

Plastic Waste Management for Sustainable Development

Inderjot Kaur
Chandigarh Engineering
College, Mohali

Under the Guidance of:
Dr. Guru Basava Aradhya S
Professor
Chandigarh Engineering
College, Mohali

Dr. Rohit Markan
Chandigarh Engineering
College, Mohali

Abstract - Plastic waste management is a critical issue. Over 400 million tons of plastics are produced in the world annually. Although there are multiple uses of plastics, its waste and the resultant pollution clogs up our rivers, oceans, land, and adversely affects our biodiversity. In fact, oil and gas companies are doubling down on plastic production with plans to build or expand over 300 petrochemical plants in the U.S alone by 2025. But these companies already produce more plastic than we can use. so where is all that plastic going? A lot of it's flowing into new markets in places like Asia, and Latin America because more than any product category, plastic is not driven by the demand for it but the supply. These companies push their products onto communities that aren't just prepared to deal with all that plastic. And on top of that they are shipping their own plastic waste into these countries too. When you add that all up, it's no wonder so much of this plastic ends up in the environment and globally, that's where a whopping 32% of plastic packaging ends up. 40% goes into landfills where plastic just piles up for the future generation to deal with.

a. Purpose:

The purpose of this project is to highlight the current scenario of plastic waste globally and in India although we have raised multiple environmental concerns regarding the plastic pollution, and we have probably heard somewhere about the giant trash island in the ocean or the sea turtle and straw. Maybe we have even heard that how plastic is being found about inside the fish we eat. The plastic crisis does get a lot of attention but the headlines usually focus on the plastic that ends up in the environment and that's just part of the story. The truth is that plastic has a whole lifecycle that's hidden from the view. It's not only affecting our biodiversity but depleting our resources (such as fossil fuels like oil or fracked natural gas) as well.

b. Methodology:

Data has been collected from various researches, industry reports, documentaries and government policies on plastic industry and its waste management.

c. Major Findings:

The findings highlight the critical need for innovative recycling technologies, and stricter enforcement of rules and regulations to ensure the sustainable management of plastic waste. We should hold big firms responsible who promote single use plastic packaging or dispose their plastic waste to other countries who do not have a proper system of waste collection. By this we can achieve our vision of a zero-waste future where all our products and packaging can be used or repaired, effectively recycled or composted, and that's how we can create a sustainable and circular economy that works both for the planet and people.

d. Keywords:

Plastic Waste Management, Recycling, Sustainability, Government Policies, Environmental Impact, Green management and Technologies.

1. INTRODUCTION

Background:

Plastic was first created in the 1860s with a noble intention to replace elephant ivory used in billiards balls. Belgian chemist Leo Baekeland created the first fully synthetic plastic in 1907.

Plastic became popular with the military during the second world war, but it only grew at a scale commercially in the 1960s. since then, it's been produced in many different forms.

Polymers are the primary component of a broad variety of synthetic or semi-synthetic materials known as plastics. Plastics may be moulded, extruded, or pressed into solid objects of different forms because of their fluidity. Their extensive use is a result of their versatility as well as a host of other qualities, including being lightweight, strong, flexible, and affordable to manufacture. The majority of contemporary plastics are produced using chemicals obtained from fossil fuels, such as petroleum or natural gas, while more recent industrial processes employ versions generated from renewable resources, including maize or cotton derivatives.

Structure of the Industry:

The plastics industry manufactures polymer material commonly called plastic and offers services in plastics important to a range of industries, including packaging, building and construction, electronics, aerospace, manufacturing and transportation.

It is part of the chemical industry. In addition, as mineral oil is the major constituent of plastics, it therefore forms part of the petrochemical industry.

Besides plastics production, plastics engineering is an important part of the industrial sector. The latter field is dominated by engineering plastic as raw material because of its better mechanical and thermal properties than the more widely used commodity plastics.

Companies:

Corporations like Unilever, Nestle, Procter & Gamble are aggressively marketing single-use plastic products around the world.

In INDIA:

PLASTINDIA Foundation, established by prominent associations, organizations, and institutions in the plastics industry of India and supported by the Ministry of Chemicals and Fertilizers, Government of India, serves as the leading organization for the plastics industry. The PLASTINDIA Exhibition and Conference takes place once every three years. Typically scheduled for the early part of February, either in the first or second week.

The aim of PLASTINDIA Foundation is to support the advancement of the plastic industry and help in the expansion of plastic and associated goods. The foundation's goal is to advance the nation through the use of plastics. The foundation aims to support India in becoming the top choice for sourcing plastic products globally, as well as in promoting the export-driven development of the

Indian plastic industry. It also aids in increasing the levels of export trade and income.

Plastic waste management industry:

The plastic waste management sector primarily concentrates on gathering plastic waste, recycling it, and properly disposing of it to reduce its impact on the environment. The industry is also expanding quickly because of environmental concerns, regulatory push, and the need for sustainable methods.

Pricing Strategies:

Pricing tactics in the management of plastic waste differ based on government subsidies, technology costs, and demand for recycled materials in the market. Businesses are urged to implement environmentally-friendly pricing and practices as well as participate in a sustainable economy.

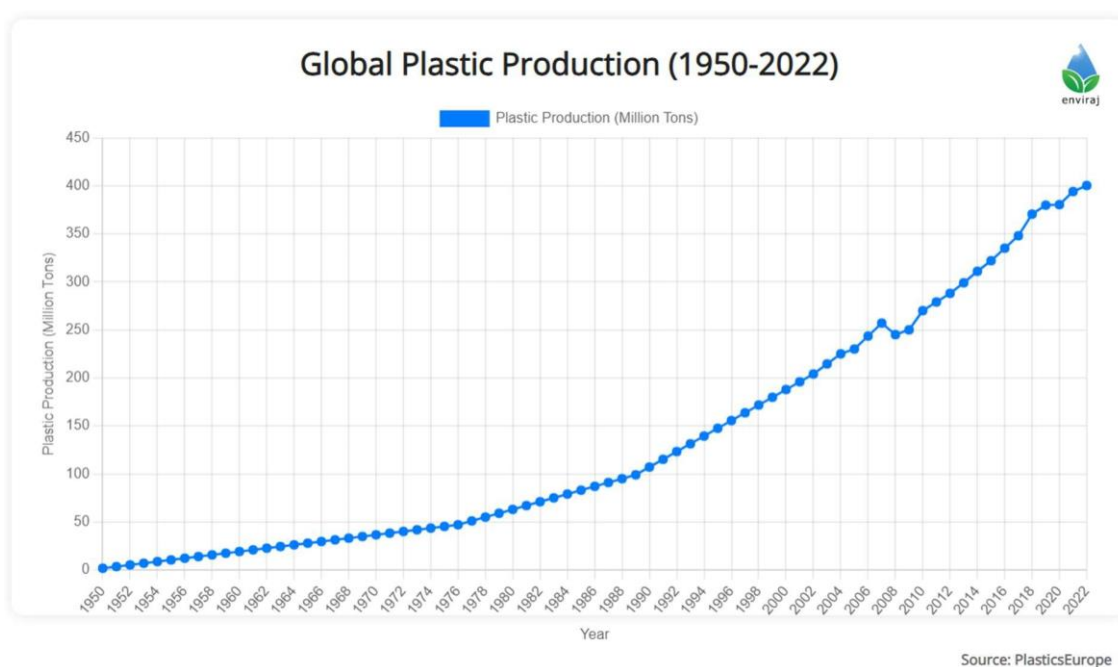
Indian Market Share:

India's plastics sector accommodates around 50,000 businesses, with the majority being micro, small, and medium-sized enterprises (MSMEs). These businesses add to the amount of Rs. The contribution to India's economy is 3.5 lakh crore (US\$ 42.89 billion) and it will provide jobs for over 50,000 individuals. The nation's plastic recycling rate is 60%, surpassing that of developed countries. The government's initiatives like "Make in India," "Skill India," "Swachh Bharat," and "Digital India" are projected to boost plastic production, with the plastics industry set to generate Rs by 2027. Annual revenue of \$122.54 billion, accompanied by exports of 2 lakh tonnes.

Reliance Industries holds the title of being the biggest producer of polymers in India, with the conglomerate responsible for about half of the nation's polyolefins production capacity in 2022.

No table of figures entries found.**Current Production Scenario:**

The global plastic production stands at over 400 million tons annually, with Asia being the largest contributor. Despite efforts, plastic recycling rates remain low, posing a significant challenge for sustainable development.



Product Details:

Understanding the various kinds of plastic is crucial for comprehending the intricacies of recycling, upcycling, and the health implications linked to plastic.

The initial stage involves understanding the fundamental principles of the different types of plastic we commonly come across, categorized by their recycling codes. Below are different kinds of plastic materials.

The first one is Polyethylene Terephthalate is also known as (PET or PETE). This plastic is widely used. It is lightweight, durable, usually clear, and commonly utilized in food packaging and textiles (polyester).

Examples include bottles for beverages, containers for food products like salad dressing, peanut butter, and honey, as well as clothing and ropes made from polyester.

High-Density Polyethylene (HDPE) is the second variety.

Polyethylene, categorized into three types as High-Density, Low-Density, and Linear Low-Density, is the most prevalent plastic globally. High-Density Polyethylene is durable and immune to moisture and chemicals, making it perfect for cartons, containers, pipes, and other construction materials.

Examples include Milk cartons, detergent bottles, cereal box liners, toys, buckets, park benches and rigid pipes.

Polyvinyl Chloride (PVC or Vinyl) is the following variety.

This tough and inflexible plastic is resilient to chemicals and weathering, which is why it is sought after in construction; its non-conductivity also makes it popular for high-tech uses like wires and cables. It is commonly utilized in medical settings due to its ability to block germs, be easily cleaned, and be used only once, which helps lower infection rates in healthcare facilities. Conversely, it should be acknowledged that PVC poses the greatest risk to human health among all plastics, as it is known to release harmful toxins such as lead, dioxins, and vinyl chloride at every stage of its existence.

Examples include Plumbing pipes, credit cards, toys for humans and pets, rain gutters, teething rings, IV fluid bags, medical tubing, and oxygen masks.

The fourth category is known as Low-Density Polyethylene (LDPE).

A gentler, more transparent, and more adaptable form of HDPE. Frequently utilized to line beverage cartons and in corrosion-resistant surfaces and other items.

Examples include: Plastic wrap, sandwich bags, bubble wrap, trash bags, shopping bags and disposable drink cups.

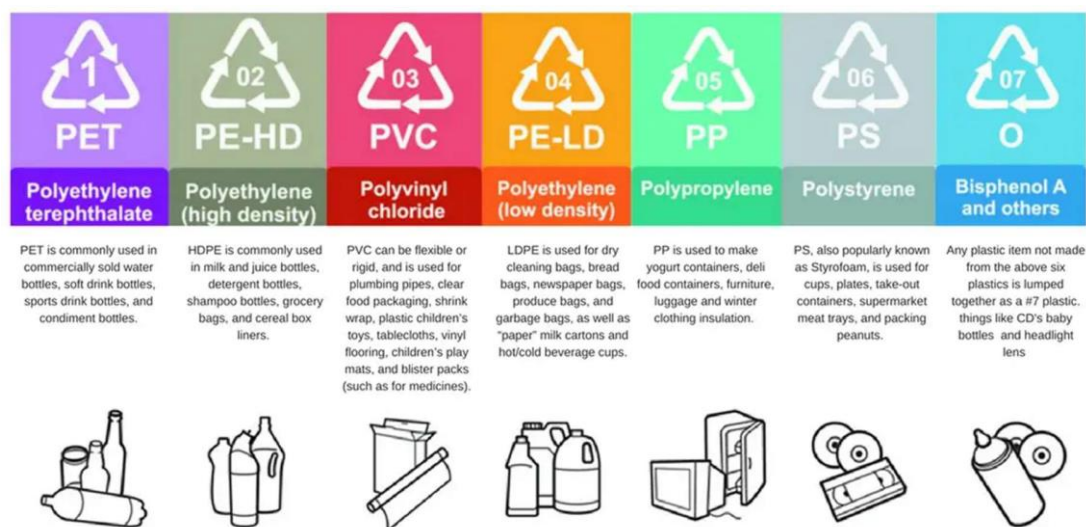
The fifth category Polypropylene (PP) is the most long-lasting plastic varieties. It has a higher heat resistance compared to other materials, making it perfect for use in food packaging and storage designed for hot items or for heating. It is pliant enough to be slightly bent, yet it maintains its form and durability over an extended period.

Examples include straws, bottle caps, prescription bottles, hot food containers, packaging tape, disposable diapers, and DVD/CD boxes.

The next category is Polystyrene, also known as PS or Styrofoam. More commonly recognized as Styrofoam, this hard plastic material is inexpensive and provides excellent insulation, making it a common material in the food, packaging, and construction sectors. Similar to PVC, polystyrene is also viewed as a hazardous plastic material. It has the ability to release dangerous substances like styrene, a neurotoxin, which can then be easily taken in by food and consumed by people.

Examples of items include cups, containers for takeout food, packaging for shipping and products, cartons for eggs, utensils, and insulation for buildings.

This group is a miscellaneous collection for plastic types that do not fit into the previous six categories or are mixtures of various types. The key point is that these plastics are usually not able to be recycled. Examples include: Eyeglasses, baby and sports bottles, electronics, CD/DVDs, lighting fixtures and clear plastic cutlery.



Products [made from plastic waste]

Sustainable plastic bricks: Rhino Machines, a company from India, has introduced the Silica Plastic Blocks, a eco-friendly building material created by using 80% recycled foundry dust/sand waste and 20% mixed plastic waste. The collaboration for the project involves R+D labs, the research division of the architectural company R+D Studio.



The adidas x Parley collaboration:

In 2015, Addidas introduced the inaugural running shoe crafted from recycled plastic waste, in collaboration with Parley for the Oceans. Through collaboration with Parley, they managed to collect plastic debris from beaches and coastal areas before it could enter the ocean and transform it into a product. This represented a pivotal moment for them and signified a shift for the fashion industry as a complete entity.



Allbirds are also leading in the shoe industry. They have shifted the industry away from synthetic materials. Their shoes are constructed using sustainable wool, recycled plastic bottles, and cardboard

material. One plastic bottle can be utilized to make a set of shoelaces. Their production method consumes 60% less energy and emits fewer greenhouse gases, resulting in a reduced carbon footprint

Sustainable Activewear:

Team Timbuktu is a tiny Australian company that designs eco-friendly clothing for active living, such as tech jackets, leggings, and crop tops. They are produced ethically and utilize fabric made from recycled water bottles.

Lately they've rebranded themselves from Team Timbuktu, to Amble Outdoors.

There are many such firms who are leading the way in making products from recycled plastics such as yoga mats, swimwear, furniture, cups and bottles etc.

Government Initiatives:

All governments worldwide have taken measures to manage plastic waste. EPR, Swachh Bharat Mission, and extended producer responsibility in India have the goal of minimizing

plastic waste. The government has banned single-use plastics entirely to reduce pollution.

Revised regulations for handling plastic waste, updated in the year 2024.

The regulations detail the exact formats and steps for registering, reporting, and certifying in regards to plastic waste management and EPR responsibilities.

Definitions that have been expanded:

Importer: Now includes imports of diverse plastics for commercial purposes, not limited to plastic packaging and related products.

Producer: Additionally involves manufacturing intermediate materials for plastic packaging and providing contract manufacturing services for brand owners.

Producers of carry bags and products made from compostable or biodegradable plastics need to acquire certification from the Central Pollution Control Board (CPCB) prior to their distribution or sale.

These products need to follow necessary labelling rules and meet FSSAI regulations for food contact uses.

Manufacturers are required to manage and document pre-consumer plastic waste produced during manufacturing activities in order to comply with reporting obligations to the State Pollution Control Board or Pollution Control Committee.

Compostable plastics need to have a label stating that they will only compost under industrial conditions.

Biodegradable plastics are required to indicate the duration of biodegradation and the specific environment for biodegradation.

3. COMPETITION SCENARIO

Major Players Network:

Key players in the global plastic waste management market include Veolia, Suez Environment, and Waste Management Inc.

In India, firms such as Ramky Enviro Engineers, Recykal, and Eco Green along with others are actively involved in recycling and managing plastic waste.

Ramky enviro engineers:

Since its establishment in 1994 in Hyderabad, India, Ramky has been dedicated to creating projects that have a positive impact on both the environment and the economy overall. Ramky has advanced steadily to establish himself as a key player in India's infrastructure development and environment management industries.

In order to actively participate in global economic advancement, Ramky Group has increased its capabilities in various sectors such as Water & Waste Water, Transportation, Industrial Infrastructure, Commercial, Residential, Social, Institutional, and Irrigation Infrastructure, Environment Management, Waste & Water Management, Energy Generation, transmission and distribution, among others.

Recykal:

Recykal is an innovative technology-based solution provider that plays a vital role in the waste management industry in India by connecting producers, waste generators, facilitators, and various stakeholders.

Eco Green India:

ECO GREEN INDIA is involved in the eco-friendly management, recycling, and reuse of Waste Electrical and Electronic Equipment (WEEE). The goal is to decrease the build-up of electronic and electrical equipment that is often either thrown away in landfills or recycled in unsanitary conditions by informal recyclers, ultimately harming the environment. The goal of recycling E-waste is to transform waste into valuable raw materials such as valuable metals, plastics, and glass, using cost-effective, environmentally friendly technologies that are suitable for Indian conditions.

Foreign Incursion:

More and more foreign businesses are coming into the Indian market, introducing modern recycling technologies and eco-friendly business strategies. There is an increasing trend of global cooperation in waste management, particularly between developed and developing countries.

Numerous international nations have joined the Indian market, with a focus on different areas of plastic waste management like

Veolia Environment (France) is recognized as a global frontrunner in waste and resource management. Their obligations are aimed at fulfilling the environmental duties related to projects for handling plastic waste in industrial and municipal sectors in Indian cities.

SUEZ, a company based in France, is engaged in several waste management initiatives in India, focusing on recycling and processing plastic waste.

Covanta Energy (USA) specializes in waste-to-energy technologies and transforming plastic waste into energy.

ALBA Group (Germany): Renowned for its recycling knowledge, particularly in plastics, it has also investigated potential in India's expanding recycling industry.

4. NATIONAL GUIDELINES

Plastic Waste Management Rules, 2016

The Plastic Waste Management Rules from 2016 require those who produce plastic waste to reduce its generation, avoid littering, store waste separately, and hand over segregated waste as per regulations.

The PWM Rules, 2016 impose Extended Producer Responsibility (EPR) on Producer, Importer, and Brand Owner for both pre-consumer and post-consumer plastic packaging waste.

The minimum thickness for plastic carry bags has been raised from 40 microns to 50 microns, and a minimum thickness of 50 microns has been mandated for plastic sheets as well.

Broaden the scope of applicability to include rural areas, not just municipal areas.

The Gram Panchayat in rural areas is responsible for implementing the rules.

Implementing waste segregation at the point of origin for both individual and bulk waste producers.

2016 regulations for managing plastic waste.

The Plastic Waste Management Rules, 2016, require plastic waste generators to reduce waste generation, avoid littering, store waste separately, and hand over segregated waste as per the rules.

The PWM Rules, 2016 impose Extended Producer Responsibility (EPR) on Producer, Importer, and Brand Owner, which covers both pre-consumer and post-consumer plastic packaging waste.

The minimum thickness for plastic carry bags has been raised from 40 microns to 50 microns, with a minimum thickness of 50 microns also required for plastic sheets.

Broaden the scope of coverage from urban to rural areas.

Gram Panchayat is entrusted with the responsibility of implementing the rules in rural areas.

Implementation of waste sorting at the point of origin for both individual and large-scale waste producers.

Plastic Waste Management (Amendment) Rules 2018:

The elimination of multi-layered plastic (MLP) is now required for MLP that are deemed non-recyclable, non-energy recoverable, or have no other use.

Recommended implementing a centralized registration system for plastics' producer/importer/brand owner registration.

The Central Pollution Control Board (CPCB) will develop a centralized registration system for registering the producer/importer/brand owner.

The objective of the regulations is to simplify the registration process for producers, importers, and brand owners, and to establish a system for gradually eliminating non-recyclable multi-layered plastics.

Plastic Waste Management Amendment Rules, 2021:

Bans single-use plastic items with low practicality and high likelihood of becoming litter by 2022.

Ban on producing, importing, storing, dispersing, vending, and utilizing specific disposable plastic items such as polystyrene and expanded polystyrene starting on 1st July 2022.

Plastic packaging waste that is not included in the elimination of single-use plastic items will be gathered and handled in an environmentally sustainable manner under Extended Producer Responsibility.

The Plastic Waste Management Amendment Rules, 2021, legally mandate this responsibility.

The thickness of plastic carry bags will be raised to 75 microns on September 30, 2021, and to 120 microns on December 31, 2022.

Plastic Waste Management (Amendment) Rules, 2022:

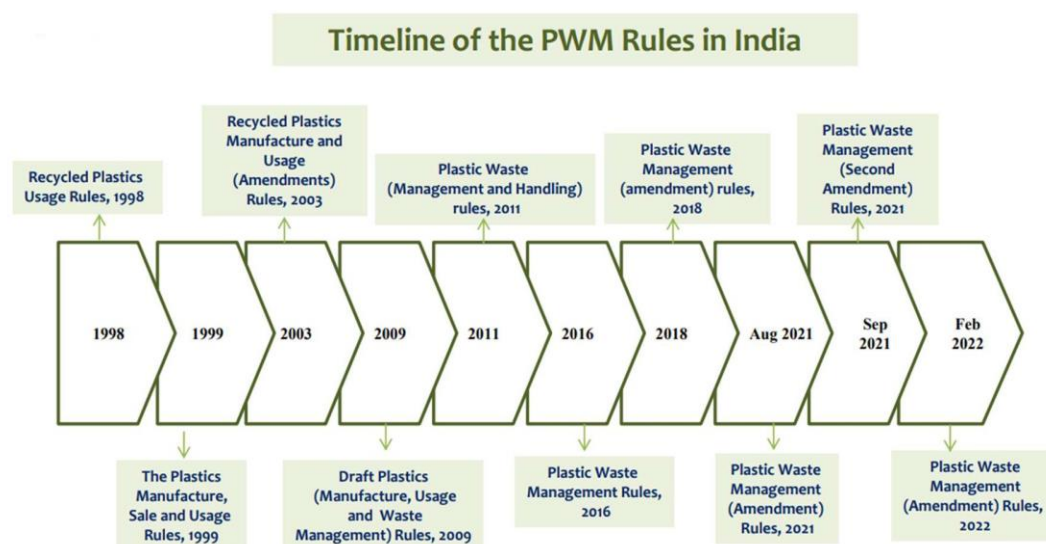
Established regulations regarding EPR for plastic packaging. These guidelines establish required goals for EPR, recycling of plastic packaging waste, reusing rigid plastic packaging, and incorporating recycled plastic content.

Those who do not reach EPR targets will face environmental compensation following the polluter pays principle.

This is done in order to safeguard and enhance the environment, as well as to avoid, manage, and lessen pollution.

The rule requires those who pollute to take responsibility for paying for the harm done to the environment, regardless of their intentions.

The guidelines offer a structure to enhance the circular economy of plastic packaging waste.



5. MAJOR MERGERS & ACQUISITIONS

Numerous important mergers and acquisitions have occurred in India's plastic waste management industry, indicating the increasing emphasis on sustainability and recycling.

Ramky Enviro Engineers Ltd.:

specializes in environmental engineering. In 2022, (REEL), a top waste management firm, obtained Re Sustainability (previously called Ramky Enviro), enhancing its capabilities in waste collection, recycling, and plastic waste management. This purchase helped with the growth of its recycling plants, specifically for plastic waste.

Lucro Plastecycle:

has been actively engaged in mergers and acquisitions within the industry. Its main goal is to gather used plastic from consumers and transform it into pliable packaging resources. They are also working to address ocean-bound plastics, which supports the implementation of a circular economy approach within the plastic waste system.

In 2024, the purchase of Materials Management Company and all american Disposal by Apex Waste Solutions, with backing from Kinderhook Industries, showcased a push to increase plastic and waste recycling capabilities.

Reliance Industries:

Reliance has been focusing on improving its abilities in recycling plastic waste. In December 2023, it made history as the initial Indian firm to adopt chemical recycling for plastic waste. Reliance converts various plastic waste into certified circular polymers through this method, which are then utilized in food packaging. This action is in line with their overall plan to support sustainable technologies that benefit a circular economy.

Novoloop & Aether Industries:

Novoloop, a leader in innovative plastic recycling, collaborated with Aether Industries to establish a trial facility in Surat, India in April 2024. The plant intends to incorporate Novoloop's "Lifecycling" technology, which transforms post-consumer polyethylene waste into high-quality materials. This project is a large investment in India's plastic recycling system and is supported by efforts to expand the technology for commercial use.

SIBUR's:

Entry Into India Another noteworthy merger and acquisition instance is when the Russian plastics leader SIBUR collaborated with Indian firms in 2024 to set up state-of-the-art plastic waste recycling facilities. The plant converts plastic waste into PET flakes for sustainable packaging, aiding India in complying with its strict recycling laws.

6. INTERNATIONAL EXPOSURE

Germany, Japan, and Sweden have implemented effective plastic waste management models that include high recycling rates and efficient waste-to-energy processes. Global cooperation in addressing plastic pollution through sustainable development goals (SDGs) is being urged by international organizations such as the UN and the World Bank.

Germany - The objective of the recently implemented German Closed Cycle Management Act (Kreislaufwirtschaftsgesetz, KrWG) is to transform waste management into resource management. The concept of using waste as a valuable resource for materials and energy is not a recent discovery; in the past, metals, glass, and textiles were recycled and repurposed. Germany has implemented a waste management policy in the last two decades, relying on closed loops and requiring producers and sellers of goods to take responsibility for disposal. This has heightened people's awareness on the importance of waste separation, brought about the development of new waste disposal techniques, and enhanced recycling capabilities. Currently, 14 percent of the German industry's raw materials come from recycled waste, resulting in lower extraction rates and reduced environmental consequences. Modern closed loop systems play a role in reaching the German Kyoto goals by contributing about 20% to reducing climate-related emissions. Managing a closed cycle not only benefits the environment but is also financially rewarding. The waste management sector in Germany has grown into a vast and influential economic industry, with nearly 200,000 workers spread across around 3,000 companies, resulting in a yearly revenue of about 40 billion euro. Resource efficiency is enhanced by 15,000 installations through recycling and recovery processes. Impressive recycling rates

of around 60% for municipal waste, 60% for commercial waste, and 90% for construction and demolition waste are clear indicators of success.

Japan has a highly sophisticated plastic waste management system, as well as advanced infrastructure and various technologies and policies for recycling and waste processing, in addition to a proactive system of collaboration with citizens and companies. Japan ranks second in the plastic management index (PMI) among 25 countries, just below Germany, which evaluates countries' plastic waste management performance from different perspectives.

Additionally, Japan ranks high globally for its handling of PET bottles, with the second highest plastic management index (PMI) due to its efficient waste management system and strong local collaboration. However, Japan also has a significant amount of plastic consumption per person. Japan needs new policies, strategies, and action plans to encourage resource circulation and create a sustainable lifestyle and society, currently achieving a 93% collection rate and an 85.8% recycling rate (as of 2019). Regarding the methods of collecting, 46% depend on local governments and organizations, whereas 54% depend on businesses, which may include PET bottle-specific bins placed near vending machines and other collection containers. Nevertheless, waste management policies and their execution are inadequate in dealing with the worldwide marine plastic pollution emergency. In the recent years, the quantity of plastic waste mixed with regular waste in Japan has been increasing, hitting 4.1 million tons in 2019. Approximately 77.2% of this total is made up of single-use containers and packaging. Japan is the second highest emitter of per capita plastic packaging waste in the world, just behind the United States, making it the top emitter in Asia. On average, a Japanese individual uses approximately 450 plastic shopping bags annually, a surprising number that is 11 times greater than Indonesia and 17 times greater than the United Kingdom. Additionally, the average Japanese person purchases 183 PET bottles each year, resulting in a total of 23.2 billion bottles nationwide annually.

Sweden's national action plan on plastics was initiated by the Swedish government on February 21st, 2022. Targets outlined in the action plan: By the year 2025, limit the consumption of plastic bags to a maximum of 40 per person annually. By 2026: Half less single use plastic cups and food containers used; reusable packaging on market increased by 20%. By 2027: At least 20% of discarded fishing gear collected. By 2030: Half less littering of single use plastic packaging; no outdoor littering of balloons or wet wipes; half less littering from cigarette butts and Snus. By 2045, plastic packaging needs to contain a minimum of 30% recycled material and achieve net-zero greenhouse gas emissions. Emissions will be negative starting from 2045. The action plan consists of 55 different actions across the entire lifespan of plastics to achieve the objectives.

7. CHALLENGES & OPPORTUNITIES

Waste Generation & Composition

India generates around 62 million tons of waste annually, with more than 75% of it remaining unprocessed. Most of the waste produced consists of organic waste, plastic, paper, glass, metal, and hazardous waste. As per a report from the Central Pollution Control Board, plastic waste makes up nearly 12% of the overall waste produced in India.

Recycling Capacities:

India's recycling capacity is not commensurate with the levels of waste generated. It is estimated that only 20-25% of the total waste generated is recycled, with a significant portion of it being recycled in the informal sector. According to the Central Pollution Control Board, India recycles about 60% of the plastic waste generated in the country. However, the recycling industry is still in its nascent stages, and the majority of the waste recycling is done by informal sector players.

Current Initiatives

India has made notable progress in efforts to reduce waste and promote recycling. The government has introduced multiple programs and policies aimed at waste management and sustainable practices. The main goal of the Swachh Bharat Abhiyan (Clean India Mission) is to ensure cleanliness and effective waste management throughout the nation. AMRUT is dedicated to enhancing waste management infrastructure in urban areas. Moreover, the Extended Producer Responsibility (EPR) framework promotes manufacturers to take accountability for the entire lifespan of their products, including their ultimate disposal.

Public resistance to reducing plastic usage:

While individuals can impact the production and usage of plastics, the ability for one person to make significant change is restricted without larger systemic reforms. Consumers have the power to make a choice in favor of sustainable products while shopping, as long as they are provided with sufficient information and transparency. With enough quantity, this market indicator has the ability to change the products that companies manufacture to satisfy that request.

However, when it pertains to single-use plastics, especially packaging, the situation becomes more complex. Rarely do individuals base their purchasing decisions on the sustainability of the packaging. Other packaging aspects such as color or visuals might hold greater significance, not to forget the attributes of the product itself.

This disrupts the communication loop between supply and demand, as well as consumers and manufacturers. To demonstrate a preference for sustainable packaging to a company, you must either purchase a similar product with better packaging or communicate your request for change to the company. In any case, the mechanism is not operating smoothly.

Despite these complexities, people can make a real difference in how plastic is used, by sending the right messages to companies and governments, and joining with others to advocate for better policies.

Lack of awareness and education on plastic waste segregation.

Inadequate understanding of waste management can lead to various harmful consequences. Improper waste handling and disposal can cause environmental pollution and health risks. Mismanagement of electronic waste (e-waste) can result in negative impacts on both human health and the environment. Insufficient understanding of waste management among hospital cleaners can put them at risk at work and lead to the spread of infections. Lack of understanding among healthcare workers regarding medical waste disposal can endanger both the healthcare staff and the community. A lack of knowledge within the community about handling domestic waste can result in the transmission of diseases by vectors and damage to the environment. Hence, it is essential to enhance understanding and consciousness about waste management in order to avoid these adverse impacts and encourage appropriate waste management and disposal methods.

Opportunities: SOLUTION:

Redesign the entire plastics system

We require a systematic method to establish a functional system, ensuring no economic value is lost and eliminating plastic waste and pollution. We must reconsider how we produce, utilize, and recycle plastics, fundamentally redesigning the framework in which the substance is utilized.

A circular economy for plastic

The circular economy is a system where materials are meant to be utilized rather than exhausted. From the beginning, it is important to design products and their systems in a way that prevents any materials from being wasted, any toxins from being released, and maximizes the utilization of every process, material, and component. Properly implemented, the circular economy offers advantages to society, the environment, and the economy.

Every packaging should be created to align with a specific system, such as reuse, recycling, or composting.

Eliminate the plastics we don't need.

Plastic offers numerous advantages. Similarly, there are certain problematic products in circulation that must be removed to attain a circular economy, and occasionally, plastic packaging can be completely sidestepped without sacrificing functionality.

Even though improving recycling is important, it is not enough to solve the plastic problems we are dealing with now. Exploring reused business models should be considered as a preferred solution, known as the 'inner loop' in circular economy terms, to decrease the demand for single-use plastic packaging. The implementation of scale models for reusable plastic packaging, which offer an economically appealing option for at least 20% of the packaging, must be put into practice.

Create new ideas to guarantee that the plastics we require can be reused, recycled, or composted. This entails a mix of revamping and creating new ideas in business models, materials, packaging design, and reprocessing technologies.



8. FUTURE OUTLOOK

The future of plastic waste management lies in the adoption of circular economy principles which emphasize reuse, recycling, and reducing waste at the design stage. Consumers will be encouraged to consume responsibly and providing them with a way to return products, also the return products would be then repaired or refurbished, extending their usability.

Increasing Public awareness and education about plastic pollution and its harmful impacts in the environment specially to marginalised communities will encourage more sustainable consumer behaviour.

Biodegradable alternatives could help reduce the reliability on traditional plastics. Alternatives to Plastics:

- Bagasse: Made from sugarcane or beet pulp. It is compostable and eco-friendly.
- Bioplastics: Plant-based plastics used primarily in food packaging.
- Natural Textiles: Includes materials such as cotton, wool, and hemp.
- Seaweed Cups: Seaweed grows rapidly, up to 60 times faster than land-based plants, making it a sustainable option.
- Algae-Blended Ethylene-Vinyl Acetate: Utilizes algae to convert air and water pollutants (ammonia, phosphates, and carbon dioxide) into plant biomass rich in proteins.
- Compostable Plastics: Can be plant-based or fossil fuel-based and degrade through biological

processes into CO₂, water, inorganic compounds, and biomass, without leaving toxic residues.



9. CONCLUSION

One of the biggest environmental challenges today is managing plastic waste. The prevalence of plastic in contemporary culture has resulted in notable environmental, financial, and medical problems because of its inadequate disposal and extended lifespan. Despite its lightweight, durable, and versatile qualities, the environmental impact of plastic is significant and cannot be ignored. From ocean pollution to land erosion and the dispersion of microplastics, the impacts of plastic waste are extensive and harmful. However, despite the obstacles, advancements are being made to tackle this increasing issue.

The entire process of plastic, from creation to disposal, is characterized by inefficiencies and environmental damage. The majority of plastics come from fossil fuels, leading to the release of greenhouse gas emissions in their manufacturing process. Furthermore, since plastic does not break down easily, it frequently finds its way into landfills, oceans, and wildlife environments, where it can remain for extended periods of time. Inadequate handling of plastic waste has resulted in severe outcomes such as reduced biodiversity, pollution of food chains, and escalated threats to human health from microplastics in water and air.

Nevertheless, there is a positive aspect in the increasing recognition and creativity regarding plastic waste control. Businesses worldwide are discovering innovative methods to transform plastic waste into useful products, thereby promoting a circular economy. An example is the use of recycled plastic to make long-lasting and environmentally friendly items such as bricks, shoes, mats, and rugs. These advancements show that plastic waste has the potential to be valuable if managed properly, transforming a formerly harmful substance into resources for creating new environmentally friendly items. This change not only cuts down on plastic waste but also conserves resources by reducing the requirement for new materials.

Additionally, there are efforts being made by governments and international organizations to control plastic production and disposal by implementing policies like plastic bans, recycling requirements, and rewards for companies using sustainable methods. These rules are crucial for encouraging industries to innovate and decrease their plastic impact, but they also depend on consumer involvement for success. It is essential to have public awareness campaigns and educational programs to promote a culture of sustainability, motivating people to cut down on plastic use through reducing, reusing, and recycling.

Despite these progressions, there is still a lot of work left to do. The existing recycling system cannot manage the amount of plastic waste generated worldwide. Only a small percentage of plastic is being recycled at the moment, with most of it being disposed in landfills or the environment. In order to effectively address the plastic crisis, a united effort is needed from governments, businesses, and consumers to support improved recycling technologies, embrace sustainable options to plastic, and decrease plastic usage from the beginning.

In summary, dealing with plastic waste is a complicated problem that demands a comprehensive strategy. Despite the serious environmental consequences of plastic, there are encouraging advancements in the repurposing and reusing of plastic waste. As society keeps progressing and adjusting, there is optimism that the ongoing plastic waste problem can be improved, leading to a more sustainable and eco-friendly future.

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