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The Management of Municipal solid waste and their economic and socio-spatial impact in an urban environment– case study city of Biskra

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Abstract:

Through this study, we seek to explore the collection and treatment of Municipal solid waste and their economic and socio-spatial impacts within the urban environment of Biskra city. Using a combination of qualitative and quantitative research methods, including field observations, interviews with key stakeholders, and analysis of municipal data, the research provides a comprehensive overview of Biskar's waste management practices. where the study investigates the economic potential of solid waste sorting and recycling, proposing them as viable solutions for generating revenue and creating employment opportunities.it also mentions some global examples of solid waste management and their great success.

Keywords: municipal solid waste, economy, solid waste, environment, impact, sorting, collecting, sorting center, treatment.

الخلاصة:

من خلال هذه الدراسة، نسعى إلى استكشاف جمع ومعالجة النفايات البلدية الصلبة وآثارها الاقتصادية والاجتماعية - المكانية داخل البيئة الحضرية لمدينة بسكرة. وباستخدام مزيج من أساليب البحث النوعي والكمي، بما في ذلك الملاحظات الميدانية، والمقابلات مع أصحاب المصلحة الرئيسيين، وتحليل البيانات، تقدم الدراسة لمحة شاملة عن ممارسات بسكرة في إدارة النفايات. حيث تبحث الدراسة الإمكانات الاقتصادية لفرز النفايات الصلبة وإعادة تدويرها، وتقترحها كحلول عملية لتوليد الإيرادات وإيجاد فرص العمل. كما تشير إلى بعض الأمثلة العالمية لإدارة النفايات الصلبة ونجاحها الكبير.

الكلمات المفتاحية: النفايات البلدية الصلبة، الاقتصاد، النفايات الصلبة، البيئة، التأثير، الفرز، الجمع، مركز الفرز، المعالجة.

Résumé:

A travers cette étude, nous cherchons à explorer la collecte et le traitement des déchets solides municipaux et leurs impacts économiques et socio-spatiaux au sein de l'environnement urbain de la ville de Biskra. Utilisant une combinaison de méthodes de recherche qualitatives et quantitatives, notamment des observations sur le terrain, des entretiens avec des parties prenantes clés et une analyse des données municipales, la recherche fournit un aperçu complet des pratiques de gestion des déchets de Biskra. où l'étude examine le potentiel économique du tri et du recyclage des déchets solides, en les proposant comme des solutions viables pour générer des revenus et créer des opportunités d'emploi. Elle mentionne également quelques exemples mondiaux de gestion des déchets solides et leur grand succès.

Mots-clés : déchets solides municipaux, économie, déchets solides, environnement, impact, tri, collecte, centre de tri, traitement.

Table of Contents

General Introduction

Chapter 01: The Management of Municipal solid waste

Chapter 02: The Management of MSW in Biskra city

Chapter 03: the economic impact of MSW management in an urban environment

Chapter 04: the socio-spatial impact of MSW management in an urban environment

General Conclusion

Table of Figures

Table of Table

Abbreviation

MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management

General Introduction

Introduction:

Municipal Solid waste management is an important and essential work for any country. It is also one of the tough, complex, time-consuming, and laborious works for urban areas of the world. Developed countries have succeeded in applying different treatment and re-use methods for the generated waste, including; recycling, composting, and energy recovery, in addition to disposing of the waste in proper landfills.

In Biskra City's urban environment, solid domestic waste collection and management are ineffective, leading to negative economic and social impacts. A lack of adequate waste management strategies not only damages the environment and exposes residents to health risks, but also places a heavy financial burden on the local government. Aside from this, the unequal distribution of waste management infrastructure across different urban areas worsens social and spatial disparities, harming the general well-being of its residents. Achieving these challenges is important for promoting sustainable urban development and improving the livability of metropolitan areas.

In this study, we explore the collection and handling of solid domestic waste in the urban environment of Biskra City, looking at its economic, environmental, and socio-spatial impact.

Problematic:

The management of municipal solid waste (MSW) in urban environments presents complex challenges with far-reaching economic, environmental, and socio-spatial implications. Urbanization, population growth, and economic development have led to an upsurge in solid waste generation, necessitating effective and sustainable waste management strategies.

One of the main distinctions between developed nations—which have attained a high degree of economic and technological advancement—and developing nations—which are still attempting to catch up with growth and progress—is the appropriate and efficient management and utilization of municipal solid waste. This discrepancy brings us straight to the issues and difficulties that our city's waste management system faces, including issues with municipal solid waste management and many other issues. With a particular focus on Biskra City, the objective of this study is to evaluate the economic and socio-spatial effects of household solid waste management, including its collection and treatment.

Questions:

I. What are the proper ways of managing municipal solid waste?

II. Does this management have economic and socio-spatial impact on an urban environment?

Hypothesis:

The main hypothesis that has been developed from this perspective are:

- Analyzing the economic impact of MSWM on an urbain environment.
- Examining worldwide methods for MSWM can offer useful perspectives and techniques for determining optimal MSWM strategies to apply in Biskra city.
- Analyzing the socio-spatial impact of MSWM on an urbain environment.

Objectives:

This thesis aims to evaluate the management of municipal solid waste in Biskra city, analyzing its economic and socio-spatial impacts on the urban environment. The study will assess current waste management practices, identify economic costs and benefits, and examine how these practices affect different areas and communities. By comparing Biskra's waste management with similar cities, the research seeks to provide practical recommendations for enhancing sustainability and efficiency in waste management.

Significance:

The significance of this thesis lies in its comprehensive analysis of municipal solid waste management in Biskra, highlighting both economic and socio-spatial impacts on the urban environment. By evaluating current practices and identifying inefficiencies, the study aims to offer actionable insights for improving waste management systems. Understanding the economic implications can help optimize resource allocation and cost-effectiveness, while analyzing socio-spatial impacts can address disparities in service provision and enhance community well-being. Additionally, the research's comparative approach with other cities can uncover best practices and innovative solutions, contributing to the development of sustainable

urban waste management policies and practices in Biskra. Ultimately, this thesis seeks to inform policymakers, urban planners, and stakeholders, fostering a cleaner, more equitable, and economically viable urban environment.

Limitations:

- The accuracy and comprehensiveness of the data on waste generation, collection, and disposal in Biskra may be limited. Incomplete or inconsistent data can affect the validity of the analysis.
- The focus on a single city, Biskra, may limit the generalizability of the findings to other urban areas with different socio-economic and environmental contexts.
- The study's timeframe may not allow for long-term observation of waste management practices and their impacts, limiting the ability to assess trends and long-term effects.
- Limited access to key stakeholders, such as local authorities, waste management companies, and community members, could restrict the depth of the qualitative analysis.
- The study may be constrained by the availability and application of advanced analytical tools and methodologies, which could impact the precision of economic and spatial analyses.
- Any recent or upcoming changes in waste management policies and regulations during the study period might affect the relevance and applicability of the findings.
- The study may not fully capture the cultural and behavioral aspects influencing waste management practices and community participation in Biskra.
- Differences in data quality, waste management systems, and urban characteristics of comparison cities may pose challenges in drawing accurate comparisons and conclusions.

The research methodology:

This thesis employs a mixed methods research design, combining qualitative and quantitative approaches. The primary sources of data collection include official websites, databases, publications, and literature reviews, as well as face-to-face interviews with relevant individuals. We also used quantitative and descriptive approaches to produce tables and graphs that help in reading and explaining the data that we collected through our approach to the Sokara-Net Foundation. We conducted interviews with them in which it was explained how their work proceeded, with regard to the part related to our study, and we monitored all the processes that affected the subject of our research, through which it enabled us to collect all the necessary data and then we analyzed it. The results will be stated after analyzing the collected information.

The work plan is as follows:

→ **C**hapter 01: The Management of Municipal Solid Waste

→ **C**hapter 02: The Management of MSW in Biskra city

→ **C**hapter 03: The Economic Impact of MSWM in an urban environment

→ **C**hapter 04: the Socio-Spatial Impact of MSWM in an urban environment

Chapter 01: The Management of Municipal solid waste

Introduction:

The problem of waste and its management mechanisms is not limited to one country alone, as it is a global problem. Through this chapter, we will address the definition of waste in general and solid municipal solid waste in particular, in addition to the various basic elements necessary in its management and treatment.

1. Municipal solid waste

1.1. What is the definition of waste?

Waste is defined as any material that is no longer usable to its owner, the waste creator, and has no economic value. Waste is classified as solid, liquid, or gaseous depending on its physical state. Planning, financing, construction, and operation of facilities for garbage collection, transportation, recycling, and final disposal are all part of waste management. Every five years, the amount of waste produced increases by one million tons. If it is not disposed of in a timely manner, it poses major health risks and has a negative impact on infrastructure. The current garbage collection system, which collects trash from streets, households, and other businesses once a day, is unable to efficiently manage the waste generated, resulting in spillover into roadways, society. (Kumar G, Swamy, & Nagadarshini, 2014)

1.2. What are the classes of waste?

different types of waste arise from various human activities and industries, and each requires specific management and disposal methods to minimize their impact on the environment and public health. For example:

- Solid Waste

This encompasses a broad range of discarded materials, including municipal solid waste (household waste), industrial waste, and commercial waste.

- Liquid Waste

Liquid waste refers to wastewater from households, businesses, and industries, as well as other liquids in various states of matter that require proper disposal.

❖ Gaseous Waste

Gaseous waste includes airborne pollutants released into the atmosphere, often as byproducts of industrial processes and vehicle emissions.

❖ Organic Waste

This category consists of biodegradable waste from plants or animals, such as food waste, yard trimmings, and wood.

❖ Hazardous Waste

Hazardous waste includes materials that are potentially harmful to human health or the environment, such as certain chemicals, batteries, and electronic equipment.

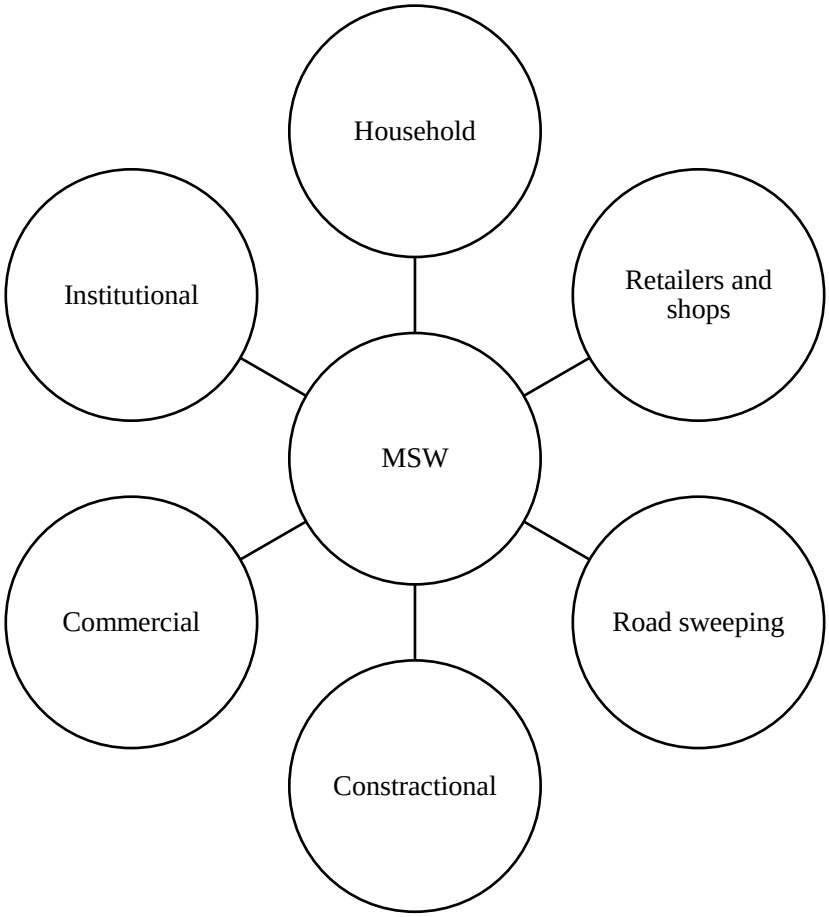
❖ E-waste

E-waste, or electronic waste, encompasses discarded electrical or electronic devices, including computers, televisions, and mobile phones.

1.3. What is Municipal solid waste?

Municipal Solid Waste (MSW), commonly called “trash” or “garbage,” includes wastes such as durable goods (e.g., tires, furniture), nondurable goods (e.g., newspapers, plastic plates/cups), containers and packaging (e.g., milk cartons, plastic wrap), and other wastes (e.g., yard waste, food). This category of waste generally refers to common household waste, as well as office and retail wastes, but excludes industrial, hazardous, and construction wastes (Municipal Solid Waste, 2016).

Figure 1: MSW sources



Source: made by author

It can be classified into five categories:

- Recyclable Material: Glasses, bottles, cans, paper, metals, etc.
- Composite Wastes: Tetra packs, toys.
- Biodegradable Wastes: Kitchen waste, flowers, vegetables, fruits, and leaves.
- Inert Waste: Rocks, debris, construction material.
- Domestic Hazardous and Toxic Waste: E-waste, medication, light bulbs, etc.

Figure 2: Food scraps waste

Source:

https://www.nrdc.org/stories/composting-101

Figure 3: Packaging waste

Source:

https://www.feastwithus.org.uk/section-1-food-and-plastic-packaging-waste/section1-3

Figure 4: plastic waste

Source: https://0waste.co.in/reasons-why-we-need-plastic-waste-management/

Figure 5: paper waste

Source: https://vecoplan.com/en/material/paper-and-cellulose/waste-paper

Figure 6: wood waste

Source: https://bodensgroup.com/wood-recycling/

Figure 7: metal waste

Source: https://earth911.com/home-garden/reducing-metal-waste/

2. Municipal solid waste management:

The management of municipal solid waste (MSW) plays an important role in the maintenance of urban sustainability and environmental conservation. This involves a series of processes designed to ensure the efficient handling of waste generated by residential dwellings, businesses, and governmental entities. Some of its key futures are:

- Waste Collection and Transportation
- Treatment and Disposal

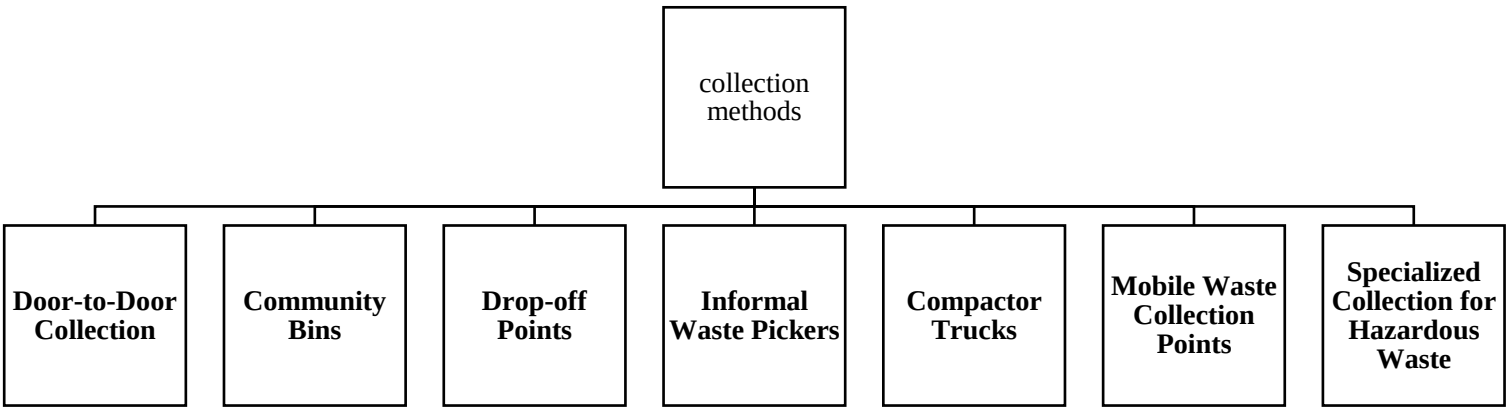
2.1. Waste Collection and Transportation:

The collection and transportation of municipal solid waste is a public service that has important impacts on public health and the appearance of towns and cities.

1.1.1. The collection Methods:

The collection of municipal solid waste involves various methods for effectively gathering waste from different sources (ex: residential, commercial...), some common collection methods encloud:

Figure 8: collection methods



Source: made by author

a) **Door-to-Door Collection**:

collection of solid waste from the door step of households, shops, commercial establishments, offices, institutional or any other non-residential premises and includes collection of such waste from entry gate or a designated location on the ground floor in a housing society, multistorey building or apartments, large residential, commercial or institutional complex or premise

This method is effective for densely populated urban areas and ensures comprehensive waste pick-up from each household.

Figure 9: Door-to-Door Collection

Source: https://www.convexiconindia.com/why-is-a-door-to-door-municipal-waste-collection-monitoring-system-essential-for-the-effective-cleaning-of-a-city/

b) Community Bins:

Residents deposit their waste into centralized bins located in common areas such as neighbourhoods, apartment complexes, or commercial areas.

Waste collection trucks periodically visit these locations to empty the bins, consolidating waste from multiple households into a single collection point.

Figure 10: Community Bins

Source: https://www.vecteezy.com/free-vector/solid-waste-management

c) Drop-off Points:

Designated locations where residents can personally deliver their waste, commonly used in areas with limited access for collection vehicles, such as rural or remote areas. Residents are responsible for transporting their waste to these points, which are then collected by waste collection vehicles for further transportation.

Figure 11: Drop-off Points

Source: https://www.wastesorted.wa.gov.au/be-a-great-sort/take

d) Informal Waste Pickers:

In some regions, informal waste pickers play a significant role in waste collection by salvaging recyclable materials from bins and dumps, contributing to the informal recycling sector.

Figure 12: Informal Waste Pickers

Source: https://www.trashonomy.com/post-consumer-plastic-waste/

e) Compactor Trucks:

These specialized vehicles compress waste to increase its density, allowing for more efficient transportation and reducing the frequency of collection trips.

Figure 14: Compactor Trucks

Source: https://www.shutterstock.com/search/cartoon-garbage-truck

f) Mobile Waste Collection Points:

Utilized in areas with limited infrastructure, these mobile collection points are set up at specific times and locations for the temporary consolidation and collection of waste.

Figure 13: Mobile Waste Collection Points

Source: https://telephonyme.com/solutions/mobility-solutions/iot-smart-waste-management/

g) Specialized Collection for Hazardous Waste:

Hazardous waste, such as: chemicals, batteries, and electronic waste. Often requires separate collection methods due to its potential environmental and health risks.

Figure 15: Specialized Collection for Hazardous Waste

Source: https://www.shutterstock.com/image-vector/3d-isometric-flat-vector-conceptual-illustration-2206360659

1.1.2. Transportation of Municipal solid waste:

a) DUMP TRUCKS AND TRAILERS

Dump trucks are used to collect waste and transport it to transfer stations, or directly to the landfills and recycling plants to be unloaded. The trailers are generally made from either aluminum or steel, and rely on hydraulic systems to unload waste from the trucks. (Judd, 2021)

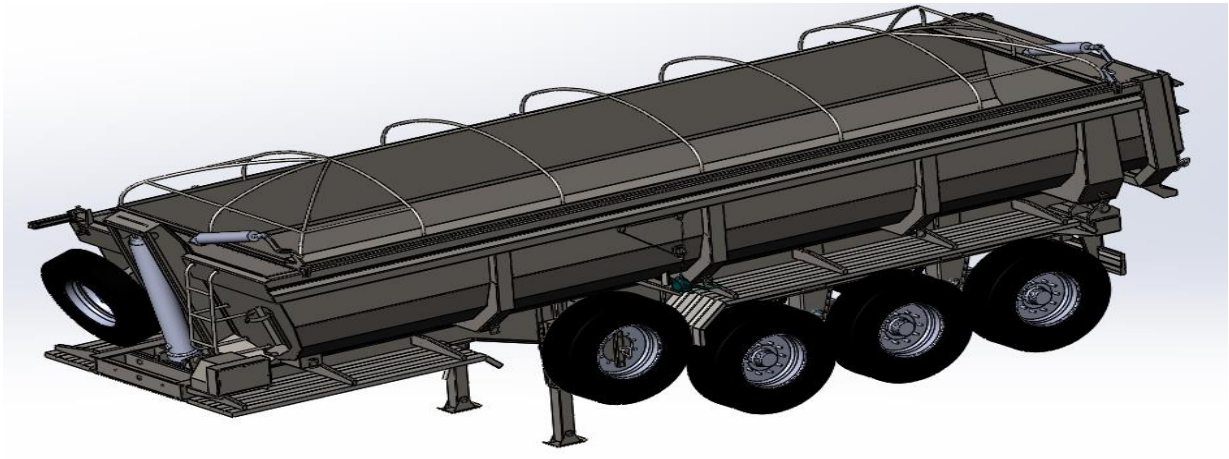
Figure 16: Dump trucks

Source: https://stock.adobe.com/dz/search?k=garbage+truck+vector&asset_id=406796988

b) LANDFILL TIPPERS

Using self-contained hydraulic power units to raise themselves, tippers can be coupled with a truck or trailer to unload solid waste at landfills. Not to be confused with dump trailers, tippers are separate units that connect to the trailers on the trucks.

Figure 17: Landfill Tripper



Source: https://grabcad.com/library/dump-semi-trailer-2

c) HEAVY EQUIPMENT

Heavy equipment consists of the robust waste loading equipment like steer loaders, wheel loaders and hydraulic excavators, as well as waste handling equipment, such as compactors and rollers, sifting machines, crushers, shredders and wheel dozers. All heavy equipment should be durable and able to handle a range of solid waste material types, from construction waste to municipal waste or hazardous waste. (Judd, 2021)

Figure 18: Heavy equipment

Source: https://www.linkedin.com/pulse/what-heavy-equip

d) WALKING FLOOR TRAILERS

Also powered by hydraulic systems, walking floor trailers are great for collecting waste from those difficult-to-reach places like tunnels, building interiors and sites located on uneven ground. Once transported to the landfills, the waste can be "walked" off the back of the trailer using moving floor slats, saving you the time and effort of having to use bulky unloading equipment. (Judd, 2021)

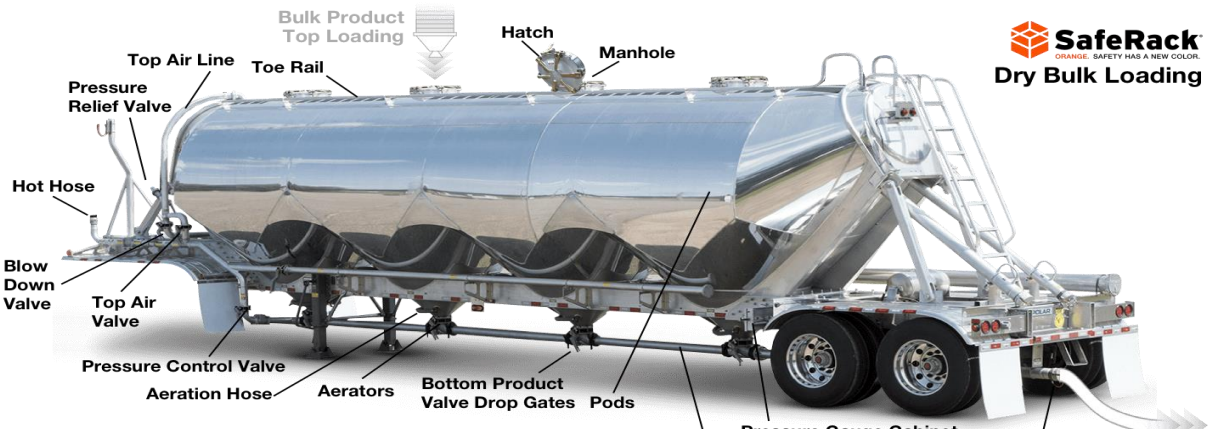
Figure 19: walking floor trailers

Source: https://bigrigs.com.au/2023/03/10/expand-waste-hauling-efficiencies-with-moving-floor-systems/

e) BULK PNEUMATIC TANKER

Vacuum-sealed to prevent contamination by moisture, dirt or germs, pneumatic tankers are most often used to transport materials such as food, chemicals or even contaminated soil. (Judd, 2021)

Figure 20: Bulk Pneumatic Tanker

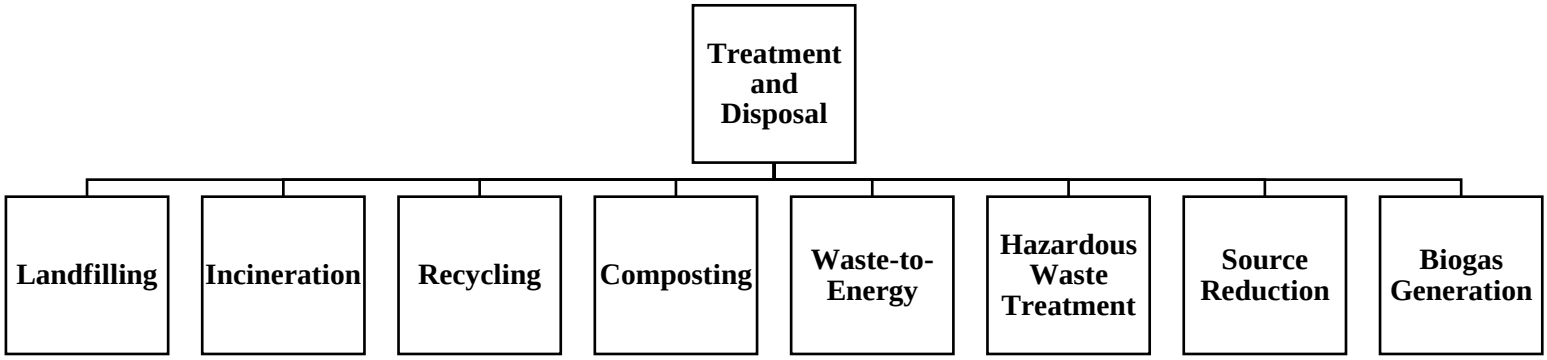


Source: https://www.saferack.com/cement-loading/pneumatic-trailer-loading/

2.2.Treatment and Disposal:

The treatment and disposal of municipal solid waste involves various methods aimed at: reducing the volume of waste, mitigating environmental impact, and recovering resources. Common treatment and disposal methods for MSW include:

Figure 21: Treatment and Disposal

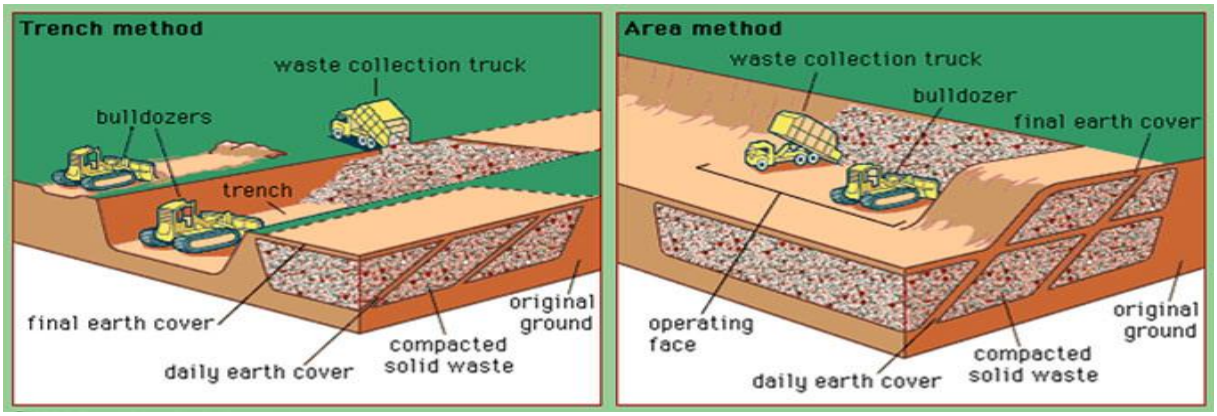


Source: made by author

a) Landfilling:

Landfills are engineered sites where solid waste is deposited and compacted. The waste is then covered with soil to reduce odors, prevent the spread of disease, and minimize environmental contamination. Landfills should meet certain design and regulatory requirements to prevent pollution of soil, groundwater, and air.

Figure 22: Landfills

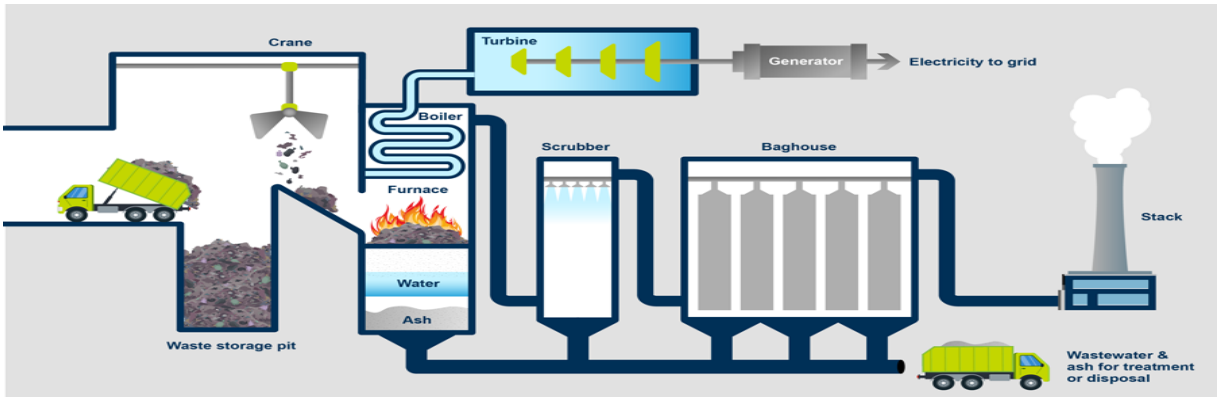


Source: https://www.linkedin.com/pulse/details-landfills-methods-g-k

b) Incineration:

Incineration, or combustion, involves the controlled burning of solid waste at high temperatures. This method reduces the volume of waste and generates energy through combustion. Proper air pollution control systems are crucial to minimizing harmful emissions into the atmosphere.

Figure 23: Incineration



Source: https://www.futurelearn.com/info/courses/introduction-to-environmental-science/0/steps/271560

c) Recycling:

Recycling involves separating, processing, and reusing materials from solid waste. Paper, plastics, glass, metals, and some types of organic waste are typical recyclable materials. This method lessens the need for raw materials, mitigates energy usage, and lessens greenhouse gas emissions.

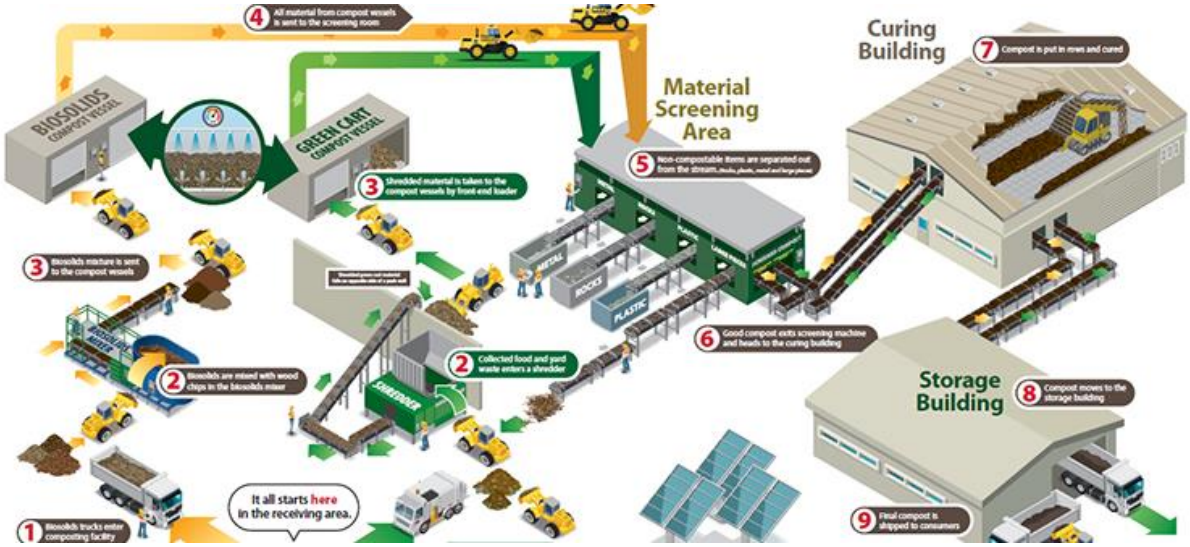
Figure 24: Recycling

Source: https://www.alamy.com/garbage-recycling-factory-or-facility-workers-image454927735.html?image

d) Composting:

Compost connotes the biological decomposition of organic waste. This method is environmentally friendly and results in a valuable soil amendment that can be used in agriculture and landscaping. Composting reduces the volume of waste going to landfills and helps divert organic waste from the waste stream.

Figure 25: Composting

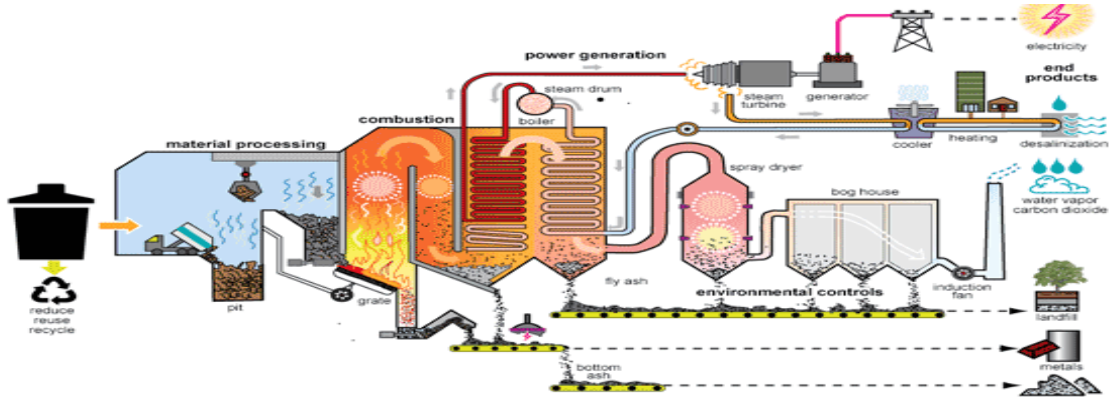


Source: https://www.calgary.ca/waste/residential/how-composting-works.html

e) Waste-to-Energy:

Waste-to-energy methods include turning solid waste into energy, frequently by means of anaerobic digestion or incineration. These methods generate heat or electricity from the combustion or breakdown of waste materials. Waste-to-energy facilities can help reduce reliance on fossil fuels and minimize waste volume.

Figure 26: Waste-to-energy

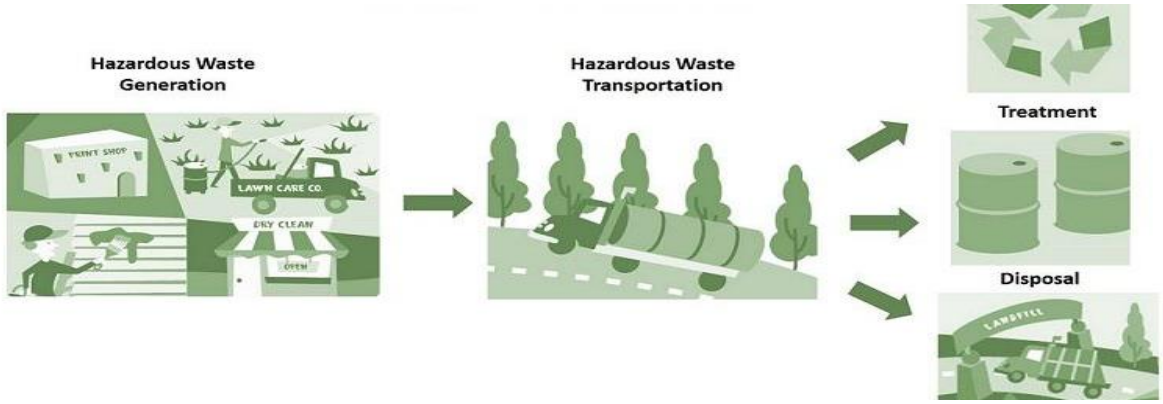


Source: https://www.eia.gov/energyexplained/biomass/waste-to-energy-in-depth.php

f) Hazardous Waste Treatment:

Due to the potential harm, it could cause to both the environment and human health, hazardous waste needs specific handling. Treatment methods include physical, chemical, or biological processes that neutralize, detoxify, or remove hazardous components from the waste before disposal.

Figure 27: Hazardous Waste Treatment



Source: https://www.openpr.com/news/2253051/hazardous-waste-treatment-market-opportunity-assessment-from#prid-2253051

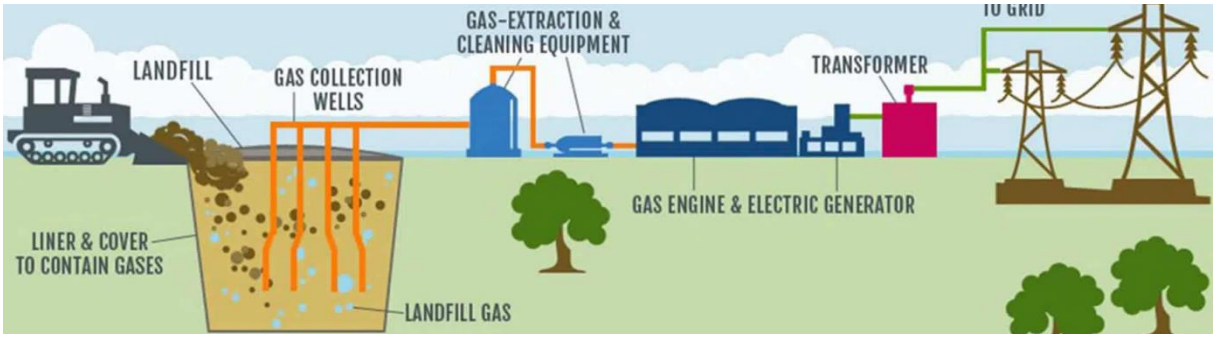
g) Source Reduction:

The objective of source reduction is to cut back on waste production at the source. This includes measures such as product redesign, material substitution, and promoting practices like reusing, repairing, and reducing packaging. Source reduction helps conserve resources and minimize the need for waste disposal.

h) Biogas Generation:

Biogas generation is an environmentally friendly solid waste disposal method that involves the decomposition of organic waste in an anaerobic environment, producing methane-rich biogas and nutrient-rich digestate. (Solid Waste Disposal Methods and Management, 2023)

Figure 28: Biogas generation



Source: https://www.kts-eng.com/en/solutions/landfill-gas/

2.3.Effects of Poor Solid Waste Management:

Poor solid waste management practices can have serious ramifications. They put a negative impact on the environment and the overall quality of life. such as:

- Environmental Pollution: Solid waste should be disposed of properly to prevent environmental contamination. Waste disposal in public areas has the potential to contaminate groundwater, surface waters, and soil with hazardous materials such heavy metals and toxic compounds.

- Air Pollution: Ineffective incineration techniques or other improper waste management methods, such as open burning of waste, can discharge dangerous contaminants into the atmosphere. Some common air pollutants are Particulate matter, Dioxins, greenhouse gases, etc. these can cause respiratory disorders and cardiovascular disorders.

- Spread of Diseases: Poor solid waste management creates breeding grounds for disease-carrying pests like rats, mosquitoes, and flies. These pests can incite diseases like dengue fever, typhoid, etc.

- Aesthetic and Visual Impact: Improperly managed solid waste, such as litter and illegal dumping, can create visual blight and negatively impact the aesthetic appeal of communities and natural areas. This can reduce property values, discourage tourism, and diminish the overall quality of life in affected areas.

- Soil Degradation: When waste is disposed of inappropriately, it can contaminate and degrade soil quality. Toxic materials may get leached into the soil. These affect agricultural production and also pose health related risks to plants and animal life.

- Wildlife and Marine Life Impacts: Poor waste management practices can harm wildlife and marine life. Animals may ingest or become entangled in improperly discarded

waste, leading to injury or death. Marine ecosystems can be particularly affected by plastic waste, causing harm to marine animals through ingestion and entanglement.

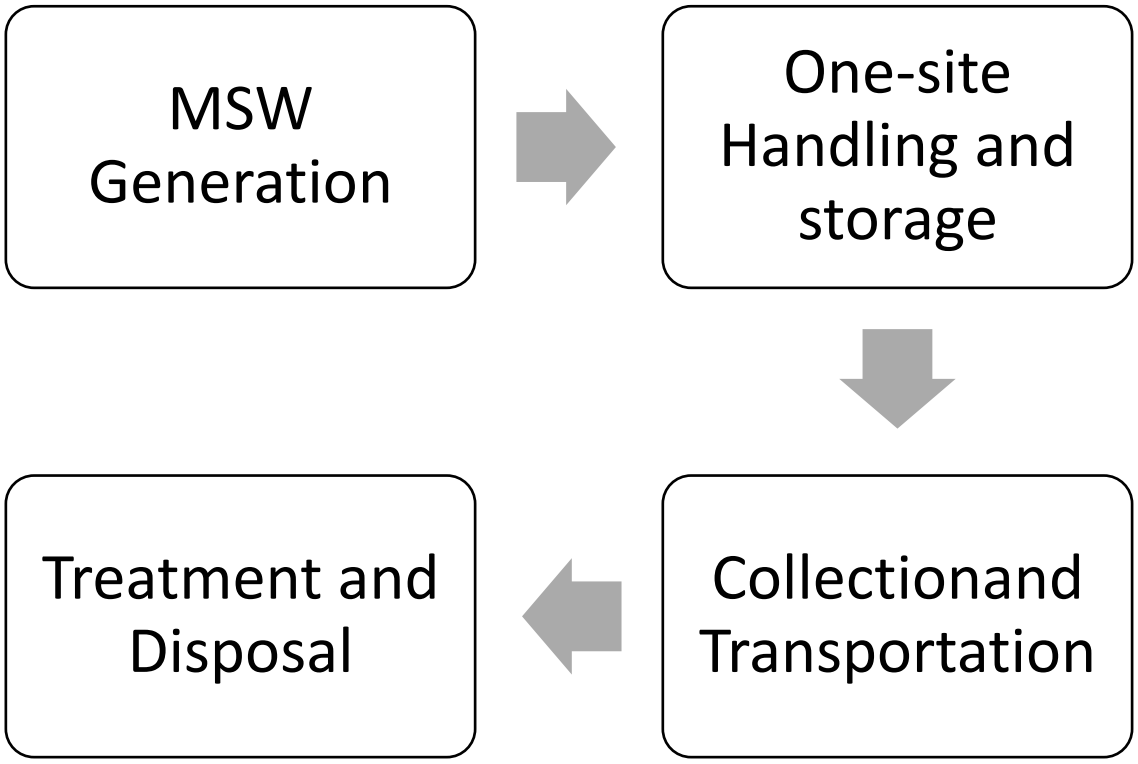
- Resource Depletion: Inefficient waste management leads to the unnecessary depletion of valuable resources. Due to improper sorting and recycling of waste, recyclable materials are lost. These result in the depletion of natural resources.

- Climate Change: Improper waste management can embolden climate change due to the release of greenhouse gases. These are emanated from the decomposition of organic waste in landfills. Methane is generated due to the decomposition of the organic waste without sufficient oxygen. (Solid Waste Disposal Methods and Management, 2023)

2.4.The importance of Municipal solid waste management

Proper waste management plays an important role in preventing the transmission of illnesses, decreasing environmental contamination and minimizing health risks linked to improper waste disposal. Besides that, it encourages the preservation of resources via recycling and waste-to-energy schemes, that way supporting the sustainable use of resources and easing the strain on landfills. In addition, proficient waste management elevates the visual appeal and habitability of communities, fostering a cleaner and more agreeable environment for inhabitants. From an economic vantage point, it has the potential to generate job prospects and nurture the growth of recycling and waste management sectors.

Figure 29: Municipal Waste Management Diagram



Source: made by author

Conclusion:

In this chapter we discussed the definition of waste and its categories. Including the definition of municipal solid waste and its various types. as wall as, its multiple management and disposal methods.

in conclusion. The efficient management of municipal solid waste is crucial for environmental sustainability and public health, requiring particular disposal methods for various types of waste to minimize their negative impact on the environment.

Chapter 02: The Management of MSW in Biskra city

Introduction:

In this chapter, we will discuss an analytical study of waste management in Biskra, moving between several important points, such as methods and stages of management. We will specialize in talking about the technical sorting center that benefits from the waste, which has become for it a raw material that can be exploited in the context of urban development, in order to reduce environment pollution that has become a threat to human health throughout the world.

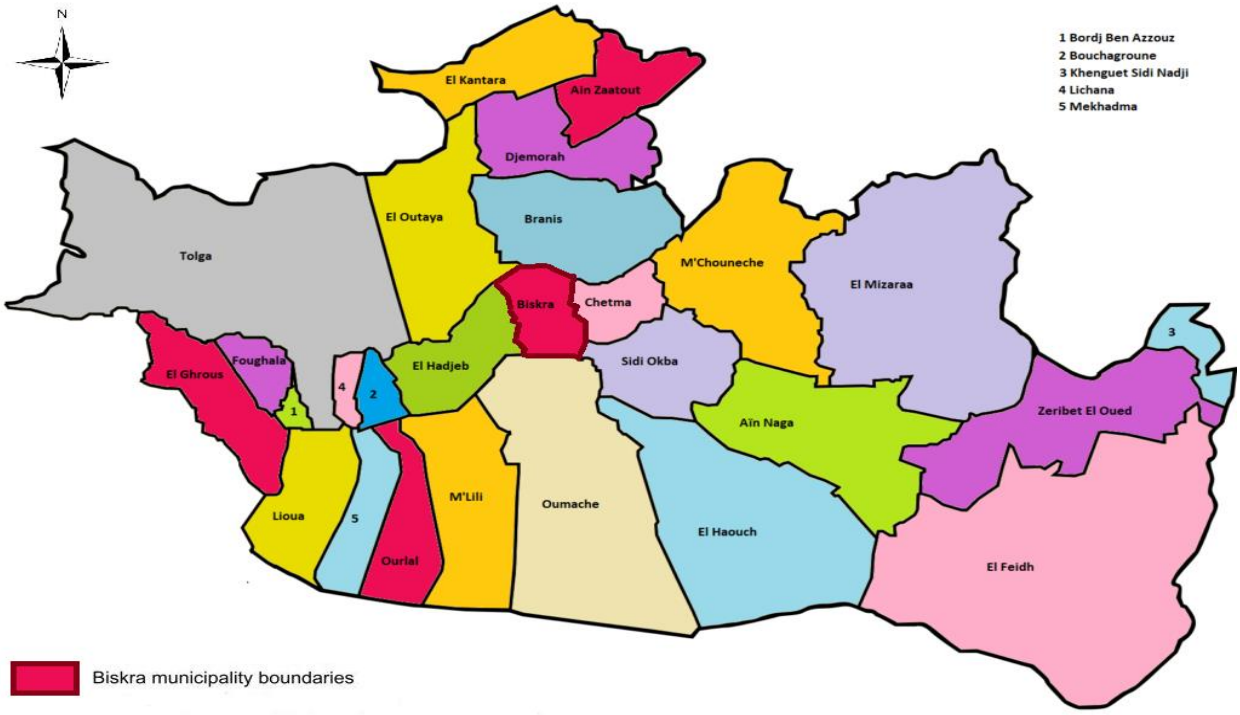
1. Biskra city location:

1.1 Geographical location:

The field of study is located in the center of the wilaya of Biskra, covering an area of 127,70 km2, which is 2.07% of the total area of the wilaya. Its administrative boundaries are as follows:

- From the north: Beranes and Lotaya.
- From the south: Oumache and Imlili.
- From the east: Sidi Okba, Chetma.
- From the west: El Hadjeb.

Figure 30: Biskra city



Source: https://gifex.com/fr/fichier/quelles-sont-les-communes-de-la-wilaya-de-biskra/ + made by author

1.2 Astronomical location:

The city is located east of the Greenwich meridian between longitudes 5° and 6° and northeast of the line between latitudes 34° and 35° north.

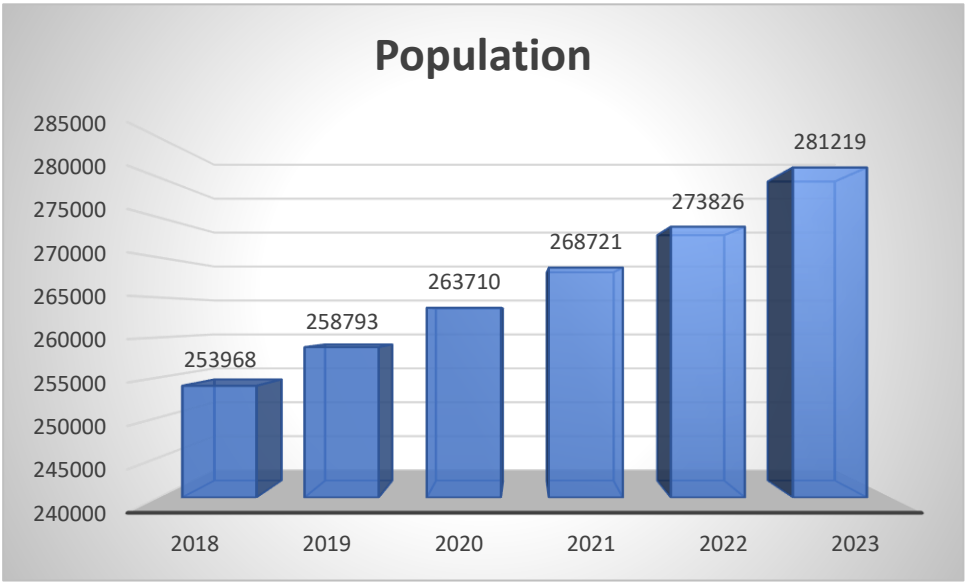
2. The population of Biskra city over the years:

Table 1: Population development between 2018 and 2023

Year	2018	2019	2020	2021	2022	2023
Population	253968	258793	263710	268721	273826	281219

Source: A.P.C BISKRA +made by author

Figure 31: Population development between 2018 and 2023



Source: A.P.C BISKRA+ made by author

3. MSW in Biskra city:

3.1. The definition of solid waste:

When it comes to the definition of solid waste Biskra city follows the Article 03 of Law (19-01) related to waste management, control and removal: “It is all the remains resulting from production, transformation or use operations. More generally, every material or product and every movable property that the owner or possessor disposes of or intends to dispose of, or it must be disposed of or removed”.

3.2. Classification of solid waste:

According to Article 03 of Law (19-01), solid waste has six types, which are:

- Household and similar waste: all waste from households as well as similar waste from industrial, commercial, craft and other activities which, by their nature and composition, are comparable to household waste.
- Bulky waste: all waste from households which, due to its bulky nature, cannot be collected under the same conditions as household and similar waste.
- Special waste: all waste from industrial, agricultural, healthcare, service and all other activities which, due to their nature and the composition of the materials they contain, cannot be collected, transported and treated in the same conditions as household and similar waste and inert waste.
- Special hazardous waste: all special waste which, by its nature constituents or by the characteristics of the harmful materials they contain, are likely to harm public health and/or the environment.

- Healthcare activity waste: all waste resulting from diagnostic, monitoring and preventive or curative treatment activities, in the fields of human and veterinary medicine.

- Inert waste: all waste originating in particular from quarrying, mining, demolition, construction or renovation work, which does not undergo any physical, chemical or biological modification during its landfill, and which is not contaminated by dangerous substances or other elements generating nuisance, likely to harm health and/or the environment.

4. The MSWM in Biskra city:

4.1. Collection:

The collection process is carried out by the workers using manual equipment, either by door-to-door collection or community bins.

Figure 32: Community Bins

Source: taken by student

Figure 33: Door-to-door collection

Source: taken by student

4.2.Transportation:

while transportation is carried out with a compactor truck (Packing bucket), one for each sector. Each truck employs a driver and three workers. The truck passes through a specific road according to the division plan of the Biskra city. At the end, the truck heads directly towards the technical backfilling center to be emptied.

4.2.1. Transportation equipment:

Table 2: Transportation equipment

The Name	The Numbers
Retro Charger enmtp	2
Compactor spreader	2
Flatbed van	2
Packing dump truck	11
Hyundai bucket truck	1
Vehicle foton transport	1
cat 1 track loader	1
Sonacom k120	1
Sonacom c260 tank	1
Agricultural tractor foton	3
Dump truck 15-ton shacman	1

Source: Accounting Office, Net–Sokara Foundation.

4.2.2. Solid Waste transportation program:

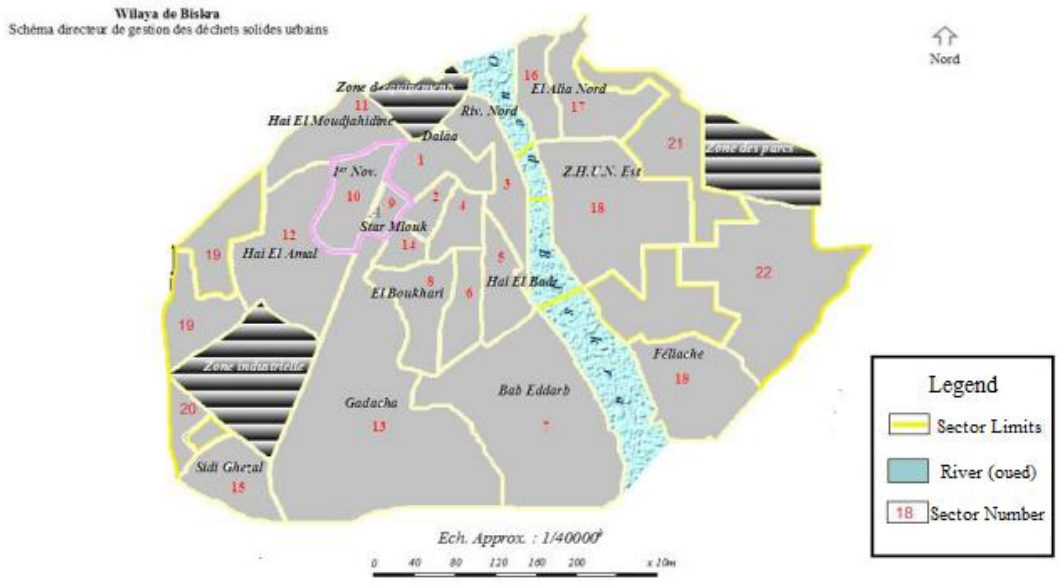
The approved institutions for the collection and transportation of MSW are:

Table 3:Solid Waste transportation program

Enterprise	Its sectors	The neighbourhoods and streets involved
Sokara net	1-2-3-4-5-6-7-8-9-10-11-12-15-16-17-18-20-21-22-30-31-32-33-34-35	HAI ES SAADA - HAI EL MOUDJAHIDINES – HAI EL BOUKHARI – HAI IBN BADIS…etc.
Torchi	13	Guedacha

Source: Administration Office, Net–Sokara Foundation +made by author

Figure 34: Division of waste collection sectors in Biskra city



Source: تسيير ومعالجة النفايات الحضرية الصلبة ودورها في التنمية المستدامة دراسة حالة -مدينة بسكرة

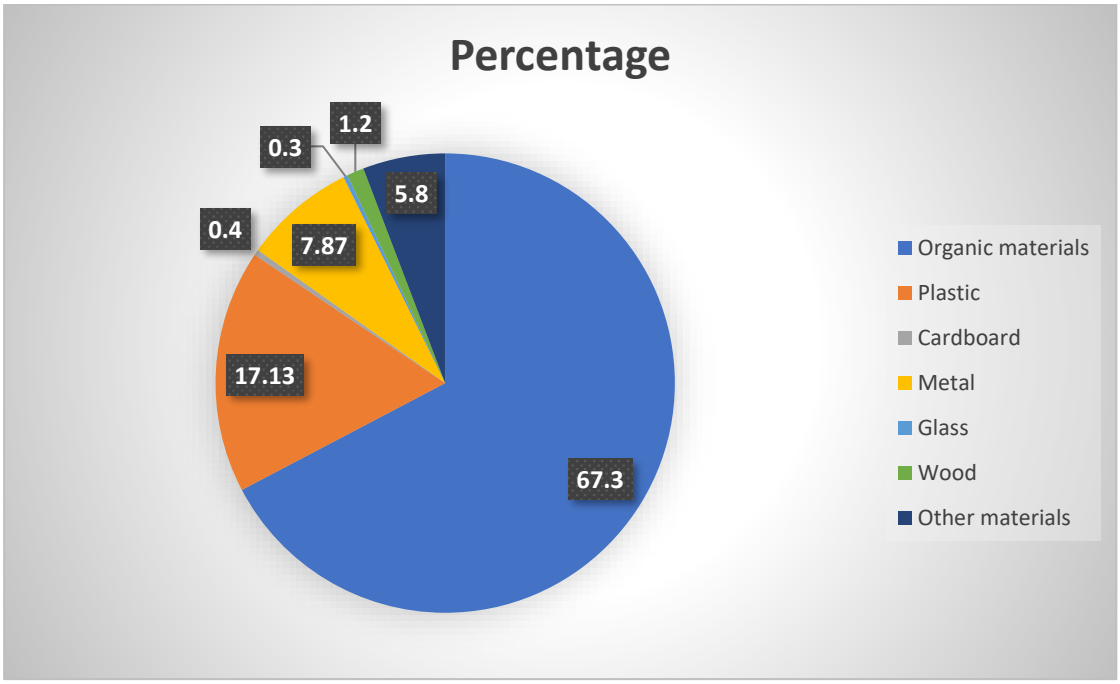
4.2.3. Waste components in Biskra city:

Table 4: Components of MSW in Biskra city

Type	Percentage
Organic materials	67.3
Plastic	17.13
Cardboard	0.4
Metal	7.87
Glass	0.3
Wood	1.2
Other materials	5.8
The total	100

Source: Landfill Center, Net–Sokara Foundation

Figure 35: Percentages of household solid waste components for Biskra city in 2023



Source: made by author

4.3.Disposal:

In Biskra city There are three types of MSW management:

4.3.1. Incineration:

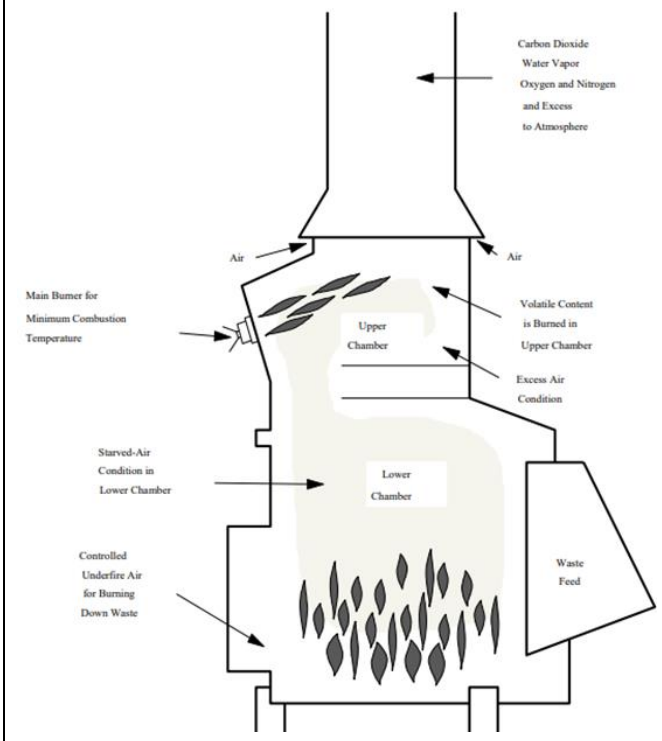
Medical waste incineration involves the burning of wastes produced by hospitals, veterinary facilities, and medical research facilities. These wastes include both infectious (red bag) medical wastes as well as non-infectious, general housekeeping wastes. Some characteristics that must be present in solid waste in order for it to be incinerated:

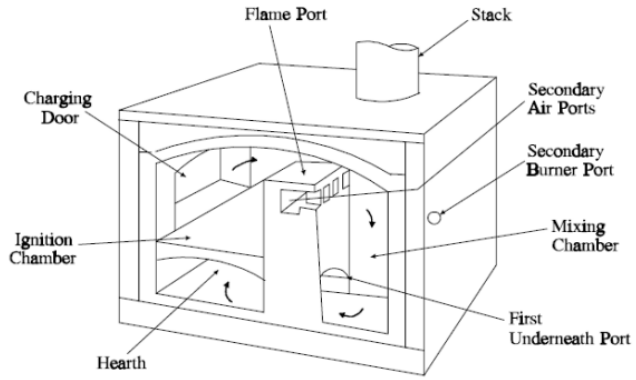
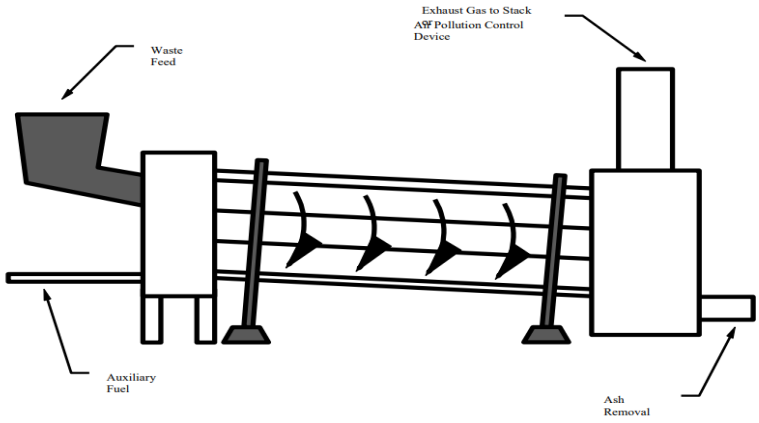
- Waste containing combustible materials only 60% of the total quantity

- Waste containing non-combustible solid materials at a rate of less than 5% of the total quantity
- Waste containing soft, combustible materials at a rate of less than 20% of the total quantity.
- Waste containing a moisture level of less than 30%

Three main types of incinerators are used: controlled air, excess air, and rotary kiln.

Table 5: the Three types of incinerators

Genre	Image
controlled air	

excess air	
rotary kiln.	

Source: https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s03.pdf

Sokara -Net disposes of medical solid waste that it transports from hospitals by burning it in one of the two incinerators which are in: SIDI OKBA, GANTRA. (boudjemaa & meziani, 2019)

4.3.2. Landfills:

It is a method of disposing of solid waste using a specific land without causing damage and hazardous effects on the environment and public health. To obtain landfill, clay or artificial layers and barriers must be used to control the discharge of water resulting from the waste leachate. After the land is completed from burying the waste, it is planted with grass to turn it into a garden, as well as a

system to control methane gas and leachate generated from landfills (boudjemaa & meziani, 2019)

Information about technical landfills in Biskra city:

The Sokara Net Foundation disposes of solid waste that was transported from homes and public areas by landfilling in the Foundation's health landfill center in the Lahzima area in the city of Biskra, which the Foundation obtained from the state through the "exploitation right". Which was prepared according to environmental standards as it does not lead to pollution of the surrounding areas. There are several conditions for establishing sanitary landfill centers, which are: 25 km away from residential units, not less than 2 km from the nearest residential unit, taking into account the direction of the prevailing winds, as one study in Britain found that the proximity of residential units to these wastes will cause the population to be exposed to increased Deformity in children increased by 7%. There is also a similar study in the United States of America, where the rate of spina bifida in children increased by 5%. (boudjemaa & meziani, 2019)

- It must be far from surface and groundwater sources;
- It is preferable to reside in non-agricultural soils.
- The advantages of the sanitary landfill method are as follows: 26
- Preserving the environment and public health.
- Avoid the spread of rodents, insects, diseases and fires.
- Maintain the overall appearance.
- An outlet can be created for methane and other gases to be used as fuel.

- One of the disadvantages of this method is that it disposes of waste and does not benefit from it, such as the waste recycling process.

Table 6: Information about technical landfills of Biskra city

area	20 hectares
Number of pits	04
Carrying capacity	19 trenches
Fullness percentage	55%

Source: Net–Sokara Foundation

Table 7: Annual waste production in the city of Biskra between 2018 to 2023

Year	2018	2019	2020	2021	2022	2023
quantity	51383,09	50876,11	45763,05	43137,57	39367,21	40271,82

Source: Sorting and recycling center

4.3.3. Recycling:

Sokara-Net Foundation recycles part of the solid waste that it transported. When the solid waste that was transported from homes, public areas, institutions, etc. is emptied, the Foundation performs a simple sorting process, which consists of collecting valuable materials and selling them. The materials that the Foundation recycled are copper, iron, plastic, aluminum, wood... Thus, this waste has transformed from being an environmental problem with a high cost of disposal to being considered waste that is convenient and has economic benefit. (boudjemaa & meziani, 2019)

5. MSW Technical sorting center:

A Municipal Solid Waste Technical sorting center is a facility designed to process and sort the waste generated by households, businesses and institutions. The main goal of an MSW Technical sorting center is to recover recyclable materials such as: paper, plastic and metal, from the waste stream and divert them from landfills, thus reducing the environmental impact of waste disposal.

5.1.Location:

The technical sorting center is located in Outaya, specifically in the landfill center, 2km northwest of Biskra city.

Figure 36: Sorting center

Source: google maps

Figure 37: Sorting center

Source: taken by student

5.2.Method of Work:

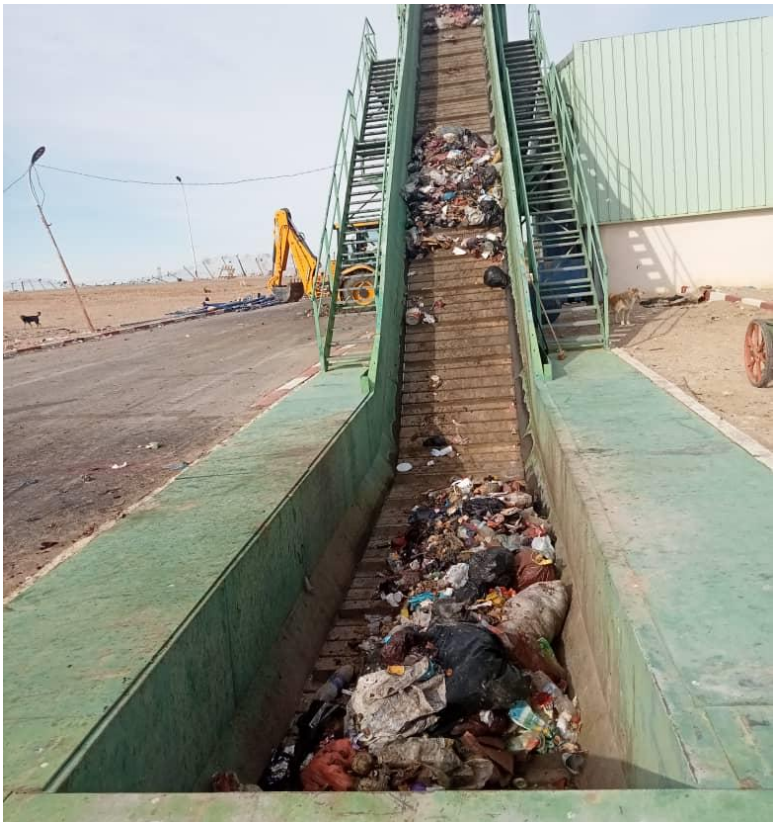
The center contains several machines that work in accordance with each other, that is, in an organized manner, as follows:

a) Unloading:

First, a truck full of waste weighing approximately 9 tons, enters the center, where it is unloaded in a designated place near the feeding conveyor belt.

Then, the waste is elevate using the feeding conveyor belt that is controlled from inside the center.

Figure 38: Feeding Conveyor belt



Source: taken by student

b) separation of fines:

After going up the feeding conveyor belt, waste is feed to a drum screen (Trommel screen) where trash bags are broken using the internal blades.

Figure 39: Drum screen

Source: taken by student

Then, the organic materials and any waste that is smaller than 5cm, will be sifted through the small openings inside the drum screen straight down into trash bins.

Figure 40: Drum screen

Source: taken by student

c) Sorting:

The waste enters the sorting conveyor, where the latter includes five chambers placed underneath it, connected to openings from which the waste is thrown by the 12 workers.

Figure 41: Sorting conveyor

Source: taken by student

Figure 42: Material Collection Bunkers

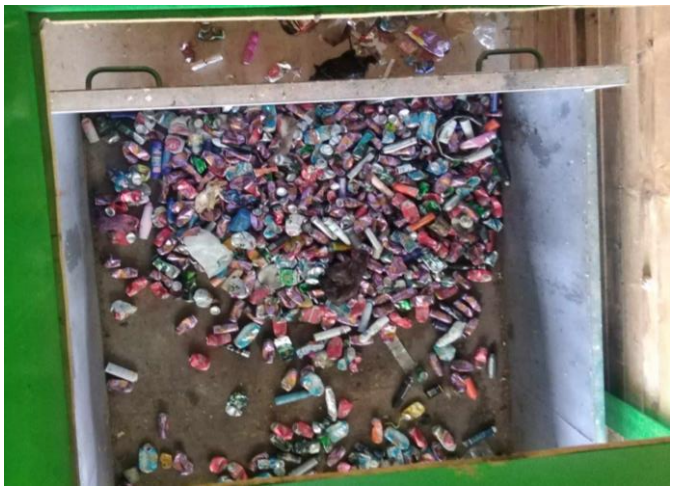
Source: taken by student

Each room contains a type of waste:

Table 8: Types of Waste

Type	Example	Reference
PET	Soda bottles, water bottles, polyester film…etc.	

PE-HD	Detergent containers, plastic bottles…etc.	
Plastic film	Shopping bags, waste bags, plastic bags, clear food containers…etc.	
Cardboard	Cardboard and Paper Bags, Books, Magazines…etc.	

Scrap Metal	Food and beverage containers	
Aluminum	Aluminum beverage cans, foil, disposable baking pans…etc.	

Source: made by author

Finally, the sorting workers throw the materials that cannot be recycled into the sixth room to go to the landfill center.

d) Compacting:

After the waste is sorted and thrown into the bins, it is taken to the waste compacter machine where it is broken into sections.

At the beginning, a cardboard clip is put inside the machine, it is followed by the sectioned waste. Then, another cardboard clip is put in.

After that, the machine is closed and turned one using a button. Where it proceeds to compact the waste into a block that weighs approximately between 2~2.5 quintal.

Figure 43: Waste Compacter Machine

Source: taken by student

Figure 44: Waste Blocks

Source: taken by student

e) Storing:

After a waste block is made, it is loaded into a truck where it is taken to be weighed and stored in a warehouse until it is sold.

5.3.The selling of waste blocks:

Despite the fact that the center has yet to start working, it has preset rules for selling the waste blocks. as follows:

- Auction:

  After collecting the waste blocks and sorting them, an auction is launched where the quantity and price of each type of waste block is already set.

- Demand:

  Where the factory sets the price of the product that it wants to buy. Then after the discussion, a contract is signed for a year or two.

5.4.Problems encountered during the waste collection process:

- There are many problems that are encountered during the waste collection process some of which are:
- Weather disturbances, such as rain and wind, that impede the waste collection process
- Citizens not adhering to the specified schedule for the waste truck's passage
- Random disposal of waste in undesignated areas
- Citizens mix materials in the waste, leading to work accidents for waste collection and transport workers.

- Insufficient number of waste bins and collection points, leading to overflow and littering.
- Operational Inefficiencies: Delays and breakdowns of waste collection vehicles, causing disruptions in the collection schedule.
- Lack of adequate manpower to cover all areas effectively, leading to inconsistent waste collection.
- Limited budget for waste management services, affecting the quality and frequency of waste collection.
- Low levels of public awareness and education about proper waste disposal practices, resulting in improper waste management.
- Instances of illegal dumping of waste in unauthorized locations, creating environmental and health hazards.
- Absence of effective recycling programs, leading to increased volume of waste that needs to be collected and disposed of.
- Inefficient coordination between different waste management departments and agencies, leading to fragmented and ineffective waste collection efforts.

Conclusion:

In this chapter. Valuable information about the current situation of waste management in the city of Biskra, which is trying to solve all the problems related to this field, which will constitute a dilemma if the situation is not controlled as quickly as possible.

we started with the concepts related to waste from Algerian law to the stages of waste management and treatment at Net–Sokara Foundation, which is considered the primary responsible for this process in the city of Biskra, then to an analytical study on the technical landfill center that ensures good waste disposal in the city of Biskra.

Chapter 03: the economic impact of MSW management in an urban environment

Introduction:

Proper Management of MSW has a significant impact on the economy of developing countries or cities. Therefore, many developing countries are striving to develop better MSW management strategies and technologies to address economic sustainability issues.

In this chapter, we will touch on the revenue of the technical sorting center in Biskra city, and its future development and economic contribution to not only Biskra city. We will also mention some global examples.

1. MSW Technical sorting center revenue:

the MSW sorting center has 100% gain, because it receives the waste for free. it is only responsible for sorting and selling the waste blocks.

Despite the sorting center not having the ability to recycle all of the waste materials (ex: paper, glass, organic materials), what it can recycle has a significant revenue, as it is shown in the table below:

Table 9: The Prices of the Sorted Waste 2023

Type	Price (DZ) for 1ton
PET	40.00
PE-HD	60.00
Plastic film	70.00
Cardboard	150.00
Scrap Metal	40.00
Aluminum	150.00

Source: Technical sorting center + made by author

Table 10: The Quantity and Prices of the Sorted Waste 2023

Type	Percentages (%)	Quantity (ton)	Price (DZ)
PET	9.05	3,618.97	144,759.00
PE-HD	5.08	2,050.91	123,055.00
Plastic film	3	1,228.68	86,008.00
Cardboard	0.4	161.09	24,164.00
Scrap Metal	4.98	2,005.54	80,222.00
Aluminum	2.89	1,163.85	174,578.00
Total	25.4	10,229.04	632,786.00

Source: Technical sorting center + made by author

From the table above we can notice that despite the center sorting only 25.4% of the total of waste, it managed to bring in 632786.00 DZD of revenue in one year.

If the center was provided with more investment, and given the ability to manage the other types of waste, it can bring in more revenue. as it is shown in the table below:

Table 11: The Quantity and Prices of Non-Sorted Waste 2023

Type	Percentages (%)	Price (DZ) for 1ton	Quantity (ton)	Price (DZ)
Organic Materials	67.3	30.00	27,102.94	813,088.00
Glass	0.3	50.00	120.82	6,041.00
Wood	1.2	40.00	483.26	19,330.00
Total	68.8	/	27,707.02	838,459.00

Source: Technical sorting center + made by author

From the table above we can notice that with the addition of Organic Materials, Glass and Wood, the revenue of sorting center is almost the dabble of the original revenue.

Table 12:The Total Quantity and Prices of Sorted and Non-Sorted Waste 2023

	Percentages (%)	Quantity (ton)	Price (DZ)
Total	93.6	37,936.06	1,471,245.00

Source: made by author

Through these estimates we can observe, that the sorting center has the ability to bring in a significant revenue even when considering the operational costs.

It also can achieve the following goals:

- Reducing the costs of raw materials in terms of production or import.
- Reducing production costs (energy used, number of galactic operations...).

- Reducing private costs for treating various diseases resulting from various types of waste (solid, liquid, gaseous) and even the effects of acoustic pollution (noise).
- Creating new institutions and investments in the field of sorting and recycling.
- Providing new job opportunities, including those whose owners do not need certificates to work in them, which results in reducing the unemployment rate, knowing that every ton of solid waste can provide seven jobs for work through recycling operations.
- Reducing the number of diseases caused by various types of waste (solid, liquid, gaseous) and even caused by sound pollution (noise).
- Spreading a culture of awareness and involving citizens in preserving the environment.
- Reducing the rates of pollution in its various forms.
- Reducing pressure on dumpsters and landfills, and exploiting the lands allocated for this purpose for other investments.
- Preserving natural resources as much as possible; Preserving animal and plant biodiversity.

2. Global Examples:

2.1. A Path to Zero Waste in San Francisco, United States:

In 2002, San Francisco announced a vision to send zero waste to landfills by 2020. Through initiatives to promote recycling and composting, San Francisco is now one of the greenest cities in North America and a global leader in waste management.

San Francisco's success has been achieved largely by robust public policy implemented by determined political leadership, strong public-private partnerships, resident education, and financial incentives for waste reduction.

San Francisco was the first city in the United States to implement strict legislation about the use of or management of specific materials. The city prohibited the use of Styrofoam and polystyrene foam in food service (2006), required mandatory recycling for construction debris (2007), banned plastic bags in drugstores and supermarkets (2009), and implemented mandatory recycling and composting for both residents and businesses (2009). San Francisco most recently also banned the sale of plastic water bottles in 2014.

State-of-the-art outreach programs covering residences, businesses, schools, and events are widespread, and financial incentives encourage waste reduction and recycling. To help residents more clearly understand their waste disposal practices and financial impact, each house or building receives a detailed bill for waste management fees. Payments are reduced if residents shift their waste from mixed waste bins to ones designated for recycling or composting. Furthermore, the size of the provided mixed waste bins was halved and the size of recycling containers was doubled. Waste bins are regularly inspected, and households that fail to comply with policies first receive warnings, followed by a financial penalty.

San Francisco also introduced the first and largest urban food waste composting collection program in the United States, covering both the commercial and residential sectors. San Francisco has collected more than a million tons of food waste, yard trimmings, and other compostable materials and turned these materials into compost for local farmers and wineries. As a result of its efforts, San Francisco achieved nearly 80 percent waste diversion in 2012—the highest rate of any major city in the United States. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.2.Financial Sustainability in Argentinean Municipalities:

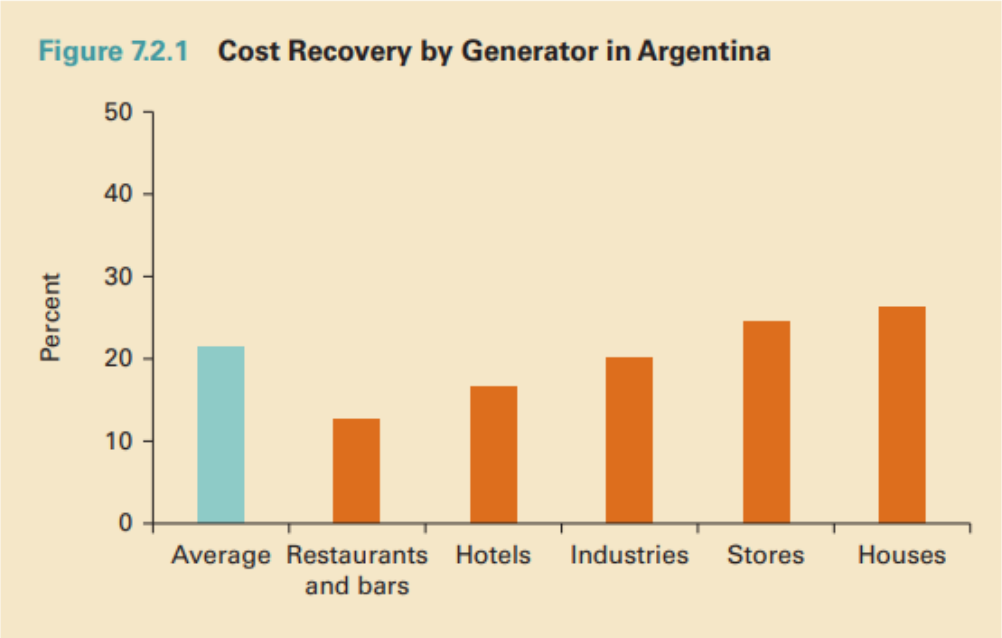
As in many other Latin American countries, municipal governments in Argentina were not aware of real solid waste management costs because they did not have a standard methodology or accounting system for estimating them. Municipalities also generally did not charge fees for waste services and very little in the way of municipal funds was earmarked for solid waste management.

Argentina quantified the total cost of its waste system to improve long term sustainability. Under the World Bank–financed Integrated Solid Waste Management Project, the Secretariat of Environment and Sustainable Development (SAyDS) developed a tool known as the Integrated Urban Solid Waste Management Economic and Financial Matrix. This tool helps municipalities understand the real costs of services and value of investments. The tool analyses each stage of the solid waste management value chain, identifies the proportion of costs recovered by fees, and identifies ways to reallocate budget resources to improve financial sustainability.

The tool was made available to all municipalities in Argentina. Based on its deployment, SAyDS and the Ministry of Environment set the following goals for municipalities:

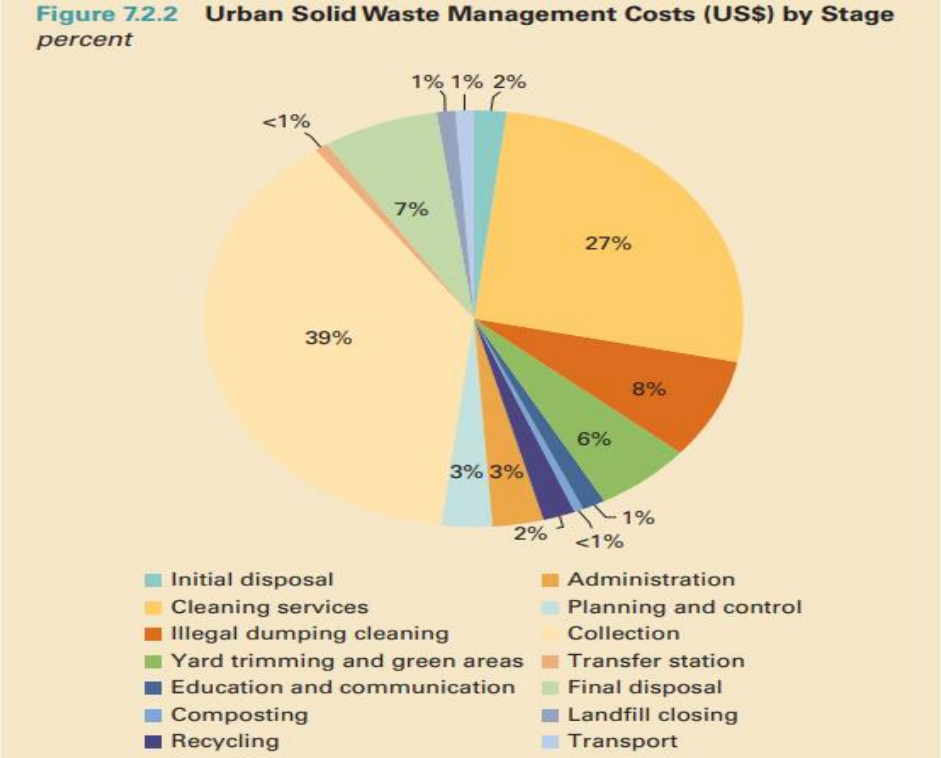
- Calculation of all integrated solid waste management costs (figures 7.2.1–7.2.3) and identification of all associated revenues toward the goal of equilibrating waste management accounts
- Development of potential new cost-recovery schemes and calculation of the associated fees using data
- Implementation of the polluter-pays principle so that larger generators of waste pay more. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Figure 45: Cost Recovery



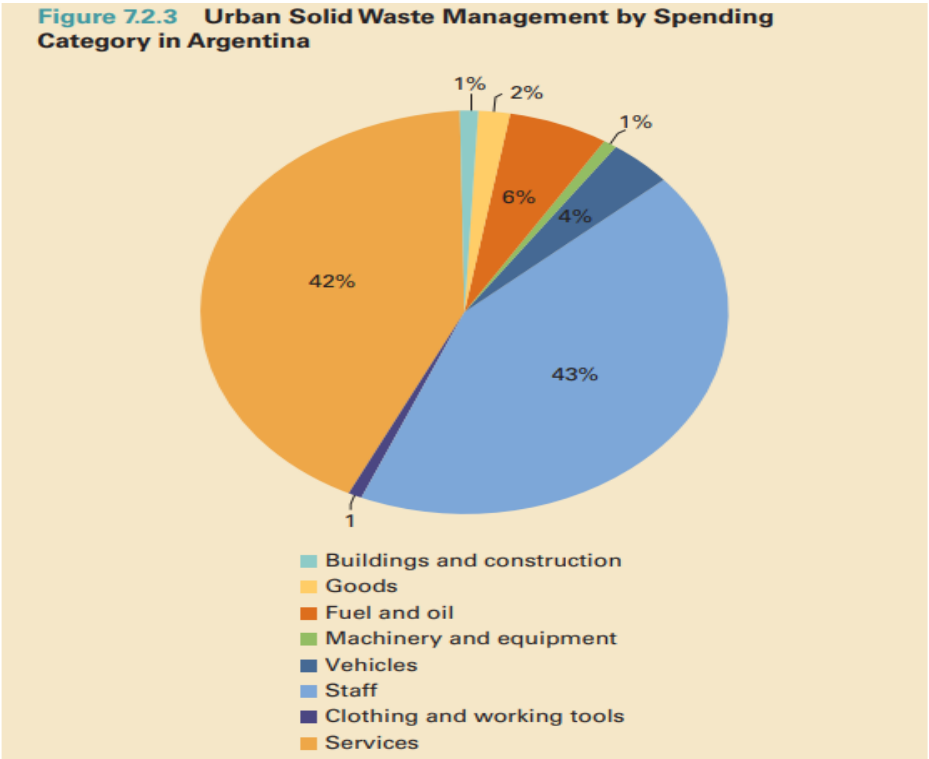
Source: (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Figure 46: Urban Solid Waste Management Costs



Source: (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Figure 47: Urban Solid Waste Management



Source: (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Through in-person and online trainings, 535 municipal and provincial staff were trained and municipalities covering 26 percent of the population collected financial data using the tool.

The municipalities of Mar del Plata, Rosario, Viedma, Concordia, and Posadas have implemented cost recovery systems using the financial matrix. Mar del Plata, a large coastal municipality, implemented a differentiated fee system across wealthy and poor neighborhoods after a broad communications campaign and outreach effort. Both the variable costs of the waste system and the operational costs of the landfill are covered. Rosario, on the other hand, applied a specific fee to large waste generators. Municipal networks have also been developed to share information and experiences, such as suppliers that provide superior goods and services or that offer more competitive costs, peer-to-peer advice on strategy and operations, and opportunities for technicians from municipalities to participate in personnel exchanges with other towns and facilities within their province.

A key factor for implementation of the financial tool was having the necessary human and financial resources. SAyDS was fully staffed with qualified teams that could carry out outreach and capacity-building campaigns to provincial and municipal governments, tailor the training to specific needs of the local governments, and scale up the training nationwide. Through this success, municipalities-built trust with the federal government and had the political support needed to improve cost recovery.

The tool was complemented by support for an institutional frame work developed by the Integrated Solid Waste Management Project that allowed for agile coordination between the municipal, provincial, and federal governments. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.3. Cooperation between National and Local Governments for Municipal Waste Management in Japan:

Japan manages its waste through comprehensive governance and advanced technologies. Of the nearly 44 million tonnes of waste generated annually, only 1 percent is landfilled. The remainder is recycled or converted to energy in state-of-the-art waste-to-energy facilities. Japan's efficient solid waste management practices can be largely attributed to effective cooperation between its national and local governments. The central and urban public authorities coordinate along several dimensions, from data collection to financing. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.3.1. Data Collection and Database Management:

Each year, the national Ministry of the Environment conducts an annual waste management survey. Local governments' responses are aggregated in a comprehensive database that both national and local governments use to develop plans, strategies, and policies. Information surveyed includes the quantity of waste that is generated and the amount of waste disposed of via recycling, composting, and incineration. The materials recovery rates reported through the survey are disclosed to the public, which provides incentives to local governments to increase sustainable disposal practices. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

The transparent data system allows local governments to compare their plans and outcomes with those of other local governments that have similar economic and demographic profiles. Local governments use this information to evaluate and continually improve their processes. Members of the public and academic

organizations may also use the data to evaluate the effectiveness of the waste management system.

In 2016, 1,741 municipalities and 578 special district authorities3 completed the national survey. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Table 13: cooperation of national and local government in Japan

Table 7.4.1 Cooperation of National and Local Governments in Japan on Municipal Solid Waste Management

Task	Local governments	Relationship	National governments
1. Survey on the state of municipal solid waste management	Collection and submission of waste-related data	Waste Data → ← Database	Collect data from local governments and aggregate responses within a central database
2. Basic municipal waste management plan	Development of a solid waste management plan	Guidelines → ← Plan	Provision of guidelines for municipal solid waste management plans
3. Waste management plan implementation	Construction of waste treatment facilities	Construction → ← Subsidies	Provision of subsidies for construction of waste treatment facilities
4. Exchange of resources and information across government levels	Collect and submit feedback to national agencies	Information ↔ Human Resources	Facilitate exchange of human resources between national and local governments

Source: Shiko Hayashi.

Source: (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.3.2. Municipal Solid Waste Management Planning:

All local governments in Japan are required to develop a local solid waste management plan that looks ahead about 10 years. To ensure consistency and thoroughness of local plans, the national government publishes guidelines for municipalities; these guidelines urge municipalities to detail their intended initiatives to sustainably treat waste and promote waste reduction, reuse, and recycling. All local governments comply with national laws and regulations,

including the Air Pollution Control Act, the Soil Contamination Countermeasures Act, the Water Pollution Prevention Act, and the Act on Promotion of Private Finance Initiatives. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.3.3. Financial Support for Municipal Solid Waste Infrastructure:

The Japanese national government provides subsidies to municipalities to develop and improve waste treatment facilities based on the waste management plans submitted by local governments. Subsidies cover up to one-third of the cost of basic infrastructure projects, and for advanced facilities, such as high-efficiency waste-to-energy facilities, subsidies often cover half of project costs. The types of projects that are subsidized include recycling facilities, waste-to-energy plants, organic waste processing sites, septic tanks, landfills, refurbishing of waste treatment equipment, and extension of the lifespan of existing waste disposal facilities. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.3.4. Information and Human Resource Exchange:

To promote connectivity and knowledge exchange between the national government and local governments, public officials and employees may take on roles in other levels of administration. There are also several mechanisms that allow local governments to report feedback to the national government, including the Japan Waste Management Association (JWMA), which includes 585 municipal governments, and the National Governors' Association. For example, at the annual meeting of the JWMA, local governments submit feedback that is aggregated by the JWMA and shared with national agencies, including the Ministry of the Environment.

Japan's coordination in key dimensions of waste management ensures that best practices are disseminated across the country, planning is conducted in a data-driven manner, and cities have sufficient financial and human resources to process waste in a most sustainable manner. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Figure 48: Japanese Bines

Source: (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Figure 49: Japanese Recycling Facility

Source: (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.4.Eco-Lef: A Successful Plastic Recycling System in Tunisia:

Tunisia provides an example of successful integration of the informal recycling sector into waste management and of the application of the extended producer responsibility principle. In 1997, the Ministry of Environment launched a national program, Eco-Lef, to address the significant issue of postconsumer packaging waste. The Eco-Lef program developed a national system for the recovery and recycling of postconsumer packaging primarily focused on plastic waste.

The Eco-Lef program is governed by a decree that specifies the methods required for the collection and management of bags and packaging waste (Republic of Tunisia 1997). The program is partly financed by the private sector through an eco-tax of 5 percent on the net added value of certain locally manufactured or imported plastic

polymers.5 The National Agency for Waste Management (ANGed) is responsible for administering the Eco-Lef program.

The Eco-Lef program has successfully improved postconsumer packaging collection and recycling rates. The system encourages individual and informal collectors to gather used plastic and metal packaging and deliver the materials to Eco-Lef collection centers. In return, waste collectors receive remuneration based on the type and quantity of packaging collected. There is a financial advantage for participating in the Eco-Lef system: prices for plastic packaging waste in a local market are about 500 dinars per tonne (US$208 per tonne) compared to 700 dinars per tonne (US$290/tonne) at Eco-Lef collection centers. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

The system has an annual budget of US$5.8 million for 2018, and currently operates through 221 Eco-Lef collection centers, 41 of which are managed by ANGed and the remainder managed by the private sector (ANGed and Ministry of Social Affairs and Environment 2018). The centers have collected more than 150,000 tonnes of plastic packaging waste since the program's launch in 2001. Depending on the type of plastic, 70–90 percent of collected waste is recycled through more than 70 active private recyclers who receive plastic collected through the Eco-Lef system. Eco-Lef has contributed to the creation of about 18,000 jobs and 2,000 micro-enterprises for collection with the financial support of the National Employment Fund, a government fund that helps vulnerable populations find employment.

The Eco-Lef experience provides several key lessons:

- The extended producer responsibility principle can create a financially sustainable system for the collection, transportation, and recycling of materials.

- Government support in connection to legal, institutional, and operational activities is critical to the development of a recycling value chain.

- Long-term ownership and management of the recycling system by the private sector can result in greater financial sustainability and operational efficiency.

- Integration of informal waste pickers into formal waste management operations can contribute to the success of recycling initiatives. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Figure 50: Eco-Lef workers collecting and waiting packaging waste

Source: (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.5.Financially Resilient Deposit Refund System: The Case of the Bottle Recycling Program in Palau:

Palau is a small country in the North Pacific with a population of 21,000 in 2015. Palau's economy relies on tourism visits to its famed Rock Islands and impressive diving sites. As of 2016, Palau received about 12,500 visitors per month.

Waste collection is coordinated within each state and waste disposal is the responsibility of the national Solid Waste Management Office of the Bureau of Public Works, which manages the M-dock semi-aerobic landfill, the country's largest landfill, situated in the capital city, Koror. Financially, solid waste management is funded entirely by the government. Although households and institutions are required to segregate waste streams, including for various recyclables and food waste, user fees are not charged or imposed on residents and businesses for waste collection and disposal, with the exception of a beverage container recycling program.

Solid waste generation is an increasing problem in Palau because of booming tourism and an increasing local population. Palau's waste system is inundated with food waste and plastics, composing 26 percent and 32 percent of waste, respectively. Tourism generates a large volume of beverage containers, and as an island state, plastic waste would overwhelm Palau if it is not addressed properly. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.5.1. Palau's Beverage Container Recycling Program:

In response to increasing plastic waste, the national government passed the Beverage Container Recycling Regulation in October 2006 to establish a national recycling program. The program is overseen by three main agencies: the Ministry of Finance (MOF), the Ministry of Public Infrastructures, Industries

and Commerce (MPIIC), and the Koror State Government. The MOF manages the recycling fund, the MPIIC implements the recycling program, ensures sustainability, and identifies opportunities to export redeemed containers, and the Koror State Government operates a redemption center.

Palau's beverage recycling system addresses containers that are 32 ounces and smaller. The national government levies a US$0.10 deposit fee to consumers for plastic, glass, and metal containers, which are typically imported.

When a container is returned to a redemption center, US$0.05 are returned to the customer, US$0.025 are channelled to Koror State, and the remaining US$0.025 are given to the national government to cover administrative costs.

The program began with a 6-month fundraising period to ensure operational sustainability during which beverage containers were taxed but the refund program was not yet in operation. This initial effort led to more than US$659,000 in revenue and funded the initial phases of the refund program. Through the program's full operation from 2011 to 2016, the national government earned US$2.2 million and refunded US$3.9 to customers by recovering more than 88 million imported containers. Through this system, about 8 percent of beverage containers were removed from the waste stream. In addition, about 98 percent of aluminium containers were recycled. Furthermore, about US$12,000 in operational costs were saved by diverting the containers from the M-dock semi-aerobic landfill. Collected beverage containers are shipped to Taiwan, China, for further processing.

The program has provided a variety of benefits. The national government has used profits to purchase heavy equipment to fix the slope of the M-dock semi-

aerobic landfill, preventing a potential landslide of the waste. Koror State has used proceeds to buy balers and other equipment to improve the efficacy of the redemption center. The program has also provided employment to individuals who collect containers from other states. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Figure 51: Compacting beverages containers inside the plant in Palau

Source: (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.5.2. Enabling Environment:

Palau's beverage recycling program serves as a model for island countries that face limited space for waste management facilities and that possess sensitive natural environments. The program has operated sustainably because of the following factors:

- Strong national government oversight: The Recycling Act of 2006 effectively mandated a disposal fee for beverage containers. Because it is an island, the government maintains strong control over the entry of goods across its borders, which makes the program easier to monitor and manage.

- Effective financial incentives: The US$0.05 that residents are paid for each redeemed container makes the program sufficiently attractive to the public. The program has virtually removed used containers from the streets.

- High public participation: The key to the sustained operation of Palau's bottle recycling program is strong public support. Palauans realize the value of preserving their environment and the economic value of tourism.

- Collaboration between Palau's national government and Koror State: National and local collaboration in Palau was made possible by clear delineation of roles and responsibilities. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.6.. Improving Waste Collection by Partnering with the Informal Sector in Pune, India:

The city of Pune has significantly advanced its solid waste management by entering into a public-private partnership with the organization SWaCH (Solid Waste Collection and Handling or, officially, SWaCH Seva Sahakari Sanstha Maryadit, Pune). SWaCH is India's first self-owned cooperative of waste pickers and other urban poor. In 2008, Pune Municipal Corporation (PMC) signed a five-year memorandum of understanding that gave SWaCH responsibility for collecting source-separated waste from households and commercial establishments, depositing the waste at designated collection points, and charging a user fee. The agreement also authorized waste collectors to retrieve and sell recyclables from aggregated waste.

Pune generates about 1,500–1,600 tonnes of solid waste per day. SwaCH provides door-to-door waste collection services to more than 500,000 households in the city and covers 60 percent of the geographical area. The remaining 40 percent not covered by SwaCH's collection operations either receive waste collection services directly from the city or dispose of waste in the city's community bins. The SwaCH door-to-door collection partnership has saved PMC about 510 million Indian rupees (about US$7.9 million) each year and has reduced carbon emissions significantly through reduced truck usage. In 2016, the agreement between PMC and SwaCH was renewed for another five years. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.6.1. Overview of the Public-Private Partnership:

Through the arrangement with PMC, 2,688 SwaCH members collect segregated waste from households, institutions, and businesses. Waste collectors sort dry waste in sheds provided by PMC and retrieve recyclables such as paper, glass, and

plastic. Waste collectors retain all income from the sale of reclaimed materials, and in 2016 SwaCH diverted 50,000 tonnes of waste to recycling.

The door-to-door collection program was introduced first through a pilot in apartment complexes in wealthy areas, where citizens were highly aware, and had a willingness to pay, and were politically supportive of the initiative. The success of the pilot created demand in other areas of the city. Awareness initiatives, including rallies, one-on-one meetings, and political endorsement by local councillors, further generated support.

SWaCH members collect monthly user fees ranging from INR 10 to INR 40 (US$0.15–US$0.6) per household and INR 100 (US$1.5) per commercial entity for waste collection services. PMC partially subsidizes collection costs in slums so that households pay about INR 5 (US$0.07) per month. The total estimated cost of collection to the city is one of the lowest in India, at about INR 4.38 per month (US$0.06) in 2015.

SWaCH members also treat organic waste. Members are trained to operate biogas plants and to compost waste. To encourage citizens to treat waste at the source, PMC rebates 5 percent of property taxes to institutions that compost their own organic waste. Many of these institutions hire SWaCH members to collectively compost about 10 tonnes of waste per day. SWaCH members also operate bio methanation plants through build operate-transfer contracts with the city.

Because the SwaCH model is based on customer satisfaction, the service provider is directly accountable to the user and has incentives to provide quality services. The service provider is entitled to collection of waste dumped outside of homes, which encourages user compliance. PMC conducts individual consultations with

households to gain user support and levies penalties on users who fail to provide payment for services.

To provide financial resilience to the public-private partnership, PMC provides an ongoing annual grant to SWaCH that covers management and training costs, awareness-generation programs, and welfare benefits for members of SWaCH. The grant does not cover the salaries of collectors. Through the partnership with SWaCH, Pune has offered sustainable and efficient daily waste collection services to residents while improving the livelihoods of waste collectors within the city. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

2.7. Improving Waste Management through Citizen Communication in Toronto, Canada:

Toronto, Canada, uses citizen engagement to build a foundation for a more efficient solid waste management system. A multipronged communication strategy has been critical for reaching various residential audiences. Toronto has launched a detailed, interactive website that educates residents on garbage reduction, reuse, and recycling. Waste management information that is relevant to citizens, such as source-separation guidelines, drop-off points, city regulations, and disposal rates and fees, are readily available on the site in a user-friendly, attractive manner.

Within the online platform, residents can use the Waste Wizard tool to understand how and on what day any item should be disposed of and when (figure 7.11.1). For instance, a search for items such as “pencil” and “clothes” yields advice on donating items in good condition wherever possible and disposing of the items in a garbage bin as a final option. A search for “plastic chair” results in guidance to place oversized items two feet away from the garbage bin on the next scheduled collection day.

Toronto also actively uses social media to reach a wide audience. For instance, YouTube videos explain garbage to kids in a fun and simple way.6 Videos are also available in foreign languages to reach growing populations living in multifamily homes, where recycling and composting rates (at 27 percent) are relatively lower than in single-family homes (at 65 percent).

Other successful initiatives to engage residents include a waste collection schedule mobile application and the 3Rs Ambassador Program, in which volunteers are trained to educate fellow residents on sustainable practices in waste reduction, reuse, and recycling. In 2016, the Mayor's Towering Challenge was organized to recognize notable reduce and reuse initiatives led by city residents. Toronto is currently focusing on applying these excellent communication strategies to implementation of its Long-Term Waste Strategy to achieve zero waste in the next 30 to 50 years. (Silpa , Yao, Bhada-Tata, & Van Woerden, 2018)

Conclusion:

In this chapter, we discussed the economic impact of municipal solid waste (MSW) management in urban environments, highlighting the gains of the technical sorting center in Biskra city, and successful global models.

In conclusion, the economic impact of municipal solid waste (MSW) management in urban environments is a complex issue with broad implications that requires adequate human and financial resources, and proper investment from both the governments and citizens.

Chapter 04: the socio-spatial impact of MSW management in an urban environment

Introduction:

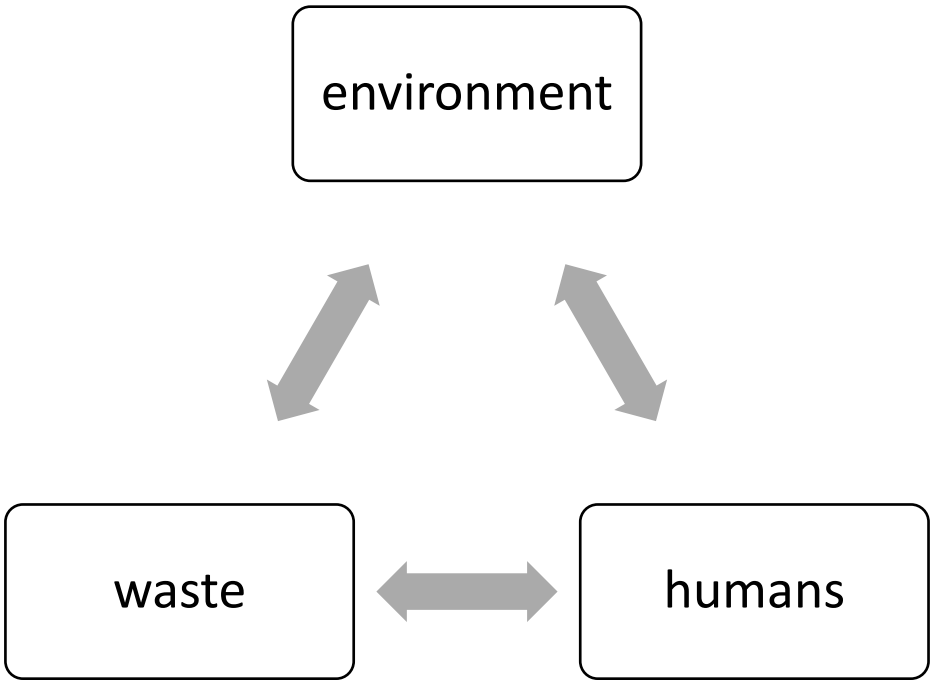
Improper municipal solid waste management can lead to health hazards, affecting the well-being of urban residents. It can also contribute to social inequality, as marginalized communities often bear a disproportionate burden of waste disposal and its associated environmental and health effects.

In this chapter we will discuss the intricate relationship between the environment, humans and Waste. As well as, the benefits of proper municipal solid waste management and the difference between manual solid waste sorting and source separation.

1. Environment, human and waste trinity

There is an intricate trinity between the environment, humans and waste. In which they affect each other in both a positive and negative ways. Over time, this relationship became an endless cycle where a person can't distinguish where it starts or ends.

Figure 52: Environment, human and waste trinity



Source: made by author

1.1.Human-Environment and Waste Interaction:

1.1.1. Negative Interaction:

a) Deforestation:

The loss of millions of acres of forests annually for different agricultural expansion has detrimental effects on biodiversity, climate change, and human food supply.

b) Water Usage:

The extraction and misuse of water resources have led to strained freshwater availability, impacting agriculture, wildlife, and ecological balance.

c) Urban Expansion:

Urban growth contributes to many different problems such as: habitat destruction, pollution, and strain on water resources.

d) Waste Production:

Waste is produced by humans and deposited in the natural environment. It is therefore an inevitable product of human-environmental interactions. Waste increases along with the world's population, modifying the landscape during waste disposal at landfill sites. This negatively impacts both the environment and human health. **Invalid source specified.**

e) Pollution:

Pollution also creates a negative impact on ecosystems. This human-environment interaction is created by humans in a variety of ways. There is pollution connected to waste, such as pollution from agriculture, landfill, and littering. There is also air pollution, water pollution, noise pollution as well as pollution from burning fossil fuels, which contributes to greenhouse gas emissions. (htt1)

f) Health Hazards:

Improper disposal of household waste can pose significant health risks to waste workers and the general public. Work-related disorders and injuries, including respiratory problems, infectious diseases, and gastrointestinal issues, have been documented among waste collectors around the world, highlighting the potential health hazards associated with mismanaged household waste.

g) Groundwater Contamination:

Household hazardous waste not only has direct impacts on human health but also contaminates groundwater, increasing the risk of contaminating wildlife habitats. Pollutants can leach from littered household waste into the ground, posing a threat to the environment and public health.

h) E-waste Impact:

Improperly managed e-waste poses significant threats to the environment, including heavy metal contamination in foodstuff, house dust, farm soil, and

groundwater. Work processes in e-waste recycling areas that are not regulated can lead to environmental pollution and health risks.

i) Water Pollution:

Contamination in rivers from point source or non-point source pollution, including agriculture, sewage, and waste water, can degrade water quality and be toxic to humans and the environment. Water pollution can lead to many deaths and illnesses worldwide, especially in low-income and third-world communities.

j) Impact on Ecosystems:

Human-generated waste, including non-biodegradable materials like microplastics, has detrimental effects on various ecosystems. Plastic pollution, for example, significantly impacts marine life and landfills, leading to negative consequences for wildlife populations and biodiversity.

k) Climate Change:

Improper waste disposal contributes to the emission of greenhouse gases, particularly methane from landfills. This exacerbates the climate crisis and poses risks to human health. In the United States, a significant portion of waste is incinerated in open-trash sites, further contributing to these large-scale risks.

1.1.2. Positive Interaction:

a) Reforestation:

Replanting areas that have been affected by natural disturbances like wildfires, drought, and insect and disease infestations, or unnatural ones like logging, mining, agricultural clearing. This can help to protect endangered species, filter our drinking water through the roots and even remove air pollutants.

b) supporting protected growth of endangered species:

By developing and implementing effective strategies for the protection and recovery of endangered species, and providing a safe and healthy environment for certain animals.

c) Urban Green Projects:

Introducing green spaces or elements into urban environments can encompass a wide range of activities, such as creating parks, community gardens, green roofs, urban forests, or planting trees along streets. The goal is to enhance the quality of urban life by providing residents with access to nature, improving air quality, mitigating the urban heat island effect, promoting biodiversity, and offering recreational spaces.

d) Protection Of National Parks:

“It is a large, naturally beautiful, ecologically rich area, relatively unaltered by people, with legal protection for its wildlife and habitats, that promotes education and recreation.” the International Union for Conservation of Nature (IUCN).

e) Water Management:

Water management is a critical aspect of environmental stewardship, given our fundamental reliance on water for survival. By adopting better water management practices and embracing systems like rainwater harvesting, we can significantly reduce our dependence on natural water supplies.

l) Recycling and Reusing:

Recycling materials like glass, plastic, and aluminum helps keep them out of landfills, contributing to waste reduction and environmental preservation.

Reusing items, such as gift wrap and tissue paper, promotes sustainable practices and reduces unnecessary waste.

m) Renewable Energy Adoption:

Embracing renewable energy sources, such as solar and wind energy, contributes to sustainable energy consumption and reduces reliance on traditional fossil fuels.

n) Eco-Prospecting and Eco-Refining:

Human waste, including greywater, brown water, yellow water, and black water, can be subjected to eco-prospecting to extract valuable nutrients like phosphorus (P). These nutrients can then be used for agricultural purposes, providing benefits to crop production and soil fertility.

Table 14: Case Studies of Human-Environment Interaction

Case Study	Region	Environmental Impact	Positive Aspects	Negative Aspects
Deforestation in the Amazon Rainforest	South America	Loss of biodiversity, disruption of water cycles, increased greenhouse gas emissions	Indigenous communities' sustainable practices, valuable resources	Habitat destruction, soil erosion, potential tipping point for the ecosystem
Desertification in the Sahel Region	Africa	Land degradation, loss of agricultural productivity, displacement of communities	Traditional land management practices, cultural significance	Overgrazing, unsustainable land-use practices, climate change impacts
Water Scarcity in California	North America	Reduced freshwater availability, impacts on agriculture and ecosystems	Water conservation initiatives, technological advancements	Droughts, population growth, unsustainable water use patterns

Source: https://www.geeksforgeeks.org/human-environment-interaction/

2. The benefits of proper MSW management:

Proper solid waste management has several benefits which does not stop at only:

2.1.Environmental Conservation:

One significant advantage is the reduction of landfill waste, and environmental conservation. By implementing recycling programs and encouraging waste separation, local communities can divert a substantial amount of waste away from landfills. For instance, the city of Adelaide has made notable progress in waste management by implementing a comprehensive recycling scheme, resulting in a significant decrease in landfill waste. This not only reduces the strain on existing landfill sites but also minimizes greenhouse gas emissions associated with the decomposition of organic waste in landfills.

By reducing the amount of waste that ends up in landfills, proper waste management can help reduce greenhouse gas emissions and the risk of water and soil pollution, which can have serious environmental consequences. (Recovery, 2023)

2.2.Cost Savings:

Implementing efficient waste management practices can result in significant cost savings for businesses. By optimizing commercial waste collection and reducing the amount of waste generated, organizations can decrease disposal fees and avoid potential fines for improper waste handling. In addition, by embracing business recycling and resource recovery, companies can reduce the need for purchasing new materials, leading to substantial long-term savings in many cases.

Effective waste management can also have economic benefits. The recycling of different materials can lead to the creation of new jobs and industries, contributing to

economic growth and development. By reducing the amount of waste that ends up in landfills, proper waste management can also help reduce the costs associated with landfill maintenance and operation. (Recovery, 2023)

2.3.Community Engagement and Reputation:

Having an effective waste management system provides an opportunity for businesses to engage with their local communities and improve their reputation through social responsibility. By actively participating in business recycling programs and other waste reduction initiatives, companies demonstrate their commitment to environmental stewardship. Such engagement not only enhances the public perception of the organisation but also fosters a sense of community pride and involvement. (Recovery, 2023)

2.4.Regulatory Compliance:

Correct waste management practices help businesses comply with relevant regulations and legislation. By partnering with organizations like Solo Resource Recovery, which have expertise in waste management, businesses can ensure adherence to local, state, and federal guidelines.

In summary, effective waste management in local communities in Australia brings multiple advantages. It helps reduce landfill waste through recycling initiatives, leading to decreased pollution and greenhouse gas emissions. Adopting circular economy principles, such as reusing materials and implementing closed-loop systems, can minimize waste generation and maximize resource efficiency.

Additionally, waste-to-energy plants contribute to a more sustainable energy mix and improve air quality, promoting public health. These examples highlight the importance

of waste management in creating a cleaner, healthier, and more sustainable future for local communities in Australia and beyond.

Through commercial waste collection, construction waste disposal, business recycling, and comprehensive waste management strategies, organizations like Solo Resource Recovery play a crucial role in creating a cleaner, healthier, and more sustainable future. By embracing these practices, businesses can reap the benefits of cost savings, enhanced reputation, and regulatory compliance, while contributing to a greener and more resilient planet. (Recovery, 2023)

3. Manual MSW sorting vs source separation:

When comparing manual solid waste sorting and source separation, it's important to understand the differences and benefits of each method:

Table 15: Manual MSW vs Source Separation

	Manual MSW Sorting	Source Separation
Process	Manual solid waste sorting involves the physical separation of waste by workers who manually sort through waste to identify and separate recyclable materials from non-recyclable waste. Workers pick and sort waste on conveyor belts or at sorting stations	Source separation involves sorting waste at the point of generation, such as households, businesses, or institutions. It requires individuals to separate different types of waste, such as paper, plastics, glass, and organic waste, into designated containers for recycling or composting.

Advantages	• Can effectively identify and separate a wide range of materials. • Allows for the recovery of recyclable materials from mixed waste streams. • Provides employment opportunities for workers in the waste management industry.	• Encourages waste reduction and recycling at the source. • Reduces contamination of recyclable materials. • Facilitates the efficient collection and processing of segregated materials.
Challenges	• Labor-intensive and time-consuming. • Worker safety and health concerns. • Prone to human error in sorting.	• Relies on public participation and awareness. • Requires proper education and infrastructure for effective implementation.

Source: made by author

Both manual solid waste sorting and source separation play important roles in waste management. Manual sorting is effective for recovering recyclable materials from mixed waste streams and creating job opportunities. On the other hand, source separation promotes waste reduction, recycling, and proper disposal at the point of generation, leading to cleaner and more manageable waste streams. Combining these methods can create a comprehensive and efficient waste management system that maximizes resource recovery and minimizes environmental impact.

4. Recommendations:

By implementing the following recommendations, the government can significantly improve the efficiency, effectiveness, and sustainability of MSWM in Biskra city, ultimately leading to enhanced economic, environmental, and social outcomes for the city.

- ✓ Strengthen Policy and Regulatory Framework:
  - ∗ Develop and enforce comprehensive waste management policies that mandate waste segregation, recycling, and sustainable disposal practices.
  - ∗ Implement strict regulations against illegal dumping and ensure consistent enforcement to maintain cleanliness and public health.
- ✓ Invest in Infrastructure and Technology:
  - ∗ Allocate funds for modernizing waste management infrastructure, including waste collection vehicles, recycling facilities, and landfill sites.
  - ∗ Support the adoption of advanced technologies such as waste-to-energy, composting, and anaerobic digestion to improve waste processing efficiency and reduce environmental impact.
- ✓ Enhance Data Management and Monitoring:
  - ∗ Establish a centralized system for accurate data collection and monitoring of waste management activities, including waste generation, collection, and disposal.
  - ∗ Utilize geospatial information systems (GIS) to optimize waste collection routes and monitor service coverage.
- ✓ Promote Public Awareness and Education:
  - ∗ Launch continuous public awareness campaigns to educate citizens about the importance of waste reduction, segregation, and recycling.
  - ∗ Integrate waste management education into school curricula to instill responsible waste practices from a young age.

- ✓ Foster Public-Private Partnerships:
  - ∗ Encourage collaboration with private sector companies and NGOs to leverage expertise, technology, and investment in waste management.
  - ∗ Provide incentives for private entities to invest in recycling plants, waste treatment facilities, and sustainable waste management technologies.
- ✓ Ensure Equitable Service Provision:
  - ∗ Address socio-spatial disparities by ensuring equitable distribution of waste management services across all areas, particularly underserved and marginalized communities.
  - ∗ Implement targeted programs to improve waste management services in low-income neighborhoods.
- ✓ Support Community-Based Initiatives:
  - ∗ Facilitate community-led waste management programs by providing technical and financial support to local initiatives.
  - ∗ Encourage community participation in decision-making processes related to waste management to ensure that local needs and preferences are addressed.
- ✓ Implement Economic Incentives and Penalties:
  - ∗ Introduce economic incentives such as tax breaks or subsidies for businesses and households that actively participate in waste reduction and recycling programs.
  - ∗ Impose penalties for non-compliance with waste management regulations to ensure adherence to best practices.
- ✓ Encourage Research and Innovation:
  - ∗ Fund research on innovative waste management solutions and support pilot projects to test new approaches.
  - ∗ Collaborate with academic institutions and research organizations to develop and implement cutting-edge waste management technologies.

- ✓ Monitor and Evaluate Progress:
  - ∗ Establish a robust framework for regular monitoring and evaluation of waste management practices and policies.
  - ∗ Use performance data and feedback to make informed decisions and continuously improve the waste management system.

Conclusion:

In this chapter we explored the intricate relationship between the environment, humans and waste. Emphasizing on the benefits of proper waste management practices and distinguishing between manual solid waste sorting and source separation

in conclusion. Combining manual sorting and source separation methods can establish a comprehensive waste management system that maximizes resource recovery and minimizes environmental impact, leading to cleaner and more manageable waste streams.

General Conclusion

The issue of managing and valuing municipal solid waste is considered a contemporary problem as it is multi-dimensional and linked to various social, economic, environmental and legal aspects. Its success depends primarily on the effectiveness of the latter, and any defect in its management reflects negatively on the human cultural environment. All statistics indicate a continuous rise in the population. Which is accompanied by an increase in the amount of municipal solid waste, which leads to the accumulation of waste in the urban center, and the emergence of crises that would hinder the development of the city. This research endeavors to explore the economic and socio-spatial impact of the topic, examining successful case studies in waste management and proposing recommendations within our area of expertise. These recommendations, if implemented and acted upon, aim to enhance municipal solid waste management, ensure sustainable cleanliness in cities, and maximize the benefits derived from this waste material.

Finally, MSWM faces several challenges, particularly when waste reduction is not prioritized. Financially, the high costs associated with waste collection, transportation, treatment, and disposal strain municipal budgets, often diverting funds from other critical services. Environmentally, treatment methods like incineration can release harmful pollutants, while landfills risk contaminating groundwater and emitting methane, a potent greenhouse gas that accelerates climate change. Additionally, inefficiencies in waste sorting can lead to the loss of valuable recyclable materials, diminishing the overall effectiveness of recycling programs. Public opposition to waste management facilities, driven by concerns over health and environmental impacts, can cause delays and increased costs. By focusing on reducing waste generation at the source through policies, public education, and promoting sustainable consumption practices, municipalities can significantly decrease the volume of waste requiring management. This not only reduces operational costs and environmental impacts but also enhances the overall sustainability and efficiency of waste management systems.

Bibliography

(n.d.). From https://search.epa.gov/epasearch/?querytext=municipal+solid+waste&areaname=&areacontacts=&areasearchurl=&typeofsearch=epa&result_template=&referer=https%3A%2F%2Fwww.epa.gov%2Fhome%2Fpage-not-found#/

Erdal, I., Demircan , V., Dervis , A., & Ekinci, K. (2017). AGRO-ECONOMIC ANALYSIS OF COMPOST DERIVED FROM ORGANIC KITCHEN WASTES. INFRASTRUKTURA I EKOLOGIA TERENÓW WIEJSKICH, 747–755.

Bauni, L. (2022). Waste Recycling is an Entry Point to Energies the Green Economy and Achieve Sustainable Development. Al-Mayadeen Al-Eqtisadiah Journal, 345-364.

Belmehdi, N., & Frouhat, H. (2024). The contribution of solid waste recycling to the achievement of the Sustainable Development Goals 2030. Journal of Economics and Sustainable Development, 191-205.

boudjemaa, s., & meziani, m. (2019). The reality of solid waste management- a case study of Sokara-Net. Nour Journal of Economic Studies, 23-35.

Coffey , M., & Coad, A. (2010). Collection of Municipal Solid Waste in Developing Countries. Kenya: Gutenberg Press, Malta.

Dr. Coad, A. (2011). COLLECTION OF MUNICIPAL SOLID WASTE. KENYA: UNON, Publishing Services Section.

INTRODUCTION TYPES OF WASTES. (n.d.). ESCAP, 170-194.

Judd, F. (2021, May 18). Solid Waste Transportation Methods: Best Vehicle and Equipment Types. From Qv21 Technologies: https://www.qv21.com/blog/solid-waste-transportation-methods

Jumba, M. (2024, junuary 20). Benefits of Proper Solid Waste Management. Paparazy Welfare 2000 presentation. Kenya, Ukunda Kwale County: Kryptone consulting ltd. From LinkedIn.

Kinnaman, T. C. (2009). "The Economics of Municipal Solid Waste Management." Waste Management. Faculty Journal Articles, 2615-2617.

Kumar G, N., Swamy, C., & Nagadarshini, K. (2014). Efficient Garbage Disposal Management in Metropolitan. Journal of Clean Energy Technologies, Vol. 2, No. 3, 258-262.

Municipal Solid Waste. (2016, March 29). From EPA: https://archive.epa.gov/epawaste/nonhaz/municipal/web/html/index.html

Municipal Solid Waste and the Environment: A Global Perspective. (2012). Annual Review of Environment and Resources, 279-299.

Prof.Shaukat , H., & Prof.Dr.Sajjad , H. (2010). Municipal Solid Waste:Engineering Principles and. Lahore: The Urban Unit.

Recovery, S. R. (2023, june 19). The benefits of effective waste management on the environment and in our communities. From linkedin: https://www.linkedin.com/pulse/benefits-effective-waste-management-environment

Reddy, P. J. (2011). Municipal Solid Waste Management: Processing, Energy Recovery, Global Examples. INDIA: BS Publications.

Silpa , K., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). What a Waste 2.0: A Global Snapshot of Solid Waste Management . Washington: World Bank Publications.

Solid Waste Disposal Methods and Management. (2023, june 28). From testbook: https://testbook.com/civil-engineering/solid-waste-disposal-methods

Solid Waste Management. (2022, FEBRUARY 11). From the world bank: https://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management

University of, M. (2023). Municipal Solid Waste Factsheet. From Center for Sustainable Systems: https://css.umich.edu/publications/factsheets/material-resources/municipal-solid-waste-factsheet

Waste Management Benefits, Planning and Mitigation Activities for Homeland Security Incidents. (2024, FEBRUARY 21). From EPA: https://www.epa.gov/homeland-security-waste/waste-management-benefits-planning-and-mitigation-activities-homeland