M Capital Group

Waste Management: Waste to Wealth

"Leveraging Novel Technologies for a Circular Economy"

September 2023

M Capital Group

www.mcapital-group.com

NEW YORK	LONDON	DUBAI
1330 Av of the Americas New York, NY 10019 United States Phone: +1 212 634 683 Fax: +1 212 634 7474	Dashwood House 69 Old Broad Street London EC2M 1QS United Kingdom Phone: +44 207 256 4246 Fax: +44 207 256 4050	Emirates Towers P.O. Box 31303 Dubai United Arab Emirates Phone: +971 4 319 7460 Fax: +971 4 330 3365

Our Word is Our Bond

DISCLAIMER NOTICE

This memorandum has been prepared by M Capital Group (“MCG”). In no case is this document a solicitation, request and/or invitation for capital in any shape or form; or any securities offering in any legal jurisdiction.

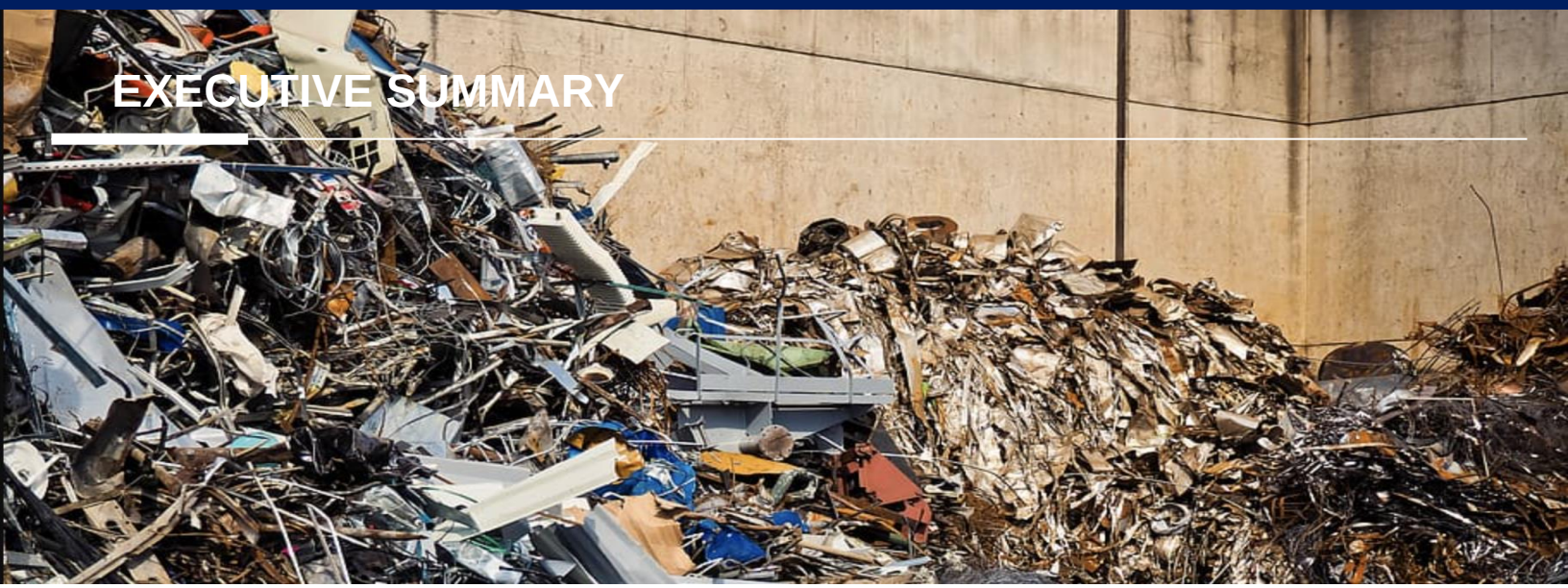
This document is not intended to form the basis of any investment decision and should not be considered as a recommendation by MCG. This document does not constitute an offer to sell or an invitation to purchase or tender.

None of the information contained in this document has been verified by MCG. No party shall have any right of action against MCG or any other person in relation to the accuracy or completeness of the information contained in this document or any other written or oral information made.

In furnishing this document, MCG undertakes no obligation to provide the recipient with access to any additional information or to update this document or additional information or to correct any inaccuracies.

TABLE OF CONTENTS

DISCLAIMER NOTICE 3
EXECUTIVE SUMMARY 5
Outlook 5
Report Roadmap 7
GLOBAL WASTE MANAGEMENT OVERVIEW 8
Introduction 8
Trends 9
Market Size 11
Market Growth 11
MARKET DYNAMICS 13
Introduction 13
Drivers 13
Challenges 15
Opportunities 16
MARKET SEGMENTATION 19
Introduction 19
Waste Type 19
Service Type 22
Disposal Methods 23
Geography 30
FUTURE TRENDS 39
Introduction 39
Trends 39



EXECUTIVE SUMMARY

Outlook

Waste management is a well-orchestrated ballet, not merely of disposal but of collection, transportation, and treatment of waste. From household trash to industrial cast-offs, the task is nothing less than managing an ever-growing, global symphony. As economies continue to expand, the increasing waste generated from economic activity is going to keep fueling the waste management industry growth.

Even with ever-changing political intervention and regulation, along with deficits of key waste management infrastructure in certain areas, waste management continues to show remarkable resilience. Driven by factors like population growth, technological innovations, government regulation, and increasing environmental consciousness, the global waste management industry is expected to continue its upward trajectory. Several reports project the compounded annual growth rate (“CAGR”) of the industry to be in between 2.5% and 5% from 2023 to 2030. Growing above the projected long-term growth rate of the Gross Domestic Product (“GDP”) of 2%.

Battling for a share of this growing industry, in the global arena, big players compete with well-entrenched local players, that are committed to innovation and sustainability. By finding efficient solutions to their local problems, these local companies not only expand their market presence, but also contribute to shaping industry growth.

Worldwide, in areas like the Middle East, South Asia and Africa, the convergence of rapid urbanization, and population boom have led to a surge in waste generation. As some governments in these areas start to impose stricter regulations, significant investment in waste management infrastructure and technologies is being undertaken. This provides promising opportunities for enterprises in the sector to make their mark and contribute to sustainable development.

Among those opportunities, investments in more advanced technologies, that can increase the efficiency of collection, transformation, and recycling processes, or in green infrastructures, more environmentally friendly, or even in finding solutions for electronic waste (“e-waste”) have shaped, and will continue to shape, the industry’s trajectory. Companies have focused on developing facilities that convert waste into energy, such as incineration or anaerobic digestion, that contribute to renewable energy generation. They have also supported the development of advanced recycling technologies, such as automated sorting systems and innovative methods for recycling complex materials. Smart-waste management solutions have also become more common with investments in technology solutions that enable real-time monitoring of waste collection and optimize route efficiency.

Leading companies have also entered regional markets with untapped potential in waste management technology, such as Africa, making a significant impact in waste collection and recycling rates. Additionally, with the growing demand for medical and electronic waste management globally, the emergence of the "Internet + medical waste" treatment model, utilizing intelligent collection and supervision systems, is revolutionizing waste disposal practices. Embracing the circular economy approach, recycling valuable metals from e-waste becomes crucial. Furthermore, with some countries restricting waste imports, private sector solutions for domestic waste management offer collaboration opportunities for investors and governments in the global waste trade arena.

COVID-19 played a key role in shaping the landscape of the waste management industry by introducing new types of waste management challenges. The pandemic drove the consumption of health-care related products for home and hospital use, such as masks, gloves, and protective suits. The usage of these products has long-term impacts on the industry and the environment as they need to be collected and treated adequately.

With opportunities exists, challenges remain. Large coastal populations and high per capita waste generation rates persist, in the US or the EU, putting pressure on these waste management systems to incorporate waste into the circular economy. Rising labor costs, alongside operating and transportation costs, further exacerbate the economic and financial challenges faced by the sector. In addition, a decrease in the public perception of environmental issues or lack of motivation to properly segregate waste can hinder effective waste management efforts. Finding sustainable and cost-effective solutions to manage waste has become a pressing concern for governments, industries, and private players alike.

This report serves as more than an overview of the waste management industry. It provides key insights into its value-chain processes, as part of emerging markets. After all, effective waste management is not just about addressing today’s needs but ensuring a sustainable future.

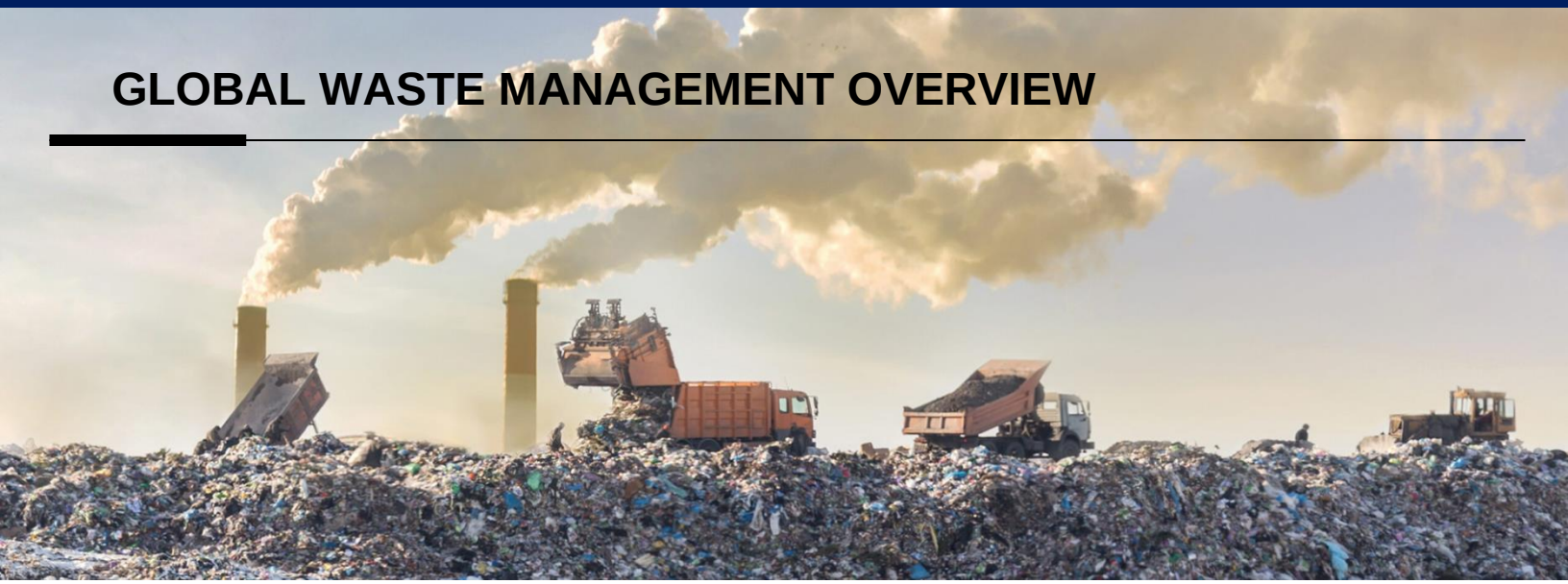
Report Roadmap

This research report aims to examine the prevalent waste management industry trends, drivers, and dynamics seen over the last few years, while looking at what is ahead. Starting with a dive into the waste management markets' background, it moves onto the most impactful trends and key considerations, to then explore the drivers which have fueled market innovation. The report concludes with an assessment of the various types of waste management, geographical background, and the competitive landscape of the industry.

The discussion highlights the industry's reaction to growing global connectivity and demand for waste management, whilst noting developments in technology and business practices, as well as effects of changes in consumer preferences on waste.

Despite the positive outlook, challenges, both industry-specific and general, remain.

GLOBAL WASTE MANAGEMENT OVERVIEW

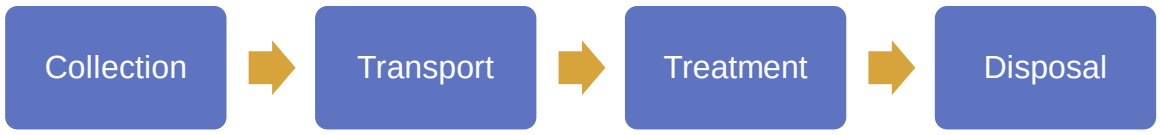


Introduction

Waste Management is about logistics. Instead of delivering the packages, it picks up the waste. Waste, in all its forms, requires careful logistical planning and implementation for proper collection, transportation, and disposal. Effective waste logistics are essential to ensure that waste is managed responsibly and does not cause harm to the environment and public health.

Waste management refers to the processes and actions required to manage waste from inception to its final disposal, including collection, transport, treatment, and disposal. It involves monitoring and regulating the waste management process and waste-related laws, technologies, and economic mechanisms. Waste can be solid, liquid, or gas, and each type has different methods of disposal and management. Waste management deals with all types of waste, including industrial, biological, household, municipal, organic, biomedical, and radioactive wastes.

Waste management process



Source: MCG, Eurostat, 2023

The purpose of waste management is to reduce the harmful effects of waste on the environment and human health. A significant part of waste management deals with industrial waste, followed by municipal waste and then medical & biomedical and electronic waste. Though less visible to society, industrial waste management plays a key role in economic activity as it manages waste produced by factories, manufacturing facilities, power plants, chemical plants, and other industrial operations. It can include various types of byproducts, residues, chemicals, and materials used in production processes. On the other hand, municipal waste originates from households, commercial establishments, institutions, and public places. It includes everyday items like food waste, packaging, paper, plastics, and more.

Proper waste management is critical for building sustainable and liveable cities, but it remains a challenge for many developing countries. The percentage of municipal budget allocated for waste management varies. According to the World Bank Group, waste management comprises 4% of municipal budgets, in case of high-income countries (a high-income economy is defined by the World Bank as a country with a gross national income per capita of US$13,845 or more in 2022), and 19% for low-income countries. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported. The Intergovernmental Panel on Climate Change (“IPCC”) anticipates that municipal solid waste will reach approximately 3.4 Gt by 2050. In addition, about a fourth of all the municipal solid terrestrial waste is not collected, and an additional fourth is mismanaged after collection, often being burned in open and uncontrolled fires. Policies and laws can reduce waste by enforcing proper waste management, banning single-use plastics, setting waste reduction targets, and raising public awareness.

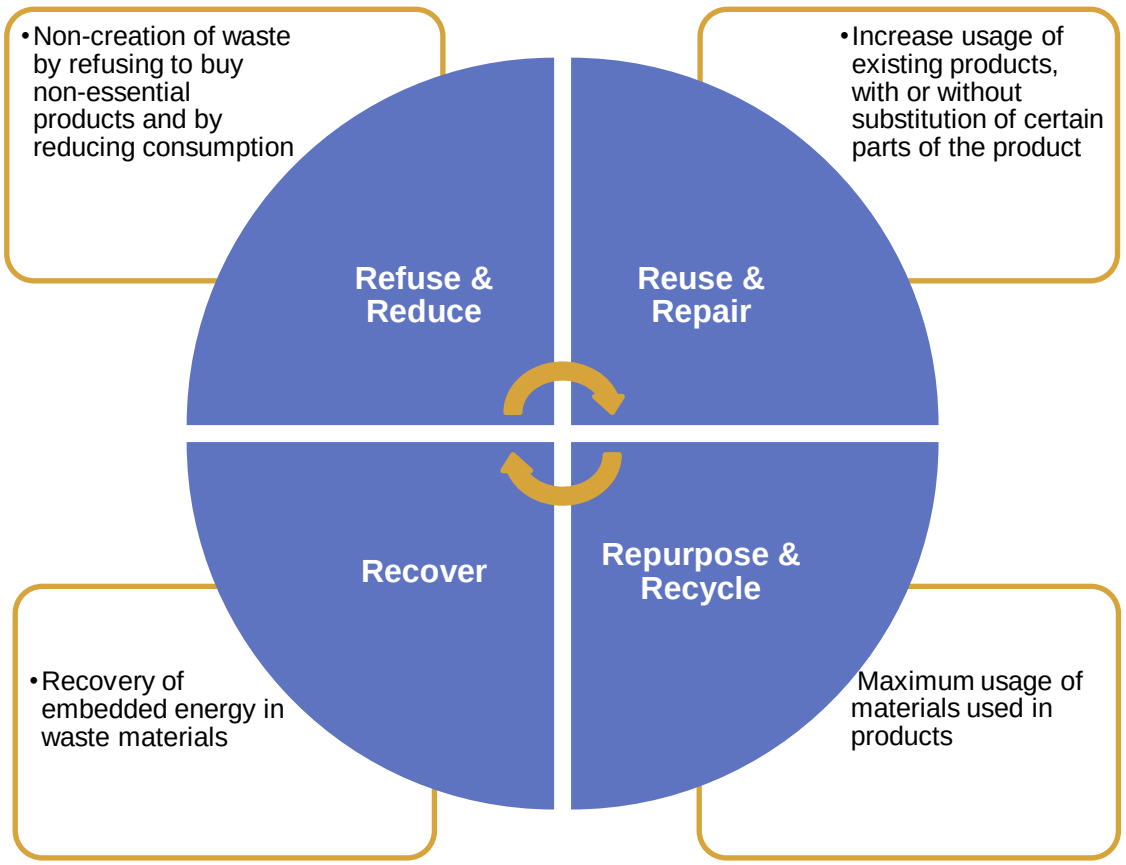
In a collective effort to raise awareness and lead the necessary change, the United Nations Environment Programme and the International Waste Management Association developed the “The Global Waste Management Outlook”, a pioneering global assessment of the state of waste management. It calls for action from the international community and establishes tools for taking a holistic approach to waste management, recognizing waste and resource management as a significant contributor to sustainable development and climate change mitigation. The Outlook primarily focuses on governance issues, including regulatory and policy instruments, partnerships, and financing models, to establish sustainable solutions.

Trends

In last years, with the increased awareness regarding climate change and technology advancements, several trends have been shaping this industry. Firstly, there has been a shift from a linear "take-make-dispose" model to a circular economy that focuses on reducing waste, reusing materials, and recycling to minimize environmental impact. Effective waste management now involves the practice of ‘7R’: Refuse, Reduce, Reuse, Repair, Repurpose, Recycle, and Recover: Refuse and Reduce relate to the non-creation of waste by refusing to buy non-essential products and by reducing consumption. Reuse and Repair increase the usage of the existing product, with or without the substitution of

certain parts of the product. Repurpose and Recycle involve maximum usage of the materials used in the product, and 'Recover' is the least preferred and least efficient waste management practice involving the recovery of embedded energy in the waste material.

7Rs in waste management



Source: MCG, Eurostat, 2023

In recent decades, technology has started to play a more and more relevant role in all the stages of waste management. Innovations like smart waste collection systems, AI-powered sorting, and advanced recycling technologies have improved processes efficiency. Data are increasingly serving as the basis for decision making in waste management. From information on the layout and characteristics of local neighbourhoods and the activity of collection trucks to data on recovery of waste fees, accurate information is allowing governments and operators to design and run more efficient operations and save money. Waste collection and associated transportation is often the costliest step in waste management, but with technology extensively available to increase efficiency, whether by optimizing routes or minimizing improper use of trucks, the scenario may start to improve. Finally, in more advanced stage of waste management, technology has been

commonly used to support reduction of the amount of waste generated globally and to change manufacturing processes to reduce waste or to increase recyclability.

Technology is playing a key role in making the industry more efficient and sustainable, but is not alone, as innovative methods of disposal are also contributing for it. Specially, in high-income countries, many waste management facilities are adopting waste-to-energy technologies to generate electricity from waste while reducing landfill usage. According to the World Bank group, in 2018, around 22% of waste disposal was already being incinerated in high-income countries, using modern incineration. With the trend to reuse waste and incorporate it back in economy, waste-to-energy incinerators have been gaining traction, though some studies report that it produces more carbon dioxide per unit of energy than traditional energy sources.

Finally, the increasing focus on environmental issues is also directly affecting the industry by emphasizing sustainable waste management practices, reducing carbon emissions and also by placing more responsibility on producers. Due to climate change, there is an increasing pressure on governments and companies to move towards green policies, that will protect the environment. As a result, overall, practices in the industry are changing and becoming more sustainable. Companies and local governments are also more opened for partnerships with innovative and efficient companies, that provide waste management solutions. Finally, regulations are pushing manufacturers to take responsibility for the lifecycle of their products, including proper disposal.

Market Size

The Global Waste Management size reached in 2022 a value of around US$500 billion to US$1 trillion. Several reports predict the industry's size to be in this range, with oscillations occurring due to different estimation methodologies and different considerations regarding definition-based what should be included in waste management. Asia Pacific led waste and accounted for over 25% of global waste in 2022.

By service type provided, the collection segment led the market, accounting for over 62% share of industry revenue in 2022. This includes the segregation of waste, loading, unloading, selecting a suitable area for storage, and maintaining these areas.

By waste type, the industrial segment took the lead, being responsible for 92% of the waste produced worldwide. Rapid urbanization and industrialization are major factors behind increasing industrial waste generation.

Market Growth

The growth of the global waste management industry is a testament to the rising awareness of sustainable practices and the adoption of advanced waste management solutions worldwide. Several studies estimated the 2023-30 CAGR to be 5%.

As countries experience economic development and an increase in living standards, consumption patterns tend to change, leading to higher waste generation. The rise in consumerism, urbanization, and population growth contribute to increased waste volumes, placing greater pressure on waste management systems.

In developed markets, a substantial portion of waste is attributed to packaging. The prevalence of packaged goods and single-use materials in these economies significantly impacts the waste stream. While packaging serves essential purposes in terms of product protection and distribution, the excessive use of non-recyclable or hard-to-recycle materials can strain waste management capabilities and contribute to environmental pollution.

MARKET DYNAMICS

Introduction

Waste management services have become essential for societies, ensuring health standards, and allowing, nowadays, products that would otherwise be wasted to renter in the economy. The market dynamics of the waste management industry encompass a range of factors that influence its growth and development. This section provides an overview of the key aspects shaping the market, including market drivers, constraints, and opportunities.

Drivers

Growth is expected to be driven by several factors, such as population growth and urbanization, technological innovation and rising environmental concerns. Always with regulation in the background, some government laws, such as the Resource Conservation and Recovery Act by the U.S. Environmental Protection Agency (“EPA”) and the 2019 Australian National Waste Policy Action Plan, also play a key role in the trajectory the industry has entered.

Population Growth & Urbanization

The world population is estimated to reach 9.9 billion by 2050, and as it increases, so does the production of waste. This increase is particularly significant in urban areas, where the growth of cities and the shift from rural to urban living have led to a significant increase in waste production. In addition, in order to fulfil the rising demand for products and services of a growing population, production will increase, leading to more industrial being produced. This rise in waste puts a strain on existing waste management

infrastructure and requires new facilities and equipment, pushing the industry forth for the creation of new companies and the further development of the existing ones.

Technological Innovation

Innovations in technology enable more efficient waste sorting, recycling, and disposal. These solutions will make waste management services more attractive for companies and public institutions, driving their demand for the services. In addition, through advancements, such as the Internet of Things, it will be possible to reach new locations, allowing the industry to expand.

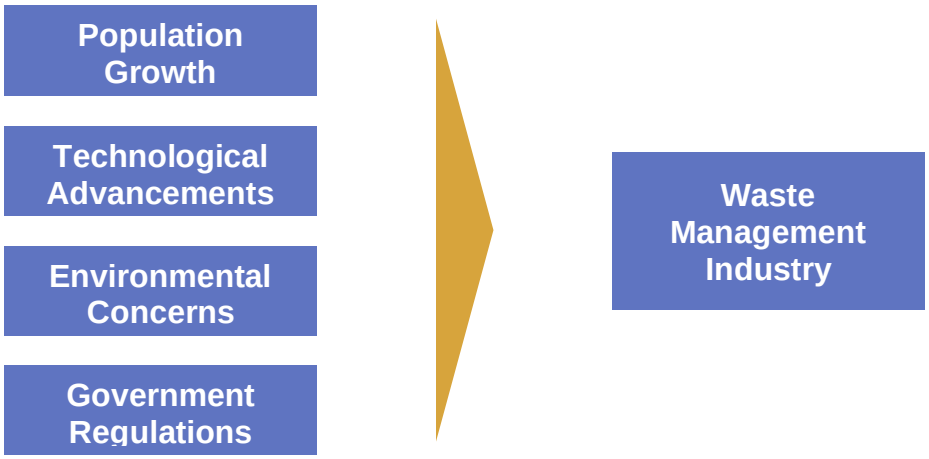
Government Regulation

Governments worldwide are increasingly focusing on environmental sustainability, leading to the implementation of stringent waste management regulations. These policies compel businesses to adopt responsible waste management practices, driving growth in the industry. Moreover, enterprises value the opportunities presented by government-funded research initiatives that aim to fund infrastructure development or research into new waste management technologies. These initiatives not only contribute to the improvement of waste management practices but also foster innovation in the field. By actively participating in and supporting such initiatives, companies can play a vital role in advancing sustainable waste management practices, benefiting both the environment and their business endeavors.

Environmental concerns

As people further value recycling products and companies that comply with ESG goals, the demand for efficient waste management services may continue growing. In the end,

Waste management industry growth drivers



Source: MCG, Eurostat, 2023

if companies are pushed by the market to improve the environmental standards of their manufacturing and waste management, this may present an opportunity for the industry.

Challenges

The waste management industry stands at a crucial juncture in the modern world, grappling with a multitude of challenges that shape its present landscape and future trajectory. The waste management process is intricately tied to the broader global supply chain, a network that has seen significant disruptions and volatility in recent times. Simultaneously, the relentless rise in global population presents a formidable challenge to waste management practices. With each passing year, the demand for goods and services intensifies, resulting in higher waste generation rates. Financial considerations further compound the challenges faced by the waste management industry. Finally, regulatory restrictions are another significant hurdle that the waste management industry confronts.

Supply Chain Instability

For the waste management industry, supply chain instability can have negative impacts on the cost, quality, and reliability of waste management operations. For example, supply chain instability can increase the costs and delays of waste collection, transportation, treatment, and disposal. It can also reduce the availability and quality of waste management equipment, technologies, and materials. Furthermore, it can reduce customer satisfaction and loyalty due to service disruptions or failures.

Global Population Growth

Global population growth can have both positive and negative impacts on the waste management industry. While it stimulates innovation and investment in waste management technologies and practices, global population growth can increase the generation and complexity of solid waste, especially in urban areas where most of the population growth is concentrated. It can also increase the pressure and competition for natural resources, land use, energy use, and greenhouse gas emissions associated with waste management activities. Additionally, global population growth can increase the challenges and costs of complying with environmental regulations and standards for waste management operations.

Increasing Cost

The high cost of operating and procuring waste management solutions is anticipated to impact market growth. Furthermore, the industry is labour intensive, with wages being a major cost. Transportation costs of waste, including collection and transportation to recycling facilities or landfills, are also high.

Regulatory Restrictions

Regulatory requirements, such as the Resource Conservation and Recovery Act and Waste Shipment Regulation by U.S. EPA, can drive up the costs and complexity of waste management operations, which can restrain market growth. Compliance with these regulations is necessary to ensure environmentally safe and responsible waste management, but it also adds to the operational challenges faced by companies in the industry.

Opportunities

The industry opportunities range from new possibilities opened through advancements in technology, to the constant changes in regulation, the untapped potential of emerging markets, the growing demand for medical materials, which will drive medical waste generation up and the shift to a circular economy. A detailed look is warranted.

Technological Innovation

Advancements in waste processing technologies offer significant opportunities in waste management opportunities. These can increase efficiency, reduce costs, and open up new waste streams for profitable management. For instance, the development of advanced recycling technologies can enable more materials to be recovered and reused. Trending technologies in 2023 include Internet of Waste, Chemical Recycling, Recycling Robots, Waste Valorisation, Artificial Intelligence, Green Waste Management, Big Data & Analytics, and Material Life Cycle Extension, etc.

Regulatory Change

Changes in waste management regulation, can create opportunities for companies in the industry. For instance, stricter regulations on landfill use can increase demand for alternative waste disposal methods, such as recycling and waste-to-energy technologies.

The RCRA in the US establishes a system for controlling hazardous and non-hazardous solid waste and encourages recycling and recovery of energy and natural resources. Companies that can offer innovative solutions for waste reduction, reuse, treatment, and disposal can benefit from the regulatory incentives and market demand. Similarly, the Waste Management Rules (“WMR”) and Waste Management Fees Regulations (“WMFR”) in Trinidad and Tobago aim to improve the national management of hazardous and non-hazardous waste, and require waste generators to pay fees based on the quantity and type of waste they produce. This can create opportunities for companies that can help waste generators reduce their waste generation and disposal costs, as well as comply with the environmental standards. In the UK, the government is expected to introduce new waste management legislation in 2023 that will require businesses to separate their food waste from other waste streams, and to report on their waste prevention and recycling activities. This can create opportunities for companies that can

provide food waste collection, processing, and valorization services, as well as waste auditing and reporting tools.

Emerging Markets

Rapid urbanization and industrialization in emerging markets are leading to increased waste generation. This can create new markets for waste management services. For example, in 2021, China generated the most municipal waste in the world, with 242 million metric tons, followed by India with 127 million metric tons. These two countries also have the largest shares of global population and municipal solid waste generation, with 18.5% and 16.4% respectively. However, their waste management systems are often inadequate or inefficient, resulting in environmental and health problems. Therefore, there is a high demand for improved waste collection, treatment, and disposal services in these countries. Another example is Africa, which is expected to have the fastest growth in urban population and waste generation in the coming decades. However, only 4% of waste is recycled in Africa, compared to 34% in Europe. This indicates a huge potential for developing waste management services that can recover valuable materials and energy from waste.

Growing Demand of Medical Waste Management

Although medical waste accounts for the smallest proportion of all types of waste, the demand for waste disposal is promising, whether it is in developed countries with advanced medical technology or in developing countries with large populations. According to the World Health Organization ("WHO"), developed countries produce about 0.5 kg of medical waste per bed per day, while developing countries can produce 0.5 - 2.5 kg of medical waste per bed per day. The US generates about 2.6 million tons of medical waste per year, while India generates 500 tons of medical waste per day.

With the development of technologies such as the Internet, big data, and the Internet of Things, a new treatment model of "Internet + medical waste" has emerged. Through intelligent collection of medical waste, the online system closely monitors the entire process of treatment to achieve effective supervision. In China, these concepts have been strategically deployed and effectively implemented in Suzhou and Jiangsu Province, since 2017.

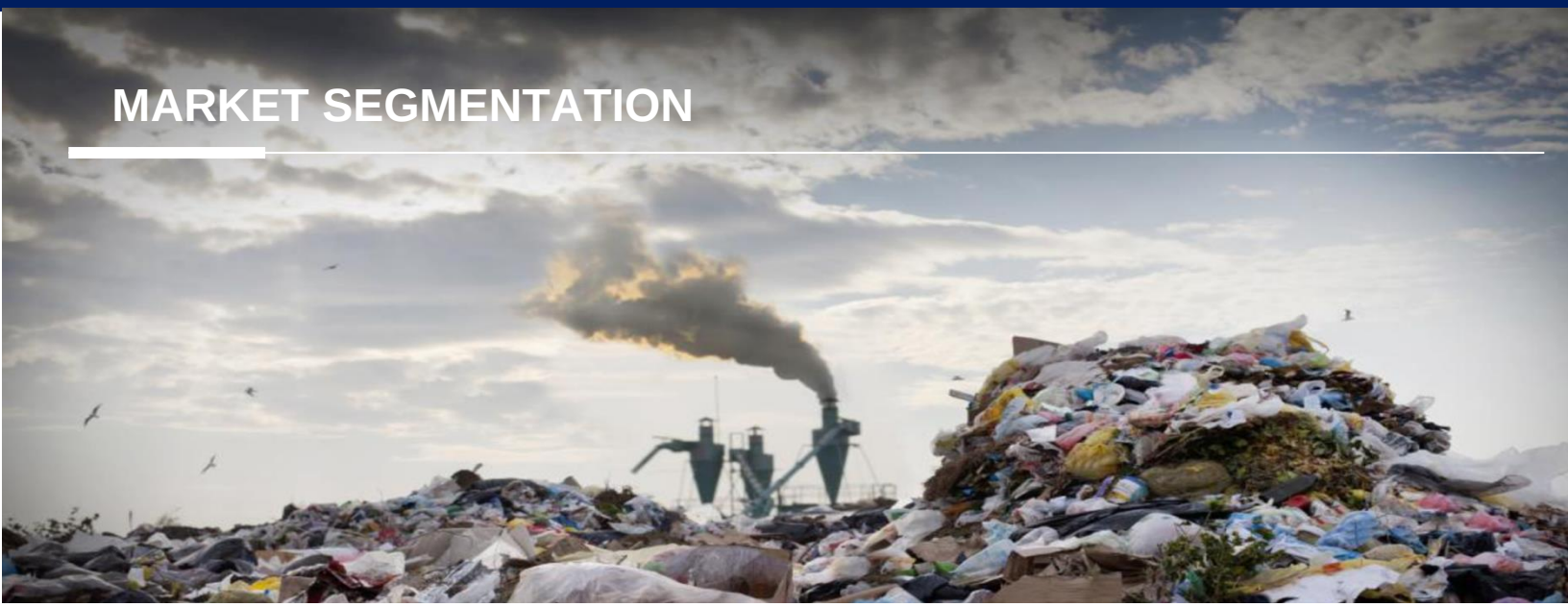
Circular Economy

The shift towards a circular economy, where resources are reused and recycled rather than discarded, offers significant opportunities in the waste management industry. Vigorously developing a circular economy, promoting the economical and intensive use of resources, and building a resource-recycling industrial system and a recycling system for waste materials are of great significance to promoting the realization of carbon peak and carbon neutrality, and promoting the construction of ecological civilization.

As the popularity of electronics increases and e-waste increases, trivial metal elements are becoming more valuable to recycle, because they can reduce the cost of mining metals like copper in electrical wires or cobalt in rechargeable batteries and help save the environment.

Global Waste Trade

Recognizing the challenges faced by countries historically exporting waste for recycling, as many nations are now imposing bans or restrictions on waste imports, MCG identifies promising opportunities in the private sector to offer tailored domestic solutions for waste management. This presents a significant challenge for governments to swiftly establish effective waste management infrastructure.



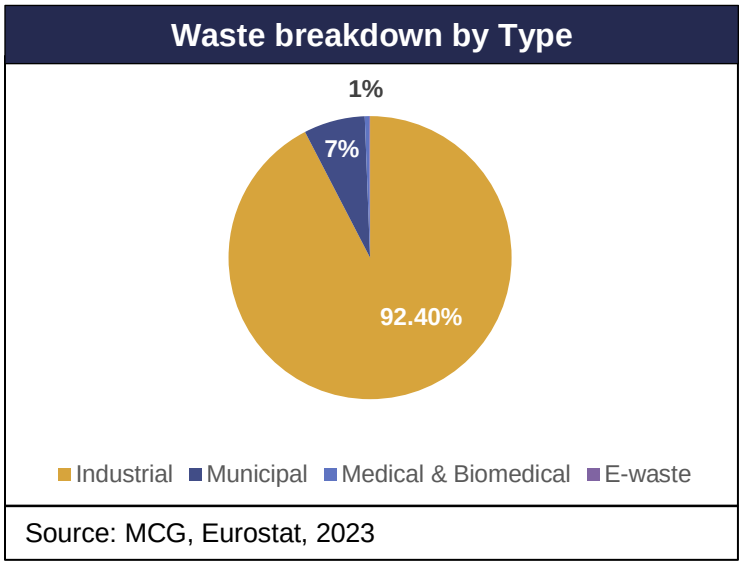
MARKET SEGMENTATION

Introduction

Market segmentation is a vital aspect of the waste management industry, enabling a deeper understanding of its diverse landscape. This section highlights four key factors in market segmentation: waste type, service type, disposal methods, and geographies.

Waste Type

The four main types of waste are industrial waste, municipal waste, medical & biomedical waste, and E-waste. According to MCG's research, industrial waste is the leading component in market value share with 92.4%, along with municipal solid waste having 7.0%, medical & biomedical waste with 0.5% and E-waste with 0.1% in 2021, globally.



Source: MCG, Eurostat, 2023

Industrial Waste

Industrial waste, a by-product of various manufacturing activities, encompasses a wide range of materials that become useless during the production process. Factories, mills, and mining operations generate such waste, which may include substances as diverse as dirt and gravel, masonry and concrete, scrap metal, oil, solvents, chemicals, scrap lumber, and even vegetable matter from restaurants. The form of industrial waste can be solid, semi-solid, or liquid. Some types are hazardous, including toxic substances, while others are non-hazardous. It is important to note that industrial waste can have profound effects on the environment, contaminating nearby soil, groundwater, lakes, streams, rivers, and coastal water.

Industrial waste is typically categorized based on its characteristics. The classifications often used by governments include hazardous waste, chemical waste, and industrial solid waste, these classifications help determine the treatment method. For instance, sewage treatment plants can handle some industrial wastes consisting of conventional pollutants. However, industrial wastes with toxic pollutants or high concentrations of other pollutants require specialized treatment systems. The solid form of waste may carry pollutants in liquid or fluid form, as seen in industries like crockery or mineral washing. Conversely, waste could be in a dissolved form where the pollutant is liquid, common in industries such as dairy.

The environmental impact of industrial waste is significant. Many factories and power plants are situated near bodies of water, using large amounts of water for manufacturing processes or equipment cooling. In less developed countries becoming industrialized, the resources or technology to dispose of their wastes with minimal environmental impact may be lacking. Untreated and partially treated wastewater is often released back into nearby water bodies, affecting marine ecosystems and the health of those relying on these waters. Wastewater containing nutrients often leads to eutrophication, causing significant harm to aquatic life. It can also have serious implications for human health and the environment, potentially affecting drinking water sources, irrigation water used for farming, and habitat for animals and plants.

The industrial waste segment led the market, accounting for over 92.4% share in 2022. Economic growth and industrialization are major factors behind the increase in industrial waste generation.

Municipal Solid Waste

Municipal Solid Waste (“MSW”), also known as trash or garbage, comprises items we routinely discard from our homes, schools, offices, and other places where we live and work. It predominantly includes food waste, packaging, furniture, clothing, bottles, grass clippings, newspapers, appliances, paint, and batteries. The proper management of this waste is crucial due to its potential impact on the environment and public health.

One of the significant concerns regarding MSW is its management. As the global population continues to grow, and societies become more consumer-orientated, the generation of MSW will follow the same trend and increase. It's estimated that globally, we generate 2.01 billion tonnes of municipal waste annually, with at least 33% of that extremely mismanaged.

Medical & Bio-Medical Waste

Biomedical waste refers to waste that is generated during the diagnosis, treatment, or immunization of human beings or animals, in research activities, or in the production or testing of biologicals. It can be solid or liquid, and it includes a variety of materials such as syringes, needles, discarded drugs and vaccines, human tissues and organs, and culture dishes and other glassware used in research laboratories.

Biomedical waste can be highly infectious and pose a significant threat to human health and the environment if not properly managed. It can contain harmful microorganisms that can infect hospital patients, health workers, and the public. Other potential risks include injury from sharps contaminated with pathogens, chemical burns or poisoning from discarded laboratory chemicals, and pollution of soil and water resources.

The management of biomedical waste involves a few steps, including segregation, collection, transportation, treatment, and disposal. Segregation is the first and most crucial step, requiring the waste to be sorted into different categories (like sharps, infectious, pathological, radioactive, etc.) at the point of generation. After segregation, the waste is collected and transported to a treatment facility.

Treatment of biomedical waste can involve several methods, like incineration, autoclaving, chemical treatment, and microwaving. Incineration is a common method for treating biomedical waste, but it can release pollutants into the air if not properly managed. Autoclaving, which uses steam sterilization, is another common method, especially for treating culture and microbiology waste, sharps, and other types of infectious waste.

In many countries, the management of biomedical waste is regulated by government legislation to protect public health and the environment. These regulations typically specify the methods for handling, storing, transporting, treating, and disposing of biomedical waste, and they often include penalties for non-compliance.

Overall, the proper management of biomedical waste is crucial for preventing disease transmission, protecting the health and safety of healthcare workers and the public, and preserving the quality of the environment.

E-waste

Electronic waste, or e-waste, refers to discarded electrical or electronic devices. It's a broad category that encompasses everything from small household appliances to computers and cell phones. E-waste is considered dangerous due to the toxicity of some of the substances contained in these devices, such as lead, cadmium, and mercury. These substances can be harmful to the environment and to human health if not properly managed.

E-waste has been growing rapidly in recent years due to the increased consumption of electronic devices globally. According to the statistics from Statista, in 2021, the world generated 57.4 million metric tons ("Mt") of e-waste, which is an increase of 9.2 Mt (or 19%) since 2014. The largest producers of e-waste in 2021 were China (10.1 Mt), the United States (6.9 Mt), and India (3.2 Mt), which together accounted for nearly 35% of the global total. If things continue as they are, the total global waste will hit 74.7 million metric tons by 2030 – almost a doubling of e-waste in just 16 years.

Despite the short-term economic benefits of electronic devices, improper disposal can lead to long-term negative impacts that are financial, environmental, and social. This waste type represents a significant waste management challenge due to the scale of the problem and the hazardous nature of some of the waste materials.

The e-waste segment is likely to expand at the fastest CAGR of 7.4% over the forecast period 2023-2030 due to rapid technological advancements leading to new electronic products and upgraded versions of existing products, thereby reducing their shelf life and in turn, increasing the e-waste generation.

Service Type

Collection

The collection segment is a crucial component of the waste management industry, responsible for gathering waste from various sources. This segment involves a range of activities, technologies, and logistics to ensure efficient and effective waste collection.

There are many collection methods, such as the curbside, most common for residential waste, or the front-load and rear-load, common for commercial waste. All these different methods involve a mean of transport, such as a compactor truck, most common in municipal waste, and someone driving it, at least.

Some of the main challenges in this segment are addressing contamination in recycling streams and ensuring proper waste segregation, integrating technology, such as IoT sensors, to optimize collection routes and reduce environmental impact, and adopting of electric or hybrid collection vehicles to reduce emissions and noise pollution.

Transportation

The transportation segment is responsible for efficiently moving collected waste from its source to processing facilities, landfills, recycling centres, or waste-to-energy plants. This segment plays a vital role in ensuring the proper handling, transport, and disposal of various types of waste. In many cases, the collection and transportation functions are done by the same entity.

Waste is usually transported by road, though it can also be transported by rail, specially for longer distances. Due to environmental concerns, the segment is undergoing some changes to adopt environmentally friendly transportation options, such as electric or natural gas-powered waste collection vehicles.

Besides this challenge, there is also an attempt to address traffic congestion and optimizing routes to reduce travel time and fuel consumption and enhance vehicle tracking and communication systems to improve operational efficiency and customer service. Overall, efficient transportation helps ensure that waste is transported safely and responsibly to its destination, whether that's a landfill, recycling centre, or waste-to-energy facility.

Disposal

In the disposal segment, companies' focus is on managing waste that cannot be recycled, reused, or recovered through other means. It involves the responsible and environmentally sound disposal of waste in compliance with regulations and standards.

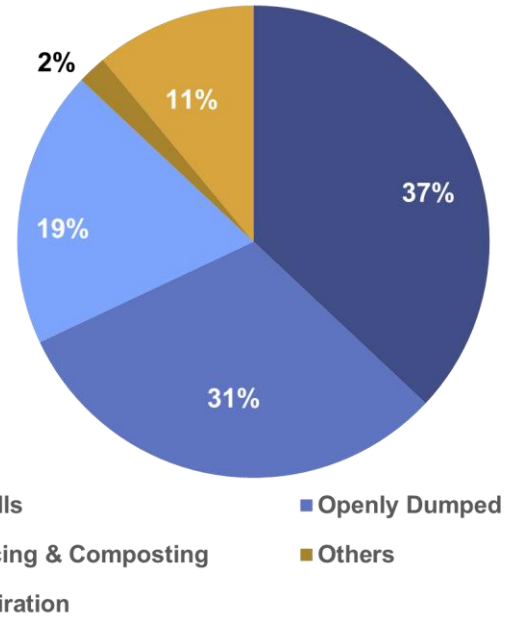
As the following section explains, there are several disposal methods, such as landfills, incineration, recycling, composting and open dumping, with both advantages and disadvantages. Disposal facilities must adhere to strict regulations to prevent soil and water contamination, air pollution, and adverse impacts on public health.

Dealing with what happens with products and resources after they have lost their original function, the segment must keep evolving and finding environmentally responsible disposal options while minimizing the environmental impact of landfills. In addition, it should promote waste reduction and resource recovery to reduce the amount of waste that requires disposal.

Disposal Methods

Worldwide, waste is disposed, with 37% going to landfills and 31% being openly dumped. However, 19% of global waste is recovered through recycling and composting, while 11% is incinerated for final disposal.

Disposal Methods



Source: MCG, World Bank, 2023

Effective waste management requires significant investment in infrastructure, equipment, and trained personnel. This includes the costs of collection, transportation, and disposal or treatment of waste, which may involve recycling, incineration, or landfilling. These processes are not only costly, but they also have economic implications related to job creation, market development for recycled materials, and potential revenue from waste-to-energy facilities.

However, failure to manage waste properly can lead to serious economic consequences as well. For instance, the improper disposal of industrial waste at a 3M Manufacturing site in Hutchinson, Minnesota resulted in contamination of the local groundwater, which necessitated an extensive and expensive clean-up operation.

From an environmental perspective, 1.6 billion tonnes of CO2 equivalent greenhouse gas emissions were generated from solid waste treatment and disposal in 2016, driven primarily by disposing of waste in open dumps and landfills without landfill gas collection systems. If no improvements are made in this sector, solid waste-related emissions are anticipated to increase to 2.38 billion tonnes of CO2 equivalent per year by 2050.

Furthermore, the cost of inaction or ineffective waste management can extend beyond direct financial impact to include negative economic implications in the form of lost productivity due to health issues, impact on tourism, and degradation of natural resources, among others.

The disposal segment is estimated to expand at the highest CAGR of 5.9% over the forecast period from 2023 to 2030. Disposal methods include recycling, incineration, composting, landfills, and open dumping. The proper disposal of waste is crucial to avoid environmental deterioration and various infections among the population caused by improper waste disposal.

Landfills

Landfills are a widely used method of waste disposal across the globe, and they play a significant role in solid waste management systems. They can be described as controlled disposal sites for municipal solid waste ("refuse") on land. This method, which originated in England in 1912 where it is known as "controlled tipping", involves depositing waste in thin layers, each up to 1 meter or 3 feet thick. These layers are promptly compacted using heavy machinery, such as bulldozers. Several of these compacted layers are placed on top of each other to form a refuse cell, which can be up to 3 meters thick. At the end of each day, the compacted refuse cell is covered with a layer of compacted soil to prevent odours and windblown debris.

Modern landfill sites are carefully chosen and prepared to minimise environmental harm. For instance, they are often sealed with impermeable synthetic bottom liners to prevent groundwater pollution. When a landfill reaches capacity, it is capped with a layer of clay or a synthetic liner to prevent water from entering. Finally, a layer of topsoil is placed, compacted, and graded, and vegetation may be planted to reclaim the land. This can be used for various purposes, such as creating parks, golf courses, or other public projects.

Globally, approximately 37% of waste is disposed of in landfills, with 8% of this being disposed of in sanitary landfills equipped with landfill gas collection systems. However, the use of landfills varies widely across regions and income as shall be discussed later.

Incineration

Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials. This process results in the conversion of waste materials into ash, flue gas, and heat. The heat produced by incineration can be used to generate electricity, providing a renewable source of energy that can supplement other power sources. Incineration can be considered a form of energy recovery, with many modern waste-to-energy facilities using this process.

One of the major advantages of incineration is the significant reduction in volume of the waste. This process can reduce the volume of original waste by up to 85-90%, significantly decreasing the amount of waste that ends up in landfills. This is particularly important in regions where land availability is a concern. Furthermore, incineration can also help with the neutralization of hazardous wastes, reducing the potential environmental and health impacts of these materials.

However, it's important to note that incineration can pose environmental challenges, particularly related to air pollution. While modern incinerators are equipped with advanced air pollution control devices to capture most pollutants, some emissions, like greenhouse gases and fine particulate matter, can still escape into the atmosphere. These pollutants can contribute to global warming and can also have adverse health effects on the local population.

Incineration is generally more expensive than landfilling, mainly due to the high costs of facility construction, operation, and maintenance. However, the cost can be offset to some extent by the energy produced during the incineration process. In addition, depending on the local legislative framework, there might be additional costs related to air pollution control and regular emission checks.

Globally, incineration is primarily used in high-capacity, high-income, and land-constrained countries as will be discussed later in the report. As of now, 11% of the global waste is incinerated.

Recycling

Recycling is a prominent waste management method used to process and repurpose waste materials instead of discarding them as trash. It plays a significant role in waste management strategies around the world and is particularly important in high-income countries where it accounts for about 19% of total waste management efforts. The main goal of recycling is to minimize the volume of waste that ends up in landfills and incinerators, thereby reducing the environmental impact of waste.

The process begins with the collection of waste, which varies greatly by income level and location, as will be discussed later in the report. Once collected, the waste needs to be sorted, with recyclable materials like plastic, paper, cardboard, metal, and glass separated from other waste.

Recycling processes differ based on the type of material. For instance, paper is typically re-pulped and then remade into new paper products, while plastic is often cleaned, melted, and then reshaped into new plastic items. Metals, particularly aluminium and steel, are melted down and reshaped, and glass is crushed and melted to be formed into new glass products. These processes can save significant amounts of energy compared to producing these materials from virgin resources.

Recycling, however, does not come without its challenges. Not all materials are recyclable, and the process often requires substantial infrastructure and investment. The success of recycling programs also relies heavily on public participation and understanding of what can be recycled. Additionally, recycling can be limited by market demand for recycled materials, which can fluctuate and sometimes make recycling less economically viable.

It's also important to consider that while recycling can help reduce the environmental impact of waste, it is only one part of a broader waste management strategy. Other elements, such as waste reduction and reuse, are also crucial for effective waste management. Indeed, the 'reduce, reuse, recycle' hierarchy emphasises that recycling should be the last resort after efforts to reduce and reuse waste have been exhausted.

Composting

Composting is an effective method of waste disposal that transforms organic materials into a nutrient-rich soil conditioner. At its core, it involves the controlled decomposition of organic material, a process that relies on the right balance of 'green' and 'brown' materials. Green materials such as grass clippings, food scraps, and manure are high in nitrogen, while brown materials like dry leaves, wood chips, and branches are high in carbon but low in nitrogen. The optimal mix of these materials requires experimentation and patience.

The composting process also depends on a few other essential elements: particle size, moisture content, oxygen flow, and temperature. Grinding, chipping, or shredding materials increases the surface area for microorganisms to feed on and helps maintain optimal temperatures. However, particles shouldn't be too small, as they might impede airflow. Microorganisms in a compost pile need enough moisture to survive, which can come from the organic material itself, rainfall, or intentional watering. Oxygen flow is crucial to accelerate the decomposition rate, and it can be enhanced by turning the pile, placing it on a series of pipes, or using bulking agents. Finally, the compost pile's temperature needs to be controlled, as microbial activity can raise the core temperature to at least 60 Celsius, promoting rapid composting and destroying pathogens and weed seeds.

There are several methods of composting, and the choice depends on the context and volume of organic waste:

- **Onsite Compositing** is suitable for small amounts of waste, like yard trimmings and small food scraps. The process is relatively straightforward and requires little time or equipment. The process can take up to two years, but manual turning can speed it up to 3 to 6 months. It's important to handle food scraps properly to avoid odors and unwanted pests.

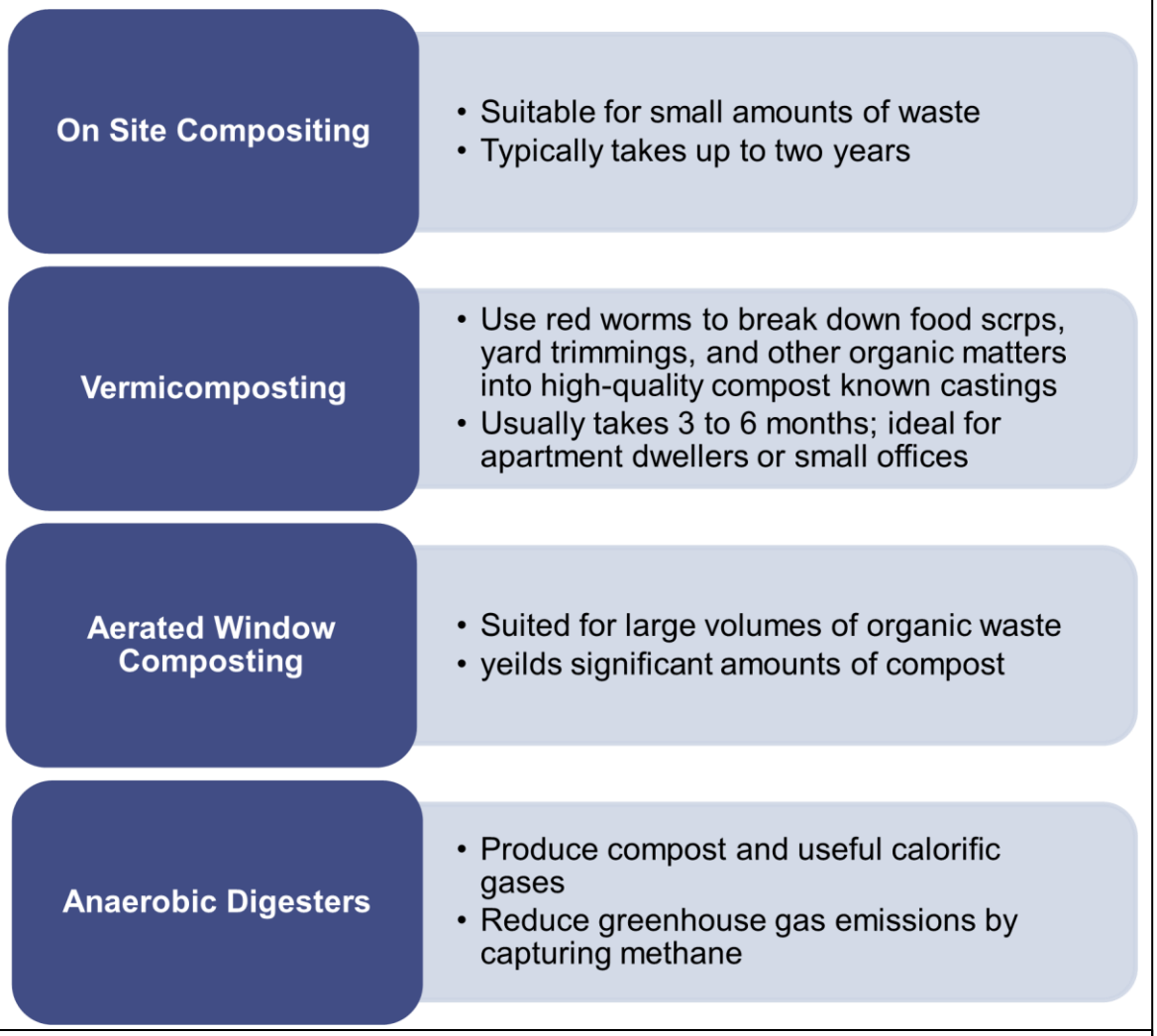
- **Vermicomposting** involves the use of red worms to break down food scraps, yard trimmings, and other organic matter into high-quality compost known as castings. A pound of mature worms can eat up to half an organic material per day. The process usually takes 3 to 6 months to produce usable castings. This method is ideal for apartment dwellers or small offices and can also serve as an educational tool for teaching children about conservation and recycling.

- **Aerated (Turned) Windrow Composting** is suited for large volumes of organic waste like those generated by entire communities or high-volume food-processing

businesses. The waste is formed into long piles called “windrows” and aerated periodically by turning the piles manually or mechanically. This method yields significant amounts of compost.

- **Anaerobic Digesters** are an effective method of producing compost, as well as useful calorific gases that can reduce greenhouse gas emissions and provide renewable energy. Anaerobic digesters also create valuable soil products and recover nutrients from organic waste. Anaerobic digestion is a promising technology that can contribute to a circular economy and a sustainable future. Anaerobic digesters have several benefits for the environment and the economy as they can: reduce greenhouse gas emissions by capturing methane that would otherwise escape to the atmosphere, generate renewable energy from biogas, produce valuable soil products from digestate, and recover nutrients, such as nitrogen and phosphorus, from organic waste, reducing the need for synthetic fertilizers and protecting water quality.

Composting methods



Source: MCG, US EPA, 2023

The environmental benefits of composting are manifold, including waste reduction, oil enrichment, and contribution to a circular economy.

Throwing away garbage in open pits or landfills without any lining or protection is cheaper than any other option, so preferred in developing countries where there are not many options for waste management. While most of the garbage is made of natural things like food scraps or plants, which can decompose and not harm the environment too much. However, food waste poses significant environmental and economic challenges due to various reasons. Firstly, wasting food squanders the valuable resources utilized in its production, such as water, land, energy, and fertilizers. Secondly, food waste contributes to climate change by releasing potent greenhouse gases like methane and carbon dioxide as it rots in landfills, exacerbating global warming. Additionally, food waste has a substantial economic impact, costing around US$940 billion globally each year, while recycling it can offer opportunities for generating revenue through biogas, compost, or animal feed sales.

Open Dumping

Open dumping is a method of waste disposal where waste is deposited in an area without any regulation or oversight. This method is typically characterised by an indiscriminate and uncontrolled disposal of waste at any site, often in a manner that is harmful to the environment. Open dumps are usually places where the public can freely dispose of their waste, but they can often become vast, unmanaged waste disposal areas for the public.

The waste materials dumped in open dumps include household waste, industrial waste, and even hazardous waste. These dumps can result in serious environmental pollution as they often lack any form of containment. Waste from the dump can easily leach into the solid and water, leading to contamination of the environment. Moreover, open dumps can also pose risks to human health and the health of animals and other forms of wildlife.

Burning of waste in open dumps is a common practice, but it can cause significant air pollution. The burning process releases harmful gases and particulates into the air, which can have adverse health effects and contribute to global warming. Despite being illegal in many places due to risks and pollution they cause, open dumping still occurs, often due to lack of enforcement of laws and regulations on waste disposal.

In many developing countries, open dumping is a prevalent method of waste disposal. It’s often seen as a cheap and easy solution, particularly in rural and remote areas where waste management infrastructure may be lacking. However, it can lead to long-term degradation of land and water resources, making these areas unsuitable for other uses.

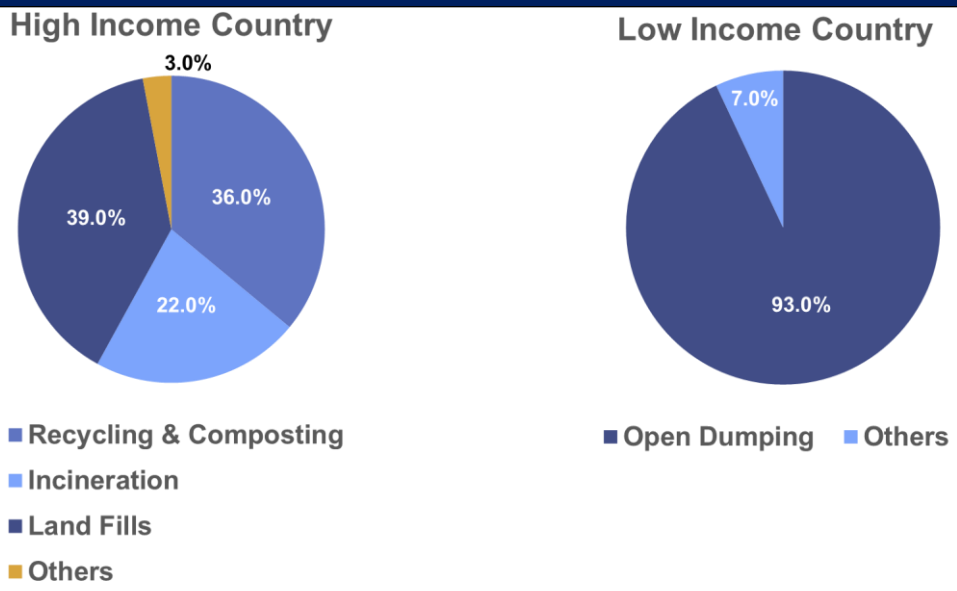
Despite the negative impacts, efforts to combat open dumping often faces challenges. Factors such as lack of awareness, insufficient waste management infrastructure, and the perceived convenience of open dumping can hinder these efforts. Yet, it’s crucial to promote alternatives to open dumping to protect communities and the environment.

Geography

The global waste industry's disposal methods vary widely based on a country's income level and regional characteristics.

In high and upper-middle-income countries, waste disposal tends to use more advanced technologies and methods, that allow to recover and recycle complex materials or transform waste into something useful for society, such as energy. In these nations, waste is more likely to be managed through controlled landfills or more stringently operated facilities. High-income countries divert 36% of waste to recycling and composting and 22% to incineration, with only 39% going to landfills. On the contrary, in low-income countries, where resources and infrastructure for waste management are often lacking, open dumping is more prevalent; about 93% of waste is dumped in this manner.

Comparative Disposal Methods
High vs Low Income Countries



Source: MCG, World Bank, 2023

In recent years, developing countries with a surge in population have implemented some measures to address the escalating waste volumes and a host of issues arising from open dumping practices. On one hand, efforts have been made to curb waste imports. Notably, China enacted a comprehensive ban on solid waste imports from January 1st, 2021, while Malaysia initiated a recycling fee of US$4.5 per kilogram on "foreign waste" imports starting from June 2021. In addition, Thailand declared its phased plan in 2022 to completely prohibit plastic waste imports. On the other hand, there has been a shift from landfilling to diverse waste management channels. Prominently, developing countries have heavily invested in the establishment of modern waste treatment facilities, including incinerators, composting plants, and biogas facilities, aiming to enhance waste disposal capacity and efficiency. These measures reflect the proactive stance taken by these

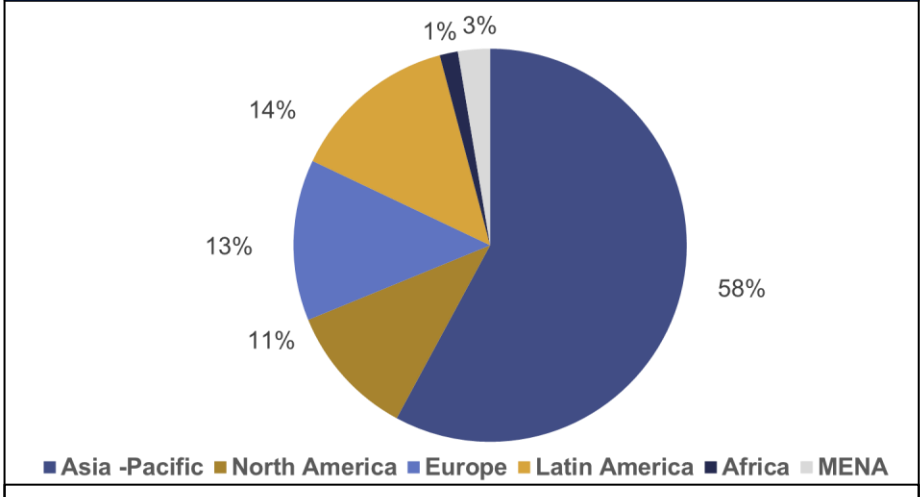
nations in tackling the mounting waste management challenges within their regions, indicating a commitment to sustainable and responsible waste practices.

The waste composition differs across income levels. High-income countries generate more dry waste that could be recycled, including plastic, paper, cardboard, metal, and glass, which account for 51% of waste. Conversely, middle and low-income countries generate 53% and 57% of food and green waste, respectively, with the fraction of organic waste increasing as economic development levels decrease. This implies that different income groups have different waste management challenges and opportunities. High-income countries could reduce their environmental impact by increasing their recycling rates of dry waste, which can save resources and energy. Middle and low-income countries could benefit from composting or anaerobic digestion of their food and green waste, which can produce organic fertilizer and biogas. Technologies in various disposal methods can reduce greenhouse gas emissions and health risks from open dumping or burning of organic waste. Therefore, waste management solutions should be tailored to the specific waste composition and context of each country.

Financing for solid waste management systems, including operational costs for integrated waste management, poses a significant challenge. In high-income countries, operating costs for integrated waste management generally exceed US$100 per tonne, whereas lower-income countries spend less in absolute terms, with costs of about US$35 per tonne and sometimes higher. These costs are often difficult to recover, particularly in lower-income countries. Possible reasons are that the amount of private investment in the field of solid waste management is alarmingly low because of the requirement of massive financial investment and limited opportunity to gain returns. Also, governments of developing nations allocate low budget for solid waste management and often lack adequate legal structures and institutions to regulate the sector.

The global waste management market exhibits varying market sizes across different regions. In 2022, the Asian-Pacific region leads, followed by Latin America, Europe, America and Africa.

Global Waste Management Breakdown



Source: MCG, 2023

North America

The waste management industry in North America is an essential service that encompasses several important sectors such as municipal waste collection, industrial waste management, and recycling. This industry is crucial to maintaining environmental health, public sanitation, and the reduction of pollution in North America. This industry in this region of the world is a multi-billion-dollar sector that is witnessing significant growth and transformation.

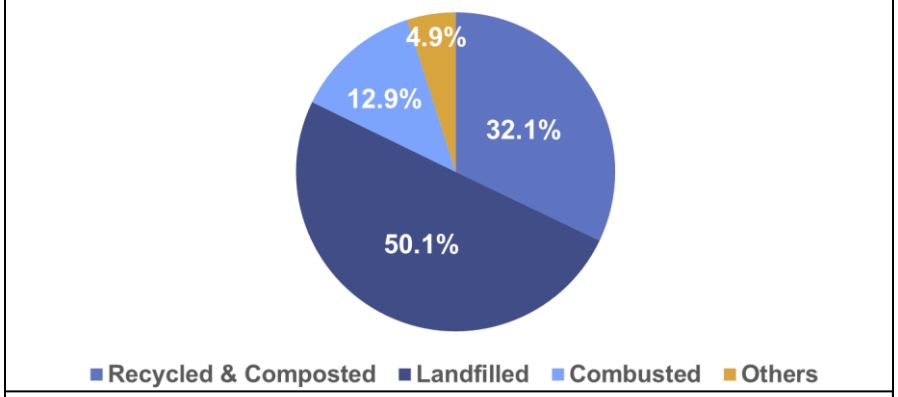
The industry is highly regulated, with several federal and state laws in place to manage waste disposal and recycling. The Environmental Protection Agency ("EPA") in the United States and the Canadian Environmental Protection Act ("CEPA") in Canada are key regulatory bodies that oversee waste management practices. EPA outlines five areas that must be controlled during composting: feedstock and nutrient balance, particle size, moisture content, oxygen flow, and temperature.

In the United States, the solid waste management is expected to grow at a CAGR of 0.75% from 2023 to 2028.

In 2018, Americans generated approximately 292.4 million tons of MSW, which equates to about 4.9 pounds per person per day. Of this, around 32.1% was recycled and composted, 50.1% was landfilled, and 12.9% was combusted for energy recovery. The recycling rate in Canada is slightly higher, with an estimated 35% of waste being recycled.

The waste management industry in North America is characterised by both public and private sector involvement. The industry includes large corporations such as WM, Republic Services, Casella Waste, and Waste Connections in the United States, which account for over 58% of the market share in terms of revenue, and GFL Environmental in Canada, as well as many smaller regional and local companies. These companies provide a range of services including waste collection, waste disposal, recycling services, and waste-to-energy solutions.

US Municipal Solid Waste Breakdown



Source: MCG, US EPA, 2022

In the United States, the waste management industry is experiencing a period of consolidation with larger companies acquiring smaller ones. In Canada, the industry is growing, driven by increased urbanisation and government regulations promoting sustainable waste management practices. However, the industry faces challenges such as increasing waste generation rates, the complexity of waste streams, and the need for more recycling infrastructure.

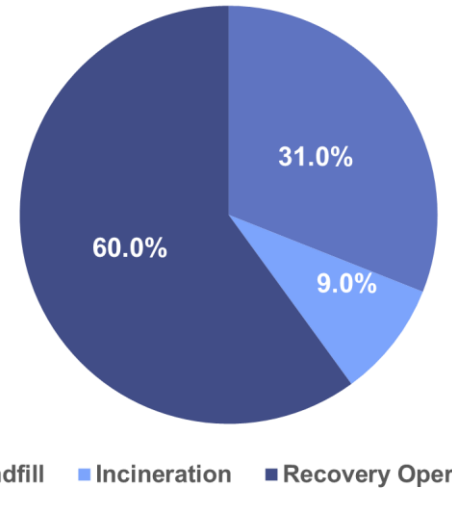
Europe

The waste management sector in Europe, responsible for all aspects of the waste cycle including collection, transportation, processing, disposal, and recycling, plays a crucial role in environmental protection and resource recovery. As a global leader in waste management, the European Union boasts some of the highest recycling rates worldwide, with standout member states including Germany, Italy, and Austria.

In 2020, the European Union generated more than 2.1 billion metric tons of waste, equating to approximately 4.8 metric tons of waste per capita. Households were responsible for around 10% of total EU waste generation that year, with the average amount of municipal waste produced per inhabitant rising to 517 kg. Denmark topped the list for per capita waste generation at almost 850 kg, followed by Luxembourg, Malta, and Germany, while Poland and Romania generated the least, at less than 350 kg per capita.

Regarding waste treatment, in 2020, 31% of total EU waste was sent to landfill sites, while almost 9% was incinerated without energy recovery. The remaining 60% underwent recovery operations, with recycling accounting for 39%. The recycling rate of municipal waste, which had been increasing over the decades, reached 48.1% in 2019, dropping slightly to 47.8% in 2020 due to disruptions caused by the COVID-19 pandemic.

European Waste Treatment Breakdown



Source: MCG, Eurostat, 2023

Eight EU members had a municipal waste recycling rate of more than 50%, with Germany leading the pack.

The EU is striving to promote a more circular economy, setting ambitious recycling targets for the coming decades. By 2030, EU Member States are legally required to recycle or prepare for reuse 60% of municipal waste. Moreover, under the European Commission's Waste Framework Directive, residual municipal waste needs to be reduced by 50% by 2030, equivalent to around 56.5 million metric tons. However, current trends suggest that the EU may not reach this target without a significant reduction in waste generation, highlighting the urgent need for waste prevention in addition to recycling.

Key players in the European waste management industry include multinational companies like Biffa and SUEZ. Biffa is a waste management company headquartered in High Wycombe, England. It provides collection, landfill, recycling and special waste services to local authorities and industrial and commercial clients in the United Kingdom. It was founded in 1912 by Richard Henry Biffa and is now owned by the private-equity firm, Energy Capital Partners. SUEZ is another global leader in sustainable development and environmental solutions, with operations in Europe, Asia, and North America.

Asia

The waste management industry in Asia has been demonstrating promising growth, positioning itself as a global leader in this sector. In 2022, the Asia region accounted for over 24.5% of the industry's global share. This significant contribution is largely attributed to government initiatives such as Swacch Bharat Abhiyan and zero waste plans implemented by several countries in the region, which have helped boost awareness and engagement in waste management practices.

The market size value of the waste management industry in Asia is projected to grow at a CAGR of 5.4%. The industry's growth in China is driven by expanding middle class and stricter government regulations on pollution.

Key players in the market, such as China Everbright International Ltd, Veolia Environment S.A., and Sembcorp Industries Ltd, have gained a significant share in the industry by integrating waste collection, transportation, and disposal services across their supply chains, optimizing operational costs, and increasing profit margins. The future of the waste management industry in the Asia Pacific region appears robust, backed by strategic government initiatives, technological advancements, and efficient practices by industry leaders.

Middle East & North Africa

The waste management industry in the Middle East and North Africa ("MENA"), particularly in the Gulf Cooperation Council ("GCC") countries, has seen significant development in recent years. It is a market, exhibiting a CAGR of 6.5% during the period 2023-2030.

The market dynamics in this region have been influenced by various factors.

The development of alternative waste-handling mechanisms, such as waste-to-energy projects, has augmented the demand for services and systems. This demand has led to the growth of recycling disposal methods in the region. Waste management processes include collection, transportation, treatment, and disposal of waste, monitoring, and regulation of the process, and the relevant waste-related laws, technologies, and economic mechanisms.

Population growth and correlated waste generation are other important factors driving the growth of the waste management market in MENA. According to MCG research, more than half of MENA countries are experiencing a 50% increase of population from 2015 to 2050, and countries such as Iraq and Sudan will double their population in 35 years. With 580 million inhabitants expected in MENA, MCG predicts the daily waste generation will be 580,000 metric tons. The waste management market will naturally expand along with the population and waste generation growth in MENA.

Increasing government action to reduce illegal waste disposal is expected to fuel the growth of the waste disposal market. For example, in 2021, the Shoura Council of Saudi Arabia approved a draft law that includes penalties for waste disposal violations, such as a maximum of 10 years in prison or a fine of US$ 8.0 billion.

Environmental consciousness is also a driving factor for the waste management market in MENA. With the increasing amount of waste produced due to urbanization and industrialization, awareness of the environmental dangers of inefficient systems is growing in the region.

The waste management market in MENA is experiencing a trend of decentralization, where countries like Tunisia passes waste management responsibilities from the central government to local municipalities. Since 2018, municipalities in Tunisia have assumed responsibilities for waste collection, which brings benefits as local institutions and private sectors have more experience and motivation to manage their own waste.

Africa

The waste management industry in Africa is a rapidly evolving sector, spurred by various socio-economic and environmental factors. The African waste management market is projected to grow at a CAGR of 7.4% during the forecast period from 2023 to 2030.

There are several key drivers contributing to the growth of the African Waste Management Industry. Urbanization, popular growth, and the increasing amount of waste generated are key factors propelling market growth.

Governments across the continent are also focusing on implementing stringent regulations regarding waste disposal and management, which will boost market growth. The integration of advanced technologies, such as the Internet of Things ("IoT") and big data analytics, into waste management is helping to enhance the efficiency of waste management services, further driving growth in the sector.

The waste management industry in Africa also faces challenges. Waste collection rates across countries in Africa are just 55%, well below the global standard. And more than 90% of waste generated is disposed of at uncontrolled dumpsites and landfills. However, the current challenges in the waste management industry present immense opportunities for public and private sectors to work on improving the infrastructure in the industry. According to a research report done by UN Environment Program, diverting wastes away from open dumpsites and landfills, along with recycling and recovery, can bring an additional US$ 8 billion annually to Africa's economy.

The waste management market varies across different African countries.

For instance, South Africa is expected to witness significant growth with CAGR of 3.4% from 2023 to 2025 in the waste management market due to the country's increasing focus on managing industrial waste and urban waste. The South African government is placing emphasis on the treatment and disposal of waste, which is helping to drive market growth in the region.

In contrast, the market in Algeria is being driven by the increasing amount of municipal waste, which amounts to 10.3 million metric tons per year. The Algerian government is focusing on improving waste management services, which is contributing to market growth in the region.

The African waste management industry is poised for significant growth over the next few years at a CAGR of 7.4%. The integration of advanced technologies, increased focus on recycling, and stringent government regulations are expected to drive this growth.

Market Drivers in Africa

Source: MCG, 2022

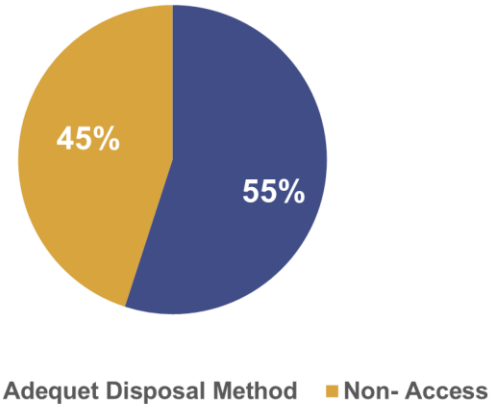
Latin America

The waste management industry in Latin America is a critical and growing sector, with a projected CAGR of 5.0% between 2023 and 2030. Latin America faces several challenges in waste management. These include recycling rates under 10%, many open-air dumps, high levels of informality in the workplace, and over 40% of waste being incorrectly managed.

On average, each person in Latin America and the Caribbean generates 0.6kg of Domestic Solid Waste ("DSW") and 0.9 kg of MSW per day. DSW makes up approximately 67% of the MSW generated in the region. Interestingly, the average waste collection rate in the region is 89.9%, which is significantly higher than the worldwide average of 73.6%. Argentina, Chile, Colombia, the Dominican Republic, Trinidad & Tobago, Uruguay, and Venezuela have almost universal waste collection coverage, with rates close to 100%.

However, despite this high collection rate, the final disposal of waste is a significant issue. Approximately 55% of the population has access to adequate final disposal coverage (in landfills), meaning that a large proportion of the waste (45%) is not disposed of or treated adequately. Consequently, MCG expects disposal sector to grow significantly.

Latin America Access to Final Disposal Methods



Source: MCG, 2023

The costs associated with waste management vary significantly between countries. On average, the unitary collection costs are estimated at US$34 per collected ton. For instance, the cost in Argentina is US$54 per ton, whereas in Paraguay, it is only US$6.6 per ton. Similar variations are seen in the final disposal costs, which average US$20.4 per ton. In Ecuador, it is as low as US$5.6, while in Brazil, it is much higher, averaging US$31.5 per ton.

Key players in the South American waste management market include Recycle S. de R.L., Proactiva Medio Ambiente, Honduras Environmental Services, and Capitol Environmental Services, Inc.

Veolia, through its subsidiary Proactiva Medio Ambiente Mexico S.A. de C.V., has a contract to design, build, and operate the first Waste to Energy facility in Latin America in Mexico City. This facility will treat around 1.6 million metric tons of household waste per year. Honduras Environmental Services offers hazardous waste management and consulting services and has been awarded Sanitary and Environmental licenses by Central Authorities.

Overall, the waste management industry in Latin America is evolving, striving to overcome its challenges, and capitalizing on new opportunities. The focus is shifting towards improving efficiency, incorporating sustainable practices, and fostering private sector involvement to address the major waste management issues.

FUTURE TRENDS

Introduction

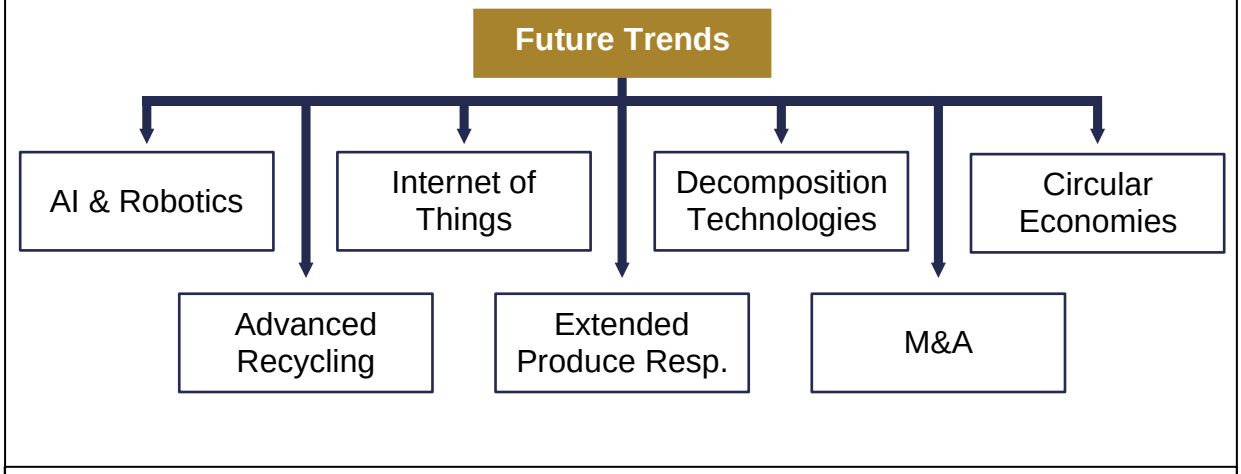
The waste management industry is undergoing significant transformations, catalyzed by advancements in technology and the increasing emphasis on sustainability. Emerging trends encompass a range of areas, including autonomous operations, digitalization, and advanced recycling methods, all aimed at increasing efficiency and promoting sustainability. This report will explore some of these trends and their potential impacts on the industry.

Trends

As we navigate an increasingly complex global context, waste management stakeholders face the dual challenge of addressing immediate concerns while also envisioning a more sustainable future. The adoption of innovative technologies, the integration of data-driven insights, and the cultivation of strategic partnerships will play pivotal roles in this endeavor. Moreover, the emergence of stringent environmental regulations, shifting consumer preferences, and the rise of conscious capitalism are compelling industry players to reimagine waste management as a linchpin for broader corporate social responsibility.

By examining these future trends, we will gain insights into the evolving landscape of waste management, paving the way for strategic decision-making, innovation, and responsible investment. As we stand on the precipice of change, understanding these trends will empower stakeholders to navigate the dynamic challenges and opportunities that await, fostering a waste management industry that aligns harmoniously with the imperatives of both our environment and our economy.

Future Trends in the waste management industry



Source: MCG, 2023

Artificial Intelligence & Robotics

AI is increasingly becoming integral to waste management processes. By incorporating AI into their workflows, companies can automate waste management, thereby improving operational efficiency. Startups are offering AI-based solutions that optimize the routes for garbage trucks, saving fuel costs and reducing traffic delays. AI is also being used to facilitate the smart sorting of waste materials, increasing the speed and accuracy of sorting, especially for plastic recycling companies. The use of big data in waste management enhances waste data analysis, thereby improving the overall efficiency of waste management operations.

Furthermore, robotics plays a crucial role in waste management, especially in tasks such as waste sorting and collection. The application of robotics in these areas is aimed at reducing human involvement, thereby making operations safer, more efficient, and more productive.

Advanced Recycling

Advanced recycling processes are being developed to improve material recovery. For example, the introduction of plastic-eating microbes that decompose plastic waste is a novel approach to managing plastic waste.

Internet of Things

The use of IoT in waste management is transforming the industry. IoT-enabled smart waste bins incorporate sensors that monitor dumpster fill levels and notify waste collectors at the right time, improving the overall efficiency of waste collection processes.

Decomposition Technologies

Innovative decomposition technologies are being introduced in the industry, such as the development of plastic-eating microbes that can decompose plastic waste, offering a novel approach to managing plastic waste.

While blockchain technology is being explored to track material lifecycle and improve recycling efficiency. This technology can help in diverting waste away from landfills, thereby contributing to sustainability.

The waste management industry is on the cusp of a significant transformation, driven by these emerging trends. While these technologies are in varying stages of maturity and adoption, they all point toward a future where waste management is more efficient, sustainable, and technologically advanced.

Extended Producer Responsibility (“EPR”)

EPR is a policy approach that holds producers accountable for the entire lifecycle of their products. This encompasses both financial and operational responsibilities, although the nature and extent may vary. Producers are mandated to provide funding and/or services to facilitate the proper management of covered products after their use phase.

In the realm of packaging, many EPR programs encourage or mandate packaging producers to participate in a collective Producer Responsibility Organization (“PRO”), although individual compliance is often allowed. The PRO takes charge of developing a producer responsibility plan and overseeing the program's implementation. In certain regions, these entities may be referred to as stewardship organizations and stewardship plans. Typically, PROs operate as nonprofit organizations, and some EPR programs permit multiple PROs within a single region.

The financial structure varies, but in most EPR programs, producers contribute fees to the PRO. These funds are then distributed to cover the costs outlined in program legislation. Generally, these costs support the end-of-life management of covered products, including collection, sorting, and processing. The specific items or materials managed within the program are defined either by legislation or the producer responsibility plan and are known as covered products.

Circular Economy

The waste management industry is gradually shifting towards the principles of a circular economy. This involves incorporating sustainable materials, circular product design, biodegradable packaging, and more to enable a closed-loop supply chain. Sustainable packaging materials and waste-to-energy solutions facilitate this transition to a circular economy.

Mergers & Acquisitions

The waste removal industry is witnessing continued consolidation and acquisitions of smaller companies by larger players. The post-acquisition period often leads to complexities, including system changes, equipment adjustments, and staff integration, which can result in increased costs, invoice discrepancies, and service disruptions. These disruptions by larger players can lead to opportunities for smaller local entrenched players.

[1]Sources: from various sources - M Capital Group Research, including data from “Global Waste Management Outlook”, United Nation Environment Programme and International Solid Waste Management Association, 2015, Statista, 2023, “What a Waste 2.0”, Word Bank, “The Impact of Waste to Energy on climate”, 2019, Zero Waste Europe, “Sanitary Landfill”, Britinnica, 2023, “ Types of Composting and Understanding the Process”, United States Environmental Protection Agency, “Top 10 Best Waste Management Copmanies in Europe 2023”, April 2023, “Waste Management in Asia – Pacific- Market Summary” , Research and Markets, August 2021, “Weathering the Essential: A Look Inside the COVDI-19 Impact on the Waste and Recycling Industry”, Waste 360, June 2020, “COVID-19 Waste Management Factsheets”, UN Enrioment Programme June 2020, “Top 8 Waste Management Trends & Innovations in 2023”, StartUs Insights, 2023, “The Benefits of Waste Sorting Robots in Recycling Facilities”, Digital Leaders, March 2022, “GCC Waste Management Market Size, Share & COVID- 19 Impact Analysis, By Disposal Method, By Waste Types, and GCC Forecast, 2022-2029, July 2022, “Africa Waste Management Market Size & Share Analysis – Growth Trends & Forecasts (2023-2028)”, Mordor Intelligence, “Solid Waste Management in Latin America and the Caribbean”, IDB, August 2015, “ In Mexico City, Veolia Will Build and Operate the First Waste to Energy Faicility in Latin America,” Veolia, May 2015, “Averda Business Lines”, Averda, 2023, “Long Business Desription for Clean Harbos/ Republic Services/Waste Mangement Inc/Veolia” , Capital IQ, 2023, “Find out 4 waste management trends that are defining the waste industry”, National Waste Associates, "A CLOSER LOOK: The Waste Management Rules, 2021 & the Waste Management (FEES) Regulations, 2021", Ministry of Planning and Development, February 8, 2023, "New 2023 Waste Management Legislation in the UK", Inspire Waste Management, February 8, 2023, “Global waste generation - statistics & facts", Statista, January 27, 2023, “Municipal waste statistics - Statistics Explained", Eurostat, January 28, 2023, “Solid Waste Management Challenges, Waste Disposal Challenges”, SpendEdge, February 8, 2023, “Solid Waste Management”, World Bank Group, February 8, 2023, Web Search for Companies on Competitor list.

M CAPITAL GROUP

NEW YORK	LONDON	DUBAI
1330 Av of the Americas New York, NY 10019 U.SA United States Phone: +1 212 634 683 Fax: +1 212 634 7474	Dashwood House 69 Old Broad Street London EC2M 1QS United Kingdom Phone: +44 207 256 4246 Fax: +44 207 256 4050	Level 41 Emirates Towers P.O. Box 31303 Dubai United Arab Emirates Phone: +971 4 319 7460 Fax: +971 4 330 3365