costs of each operation as a total sum as well as per tonne of waste.

Any type of impact - environmental, social and financial cost for the public sector - is associated with the amount of the waste generated (tonnes): therefore, any cost analysis should be connected

to the amount of waste managed, thus requiring the expression of cost by the tonne.

Expressing the cost per tonne also aligns the cost expression with the Polluter Pays Principle, because it connects the cost to the amount of waste generated and managed.

The expression of the cost per tonne also allows the comparison of different management alternatives and it allows to underline if some types of waste are more expensive to manage than others.

8.1.3 Assess the Feasibility of Using the Structure of Cost Provided in This Study

The structure of industrial cost management provided by this study (Figure 5) shows the main operations undertaken by each company in performing sound waste management.

These two tools – structure of cost and data collection by questionnaire - could be a first step for the industrial sector to build a procedure for the correct and complete recording and calculation of costs.

The example from Annex 1 for the calculation of the cost of storage is as per Table 13.

8.1.4 Private Enterprise Should be Sensitised on the Complete Structure of the Costs Undertaken by the Public Sector for the Management of their Industrial Waste

The complete structure of the SWM system run by the public sector in Mauritius is described in Figure 4 that shows where the industrial waste merges with municipal waste.

When all the SWM phases undertaken by the public sector, as described in Figure 4, are considered, the total cost for the management of industrial waste ranges from MUR/tonne 1,511 to 1,971.

This analysis has shown that a cost of MUR/tonne 1,031 is mostly undertaken by the public sector and the remaining cost is provided for by the private sector.

Private enterprises should be encouraged to alleviate the burden of hidden costs (MUR/tonne 1,031) on the public sector.

Table 13. Sample Record Form; for Waste Storage Cost Calculation

		Waste Type	
General Information	Description of container type		
	Number of containers per type		
	Longevity (years)		
	Description of storage area		
Costs (MUR)	Capital	Initial cost	
		Yearly amortization	
		Dedicated building initial cost	
		Dedicated building amortization	
		Other (equipment)	
		Subtotal	
	Operation and maintenance	Cleaning (water, detergent)/year	
		Maintenance (repair, materials)/year	
		Personnel/year	
		Other	
		Subtotal	
	Overhead	Allocated administrative cost	
		Other	
		Subtotal	
		Total	

8.1.5 Recycling Companies or Recycling Activities Need to Be Monitored and the Critical Elements Highlighted

To support the efforts industries are undertaking to move towards a circular economy, it is important that the overall data on the amount of waste being reused and recycled is collected and recorded by an industrial solid waste management system.

The relevance of reducing waste generation is stressed, given that it currently costs over MUR/tonne 1,000 the Solid Waste Management Division, of the Ministry of Environment, Solid Waste Management and Climate Change, to manage waste in the country. The feasibility of issuing incentives to industries and/or recycling companies when they are diverting waste from the land-fill could be assessed.

Moreover, incentives to undertake recycling activities could be provided to local companies.

8.2 RECOMMENDATIONS TO POLICYMAKERS

8.2.1 Organise SWM System Data Under the Responsibility of the Public Sector

The method presented here – the complete Waste Flow Analysis - could be assessed by the Ministry of Environment, Solid Waste Management and Climate Change for its usefulness in providing a description of the SWM system currently performed by the public sector.

It is suggested that the SWM system description integrates in a single system the activities carried out by the local authorities and those under the responsibility of the Ministry of Environment, Solid Waste Management and Climate Change.

The methodology adopted in this study, the Waste Flow Analysis, could serve as a basis to:

- describe the current SWM system in much more detail than the one adopted here: providing details on all the operations carried out and the equipment and facilities being used so that the environmental impacts could be calculated (for example by Life Cycle Assessment) and all costs could be defined in detail;
- define what data require a further effort of gathering and organisation; and
- quantify in detail waste types from different sources - household; service, industry, agriculture so as to support the periodical updating of the National SWM Strategy.

8.2.2 Keep a Full Cost Budget to Allow for the Selection of Investments and the Evolution of the Current SWM System

The detailed and complete description of the structure of the SWM system is the prerequisite to be able to keep and update a full cost budget for the public sector. This is the essential basis to assess what specific projects could be financed for the evolution of the current SWM system and to motivate the request of international and national investment.

The tools provided in this study could also be used by the public sector to:

- deepen the analysis of SWM costs so as to associate a precise cost to each phase of SWM; and
- formulate a complete budget for SWM.

All the data on the amount of the waste collected, on the operation and activities conducted for its management and on their costs could be made publicly available on a dedicated webpage.

The knowledge of the current and full cost of SWM, of its critical elements and the formulation of scenarios for the evolution of the system are also necessary to encourage enterprises to contribute to the overall solid waste management sector budget.

Table 14 provides an example of how to organise the SWM budget of the public sector.¹⁵

8.2.3 Review the Overall Mechanism for the Cost of Management of Industrial Solid Waste to Encourage Sustainable Development

This preliminary analysis has proved that a consistent portion of the cost of the management of industrial waste – over MUR/tonne 1,000 - is undertaken by the public sector, this compares with the estimate of MUR/tonne 480 – 940 incurred by the private companies for the collection and transportation of waste to transfer stations.

Defining the structure of cost for SWM by the public sector and identifying the operations performed in favour of the industrial waste management would allow an estimation of the extra costs incurred and encourage private operators to assume a judicious management of their solid wastes in the long term. Such an exercise should be done by taking into consideration all other relevant direct and indirect cost burdens imposed on operators.

Stakeholders should be encouraged to give more consideration to this cost aspect.

If the hidden cost of SWM undertaken by public finances could be reduced, funds could be directed to innovative projects benefitting the overall SWM system: for instance, by introducing the segregated collection of the organic fraction of municipal waste and managing it by anaerobic digestion, thus generating energy.

8.2.4 Support the Industrial Sectors by Providing a Method to Keep the SWM Budget

Once the structure of SWM cost is defined for the activities carried out by the public sector, an analogous method could be provided to homogenise the expression of cost across sectors. This method should be developed in collaboration with the industrial sector representatives.

8.2.5 Building a Database from the Industrial Waste Audit

The analysis presented in this study shows that it is particularly important to quantify the amounts and types of industrial waste generated: for reasons concerning both environmental protection and cost covering.

Given that there is an Industrial Waste Audit Regulation, where industries report on their waste, it is strongly recommended to build a database to determine the amount of industrial waste generated. It is recommended that the MoIDSC be co-opted as a member in the Industrial Waste Audit Committee at the Ministry of Environment, Solid Waste Management and Climate Change on an ad-hoc basis as and when required, to develop a synergy in the sharing of data and information on industrial waste.

8.2.6 Perform Training on the Method of SWM Full Cost Accounting

This study on the structure of the costs for industrial solid waste management once more underlines the need to make SWM a central issue of the public policy agenda in Mauritius.

The accounting expertise in both the public and private sectors has to be aligned with the specific requirements of SWM.

This study thus recommends that a dedicated training programme be implemented for Governmental and local authority officials on the method of SWM Full Cost Accounting and on the most effective planning approaches that can be adopted to design and finance a more effective system.

¹⁵ See Annex 3

Table 14. How to Organise SWM Cost for a Single Budget

SWM Phase	Example of Technical Elements	Operating Expenses (OPEX)	Capital Expenditures (CAPEX) and Investment Costs
Collection of household, commercial and business waste (municipal waste)	<ul style="list-style-type: none"> • bins used • costs for buying new bins to organise the segregated collection of a selected waste fraction 		
Transport to TSs	<ul style="list-style-type: none"> • vehicles: types, age, lifetimes, fuel consumptions, maintenance • distance covered for collection and transportation to TSs 		
Operation of TSs	<ul style="list-style-type: none"> • maintenance 		
Transport of mixed waste to landfill	<ul style="list-style-type: none"> • vehicles: types, age, lifetimes, fuel consumptions, maintenance • distance covered 		
Management of landfill and energy recovery	<ul style="list-style-type: none"> • landfill technical characteristics: lining, cover, biogas recovery 		
Investment for introducing the segregated collection of the organic fraction	<ul style="list-style-type: none"> • types of bins • change in collection organisation • markets for compost • markets for recyclables 		
Investment for an anaerobic digestion plant to treat organic waste from the segregated collection of municipal waste with industrial or agricultural waste	<ul style="list-style-type: none"> • annual capacity • technology chosen • markets for digestates • energy recovery and feed-in tariffs 		

COST STRUCTURE OF INDUSTRIAL WASTE MANAGEMENT

Questionnaire for companies

General information

Name of company:

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Company department responsible for industrial waste management:

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Contact person (name, role, phone, email):

Location (latitude, longitude) of the activity (please also provide in a separate file):

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Sector and sub-sector of activity:

Textile Printing

Food Others

Chemical

Number of employees: Male: Female:

Company size (small, medium, large)

ISO certification if any: Detail:

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Other certifications if any: Detail:

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Waste minimization policy if any (please describe):

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Section 1. Summary of Industrial Solid Waste Generation and Cost

Table 1.1. Industrial Solid Waste Generation (*add lines as needed*)

Main industrial processes	Main products (kg/year)	Main materials and energy used as input (kg/year)	Main industrial waste generated (kg/year)
Describe (A)	Describe types and relevant characteristics (B)	Describe (C)	Describe main composition and if waste is hazardous (D)

Comments/recommendations:

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Table 1.2. Total Cost for Industrial Waste Management (*add lines as needed*)

Industrial waste (as in 1.1. D) (A)	Main products (kg/year)	Total cost of waste management (MUR/year)* (B)	Cost of waste related municipal tax if any (MUR/year) (C)	Cost of industrial license if any (MUR/year) (D)
Type (A1)	Amount generated (kg/year) (A2)			

*The total is given by the sums of the cost detailed in sections 2 and 3

Describe method for compiling industrial waste management cost:

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Comments/recommendations:

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Section 2. Detail on Costs for Industrial Solid Waste Management

Table 2.1. Storage (*Annex 1 gives an example of detailed method for cost calculation*)

Cost item (A)	Cost (MUR/year) (B)	Comments (C)
Containers		
Personnel		
Maintenance of container		
Amortization of initial cost		
Other		

Total cost for storage of industrial waste (MUR/year):

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Comments/recommendations:

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Table 2.2. Transport to Transfer Station (add lines as needed)

Industrial waste (as in Table 1.1. D) (A)		Type of transport arrangement and transport cost* (B)								
		Private contractor (B1)			Local authority (B2)			Own vehicle (B3)		
Type (A1)	Amount generated (kg/year) (A2)	Describe type of vehicle and capacity (B11)	Quantity transported (kg/year) (B12)	Cost (MUR)** (B13)	Describe type of vehicle and capacity (B21)	Quantity transported (kg/year) (B22)	Cost (MUR)** (B23)	Describe type of vehicle and capacity (C11)	Quantity transported (kg/year) (C21)	Cost (MUR)** (C13)

*Fill in private contractor and/or local authority and/or own vehicle for each waste type depending on solution(s) used
 **Indicate if cost is in MUR/year or MUR/trip

Total cost for transport of industrial waste to transfer station (MUR/year):

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Comments/recommendations:

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Table 2.3.1 Transport to Recycling (add lines as needed)

Industrial waste (as in Table 1.1. D) (A)		Type of transport arrangement and transport cost* (B)					
		Private contractor (B1)			Own vehicle (B2)		
Type (A1)	Amount generated (kg/year) (A2)	Describe type of vehicle and capacity (B11)	Quantity transported (kg/ year) (B12)	Cost (MUR)** (B13)	Describe type of vehicle and capacity (B21)	Quantity transported (kg/ year) (B22)	Cost (MUR)** (B23)

*Fill in private contractor and/or own vehicle for each waste type depending on solution(s) used
 **Indicate if cost is in MUR/year or MUR/trip

Total cost for transport of industrial waste to recycling (MUR/year):

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Comments/recommendations:

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Table 2.3.2 Detail of Cost When Transport to Recycling is Done with “Own Vehicle”
(add columns as needed)

Information	Vehicle type 1 (A)	Vehicle type 2 (B)	Vehicle type 3 (B)	Comments (D)
Number owned				
Age(s)				
Weight empty				
Weight full				
Capacity				
Cost item per vehicle*	Average cost per vehicle for vehicle type 1 (MUR/year) (E)	Average cost per vehicle for vehicle type 2 (MUR/year) (F)	Average cost per vehicle for vehicle type 3 (MUR/year) (G)	Comments (H)
Fuel				
Personnel				
Maintenance				
Amortization of initial cost				
Other				

*If vehicle(s) used for other purposes than waste transport, reflect here only the portion relevant to waste

Comments/recommendations:

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Section 3. Recovery of Industrial Solid Waste

Table 3. Revenues or Costs from Industrial Solid Waste Recovery *(add lines as needed)*

Industrial waste (as in Table 1.1. D) (A)	Type of transport arrangement and transport cost (B)				
	Recovered internally (B1)			Private contractor (B2)	
Waste type (A1)	Amount recovered (kg/year) (B11)	Product substituted (B12)	Revenue or cost (MUR/year)* (B13)	Amount recovered (kg/year) (B21)	Revenue or cost (MUR/year)* (B22)

*Indicate clearly if the recovery solution is a revenue or a cost

Comments/recommendations:

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Section 4. Other comments or recommendations

Insert other comments or recommendations relevant to the management of industrial waste and/or the cost you are confronting (specifically for your company or more generally for Mauritius):

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Annex 1: Example of Detailed Method to Calculate the Cost of Waste Storage

		Waste type			
		Container type 1	Container type 2	Container type 3	
General information	Description of container type				
	Number of containers per type				
	Longevity (years)				
	Description of storage area				
Costs (Mur)	Capital	Initial cost			
		Yearly amortization			
		Dedicated building initial cost			
		Dedicated building amortization			
		Other			
		Subtotal			
	Operation and maintenance	Cleaning (water, detergent...)			
		Maintenance (repair, materials...)			
		Personnel (hours/month)			
		Other			
		Subtotal			
	Overhead	Allocated administrative cost			
		Other			
		Subtotal			
	Total				

COST STRUCTURE OF INDUSTRIAL WASTE MANAGEMENT

Questionnaire for public authorities

General information

Office responsible for solid waste management in the Ministry of Environment, Solid Waste Management and Climate Change:

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Contact person (name, role, phone, email):

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Describe the organisation and personnel of the Ministry of Environment, Solid Waste Management and Climate Change and local authorities involved in the definition of WM costs:

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Section 1. Summary of Municipal Solid Waste Management and Cost

Table 1. Municipal Solid Waste Management and Cost (to be filled in for each local authority, add lines as needed)

Name of local authority (A)	Amount of municipal solid waste collected by the authority (kg/year) (B)	Total cost of municipal solid waste collection for the authority (MUR/year) (C)	Describe method for calculating the collection cost (D)	Municipal taxes collected from industrial establishments for waste collection (MUR/year) (E)	Municipal taxes collected from private households and other users for waste collection (MUR/year) (F)

Provide in addition map(s) showing the territory served by each local authority.

Comments/recommendations:

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Table 2.1. Waste Collected (to be filled in for each local authority)

Industrial sector	Number of establishments from which industrial waste is collected (A)	Amount of industrial waste collected (kg/year) (B)
Textile		
Food		
Chemical		
Printing		
Others		

For each local authority describe the contractual arrangement adopted for solid waste collection (e.g. in-house, all private, mixed):

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Comments/recommendations:

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Table 2.2. Transport of Industrial Solid Waste from Establishment to Transfer Station
(to be filled in for each local authority)

Information	Vehicle type 1 (A)	Vehicle type 2 (B)	Vehicle type 3 (B)	Comments (D)
Number owned				
Age(s)				
Weight empty				
Weight full				
Capacity				
Cost item per vehicle*	Average cost per vehicle for vehicle type 1 (MUR/year) (E)	Average cost per vehicle for vehicle type 2 (MUR/year) (F)	Average cost per vehicle for vehicle type 3 (MUR/year) (G)	Comments (H)
Fuel				
Personnel				
Maintenance				
Amortization of initial cost				
Other				

*If vehicle(s) used for other purposes than waste transport, reflect here only the portion relevant to waste

Total cost of vehicles owned by local authorities for industrial waste collection (MUR/year):

Comments/recommendations:

Table 2.3. Management of Transfer Station

(Annex 1 gives an example of method for cost calculation, add columns for additional transfer stations as needed)

Information	Transfer station 1 (A)	Transfer station 2 (B)	Transfer station 3 (C)	Comments (D)
Name				
Area occupied				
Time in operation				
Informal worker(s)				
Other relevant information				
Cost item per transfer station	Average cost for transfer station 1 (MUR/year) (E)	Average cost for transfer station 2 (MUR/year) (F)	Average cost for transfer station 3 (MUR/year) (G)	Comments (H)
Fuel				
Personnel				
Maintenance				
Amortization of initial cost				
Other				

Total cost for transfer station management and maintenance (MUR/year):

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Comments/recommendations:

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Table 2.4. Transport of Industrial Solid Waste from Transfer Station to Final Destination

Cost item	Cost (MUR/year) (A)	Comments (B)
Fuel		
Personnel		
Maintenance		
Amortization of initial cost		
Other		

Total cost paid to private transporters (MUR/year):

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Comments/recommendations:

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Table 2.5. Cost of Disposing Industrial Waste to Landfill

Cost item	Cost (MUR/year) (A)	Comments (B)
Land		
Personnel		
Operation		
Amortization of initial cost		
Anticipation of post-mortem cost		
Other		
Revenue item	Revenue (MUR/year) (C)	Comments (D)
Revenues from sale of energy		

Cost paid by private transporters per kg of industrial waste disposed of at landfill (MUR/year):

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Method used to calculate landfill cost (per kg):

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Comments/recommendations:

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Table 2.6. Cost of Disposing Industrial Waste to Composting

Cost item	Cost (MUR/year) (A)	Comments (B)
Land		
Personnel		
Operation		
Amortization of initial cost		
Anticipation of post-mortem cost		
Other		

Cost paid per kg of municipal solid waste disposed of for composting (MUR/year):

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Method used to calculate composting cost per kg:

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Comments/recommendations:

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Section 3. Other Waste Management Costs

Table 3. Other Costs

Cost item	Cost (MUR/year) (A)	Comments (B)
Street sweeping		
Collection of abandoned waste		
Billing and fees collection		
Information campaign on waste management		
Other costs		

Comments/recommendations:

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Section 4. Other Comments or Recommendations

Insert here other comments or recommendations relevant to the management of industrial waste or and the cost you are facing.

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Example of Method to Calculate the Cost of Transfer Station For Each Transfer Station

Transfer station 1	Land Initial cost	Capital cost (MUR)
	Land yearly amortization	
	Dedicated building - initial cost	
	Dedicated building - amortization	
	Other	
	Total	
	Containers - initial cost	O&M (MUR)
	Containers - cost amortization	
	Cleaning (water, detergent)	
	Maintenance (repair, materials)	
	Personnel hours / month	
	Other	
Total		
Allocated administrative cost	Overheads (MUR)	
Other		
Total		

ANNEX 3 - FULL COST ACCOUNTING

This IWM-CSR has adopted the principles of the Full Cost Accounting approach to quantify all direct and indirect costs, as well as hidden costs.

Given that “SWM can entail significant expenditures both before and after the operating life of equipment, facilities and plants, Full Cost Accounting focuses on the flow of economic resources (assets) and recognises costs as finances are used or committed, regardless of when money is spent”. (Florida Dept Envir. Protection, 1997).

Full Cost Accounting is relevant for SWM because it defines the three major classes of costs which must be calculated:

1. Up-front costs comprise the initial investments and expenses necessary to implement SWM services;
2. Operating costs are the SWM expenses on a daily basis; and
3. Back-end costs include expenditures to properly wrap up operations and take proper care of landfills and other SWM facilities at the end of their useful lives.

Up-front costs: the initial investments and expenses necessary to manage solid waste include:

- planning
- land acquisition
- approval process
- construction and modification of facilities, plants, and infrastructure
- support services provided by other local government departments
- costs for negotiating and administering contracts.

Operating and maintenance costs: the costs of the daily operation and maintenance of equipment, facilities and infrastructure.

Back-end costs: the expenses of properly closing down SWM facilities and plants at the end of their useful lives. Cash outlays for back-end costs are not made until after the useful life of the facility has ended, those costs are said to be “accruing” (‘accumulating’) during the active life of the facility. They include:

- costs of closure and long-term care
- decommissioning of buildings and equipment
- post-operating of landfills
- retirement and post-employment health benefits for employees.

As an example, considering landfill management, the total cost to be accounted for is much higher than the sum of the yearly cost of operation and maintenance for the operating period but these costs could be the only costs seen if cash-flow budgeting is adopted, which looks only at the on-going situation.

Full cost accounting supports the effective assessment of alternative SWM systems, because it estimates and includes the entire up-front and back-up costs, which are added up and appropriately distributed along the years of operation.

Structure of the costs

The table¹⁶ below illustrates how to associate the voices of cost to each activity performed for solid waste management.

The columns in light blue indicate the activities currently undertaken in Mauritius.

The columns in red indicate plants that do not currently exist in Mauritius. This approach was adopted to define the questionnaires provided to both the participating industries and to the SWMD of the Ministry of Environment, Solid Waste Management and Climate Change for the analysis of the current costs.

Need for tariffs

Segregated collection is the first operation required to initiate a material recovery chain by providing waste with homogenous characteristics. The recovery of materials requires access to the appropriate local industrial facilities and to local, national or international markets; the revenues are highly dependent on market fluctuations. In fact, prices of recyclable waste fractions are variable on the global market and also depend on the prices of the corresponding raw materials.

Revenues from recycling are on the positive side of a balance sheet; but for municipalities the revenues from the sales of recyclables do not usually cover even the costs of segregated collection and of ensuring the transportation to and operation of sorting and reprocessing plants. Thus, even in simple SWM systems, the value recovered from materials from waste is not going to substitute for the need to bill service tariffs from households and other waste generators, such as the industrial sector which is the focus of this study.

Revenues from the sale of energy

Energy recovery from waste includes:

- electricity produced from the biogas recovered from engineered landfills where biodegradable waste is deposited,
- anaerobic digestion from organic waste: it requires the ability to design and finance the up-front investment for the plants,
- thermal treatment of residual waste: it requires high investments and a significant capability of local experts to run the operation.

The sale of energy also requires decision at the national level to set feed-in tariffs or other forms of economic incentive.

¹⁶ Adapted from S. Tunesi, J. Gorelick. 2018. "Solutions design for Solid Waste management - A Guidebook to an effective method for low and middle-income Countries and Cities". Pag. 260. CreateSpace

Annex 3	COLLECTION	TRANSPORT to 1 ST DESTINATION	TRANSPORT to further destinations / LANDFILL / EXPORT	TRANSFER STATIONS	LANDFILL	SORTING PLANT (MRF)	Composting	ANAEROBIC DIGESTION	ENERGY RECOVERY	TOTAL per COST TYPE
<u>OPERATING & MAINTENANCE</u>										
Fuels and goods										
Personnel										
Cleaning										
Services from private providers										
Rentals										
<u>OVERHEADS</u>										
Budgeting and administration										
Billing										
Information campaigns										
<u>INVESTMENT / CAPITAL</u>										
DEPRECIATION of new fixed assets acquired by investment (building, plants, equipment)										
DEPRECIATION of pre-existing fixed assets (building, plants, equipment)										
Investment and capital cost										
Large capital maintenance cost										
Annual RESERVES for future investments										
<u>REVENUES: SALES OF MATERIAL</u>						X	X	X		
<u>REVENUES: SALES OF ENERGY</u>					X				X	
TOTAL per ACTIVITY										

NOT in SWM strategy for the short-term but potentially available for specific types of industrial waste

Costs must include post-mortem management






The Partnership for Action on Green Economy (PAGE) supported the Government of Mauritius in carrying out the Industrial Waste Management Cost Structure Review (2021 IWM-CSR). The outcome of this study provides answers to part of the recommendations of the PAGE Industrial Waste Assessment (2017 IWA) published in 2017.


This report is a product of a collaborative effort between UNIDO, the Industrial Development Division of the Ministry of Industrial Development, SMEs and Cooperatives, and Business Mauritius. The review of the legislative and institutional framework for solid waste management identified constraints impacting on the recovery of materials and energy from industrial solid waste. A set of recommendations – giving relevance to discussions involving several stakeholders – is presented addressing relevant policy issues.

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