www.envsciarch.com

ENVIRONMENTAL SCIENCE ARCHIVES
ISSN: 2583-5092
Volume IV Issue 2, 2025

REVIEW OPEN ACCESS

Reviewing Sustainable Solutions to Plastic Waste: Strategies for a Cleaner Planet

Madhu Bala and Manpreet Kaur
Department of Zoology and Environmental Sciences, Punjabi University, Patiala, India
*Correspondence for materials should be addressed to MB (email: madhubaladhakane@gmail.com)

Received: 2025/08/19
Accepted: 2025/09/11
Published: 2025/09/15

Abstract
Plastic waste increases due to widespread use. Disposed plastic turns into waste, worsening pollution. Plastic does not biodegrade easily; it can take over 500 years to decompose, leading to environmental accumulation and crisis. Ramifications of plastic waste are significant, causing extensive harm. Plastic waste is a pressing environmental concern, requiring efforts from all sectors. There are various causes, consequences, and solutions to reduce plastic waste. Potential solutions for plastic pollution include the R4 framework: Reuse, Reduce, Replace, and Recycle. Each product has its own end-of-life stage; certain components can be salvaged for reuse. Waste materials are recovered and repurposed through recycling. Plastic recycling aids in diminishing pollution and conserving resources. Recycling involves collecting and processing materials into new products. Enhancing recycling systems is crucial for effective waste management. Reusing plastic items reduces waste and environmental footprint. Curbing single-use plastics and advocating for alternatives can alleviate plastic waste. Utilizing bioplastics from renewable sources is a sustainable alternative to traditional plastics. Collective action is necessary to address plastic waste. Strengthening waste management, embracing extended producer responsibility, and advocating for circular economy practices are pivotal measures. Encouraging reduced plastic content in products is essential. Global regulations aim to tackle plastic pollution and protect communities from its effects.

Keywords: Plastic waste; R4 framework; Recycling; Bioplastic; Single use plastic

Introduction

Plastic, once celebrated as groundbreaking material, has now emerged as a global scourge. Its omnipresence in our daily lives has precipitated a distressing accumulation of plastic waste in our environment. From single-use bags to microplastics, this enduring substance permeates our oceans, soil, and even the air we inhale. Globally, we utilize over 260 million tons of plastic annually, constituting approximately a significant portion of world oil production (Thompson et al., 2009). The term "plastic" is derived from the Greek word 'plastikos,', signifying the ability to be molded. Plastic is widely recognized as a synthetic polymer, synthesized through the polymerization of monomers extracted from petrochemicals, combined with various additives (Torres-Agullo et al., 2021). The inaugural synthetic plastic—Bakelite—was produced in 1907, heralding the dawn of the global plastics industry. The term "plastics" encompasses a diverse array of materials that, at certain stages of manufacture, possess the capacity to flow, thereby allowing them to be extruded or molded. Plastics have significantly shaped modern life, finding applications across numerous sectors including agriculture, construction, transportation, thermal insulation, packaging, manufacturing, electronics, furniture, toys and leisure items, automobiles, and medicine (Oehlmann et al., 2009). Presently, 85% of medical devices, such as intravenous bags, disposable syringes, sterile packaging, and joint replacements, are fabricated from plastics due to their lightweight and biocompatible attributes (Ilyas et al., 2018). Synthetic polymers are predominantly produced through the polymerization of monomers derived from oil or gas, with the addition of various chemical additives to create plastics. Currently, there exist approximately 20 distinct categories of plastics, each encompassing numerous grades and varieties (APME, 2006). Plastics are extraordinarily versatile materials; they are economically viable, lightweight, robust, durable, resistant to corrosion, and exhibit exceptional thermal and electrical insulation properties.

Classification and Types of Plastic

Most plastic monomers, such as ethylene and propylene, are derived from fossil hydrocarbons. None of the prevalent plastics exhibit degradation in natural environments. Based on particle size, plastics are categorized as follows:

- Nano plastics: particle size < 100 nm
- Small microplastics: particle size 0.00001–1 mm
- Large microplastics: particle size 1–4.75 mm
- Meso plastics: particle size 4.76–200 mm
- Macro plastics: particle size > 200 mm

The classification of plastics based on their chemical structure includes polymers such as acrylics, polyesters, silicones, and halogenated plastics. Additional classifications depend on the characteristics of the manufacturing process. Plastics can be subdivided into two principal categories: thermoplastics and thermosetting plastics.

Plastics melt at specific temperatures. Polypropylene degrades at 300-475 °C. Polypropylene can be copolymerized with polyethylene. Polypropylene is impermeable to water. The chemical formula for polypropylene is $(C_3H_6)n$. Polyethylene has remarkable strength and low moisture absorption. PET is non-biodegradable, impermeable to oxygen, CO_2, water, and decomposes at low temperatures. The chemical formula for PET is $(C_{10}H_8O_4)n$. High-density polyethylene tolerates high temperatures. HDPE is non-biodegradable and has high stiffness and toughness. The chemical formula for HDPE is $(C_2H_4)n$. LDPE degrades at 290-350 °C. Low-density polyethylene is insoluble and has low water permeability. LDPE has favorable CO_2 and O_2 permeability. The monomer for LDPE is ethylene. Polyvinyl chloride can be rigid or flexible. The chemical formula for PVC is $(H_2C\text{-}CHCl)n$. PVC is resistant to chemicals. Polystyrene is transparent and nonpolar. PS is insoluble in water. The chemical formula for PS is $(C_8H_8)n$. Polycarbonate, polyamide, acrylic, ABS, fiberglass, and nylon are used in various products. Biodegradable plastics degrade in sunlight or water. Examples of biodegradable plastics include starch-based, cellulose-based, and soy-based plastics. Plastic is valuable but becomes a pollutant if mismanaged. 1-2M tonnes of plastic enter oceans yearly, harming wildlife.

Impacts of Plastic Pollution

Plastic debris has proliferated in natural habitats from the polar regions to the equator (Barnes et al., 2009); it constitutes a conspicuous element of the detritus present in the marine environment. The preponderance of literature addressing the accumulation of plastic in ecosystems and the consequent ramifications for wildlife predominantly originates from marine habitats (Gregory, 2009). Monitoring indicates that the degradation of most plastics is protracted, with low-density polyethylene (LDPE) requiring an estimated 500 to 1,000 years to decompose, while polyvinyl chloride (PVC) is virtually indestructible. Polyethylene (PET), polyvinyl chloride (PVC), polystyrene (PS), and polypropylene (PP) are not environmentally benign. The leached toxins (LT) derived from these plastics pose significant hazards. Certain types of plastics can be acutely toxic, potentially inducing carcinogenic effects, neurological damage, rapid genetic alterations, and metabolic disorders. A multitude of national and international initiatives has been launched to catalog the quantities and classifications (uses, sources, material types, sizes) of plastic waste and, in certain instances, to facilitate the removal of debris (Ryan et al., 2009). Substantial volumes of plastic debris have already infiltrated marine habitats, spanning from remote shorelines and inaccessible depths of the ocean to densely populated coastlines. The omnipresence of this debris in marine environments has led to numerous reports of species ingesting and becoming ensnared in plastics. Due to the resilience of plastics, such encounters frequently result in injury or impaired locomotion, ultimately culminating in mortality (Gregory, 2009). There is mounting evidence that plastics are fragmenting within the environment, thereby increasing the likelihood of ingestion by a broader array of organisms (Barnes et al., 2009). In addition to these physical repercussions, speculation has persisted for over three decades regarding the potential for the transfer of toxic chemicals to wildlife through the ingestion of plastic debris. Recent publications have revived concerns surrounding this issue (Mato et al., 2001; Thompson et al., 2009; Arthur et al., 2009; Teuten et al., 2009), presenting a synthesis of existing evidence alongside novel data on the accumulation of chemicals from plastics by wildlife.

Global scenario

The world generates over 400 million tons of plastic annually (UNEP, 2018). The predominant industrial sector contributing to this figure is plastic packaging, a single-use material engineered for immediate disposal (Fig.1). The demand for plastics spans various sectors, including packaging,

construction, and building materials. Notably, approximately 40.5% of plastic consumption is attributed to the packaging sector. The global packaging market is vast; in 2000, its size was estimated at around $383 billion, projected to surge to approximately $980 billion by 2020 (Sydow & Bieńczak, 2019). Plastics are extensively utilized in the modern construction industry, with components such as hinges, screws, and larger structural elements crafted from plastic. The market demand within the building and construction sector accounts for about 20.4%. The remaining demand for plastics is distributed across the automotive, electrical and electronics, household, and agricultural sectors.

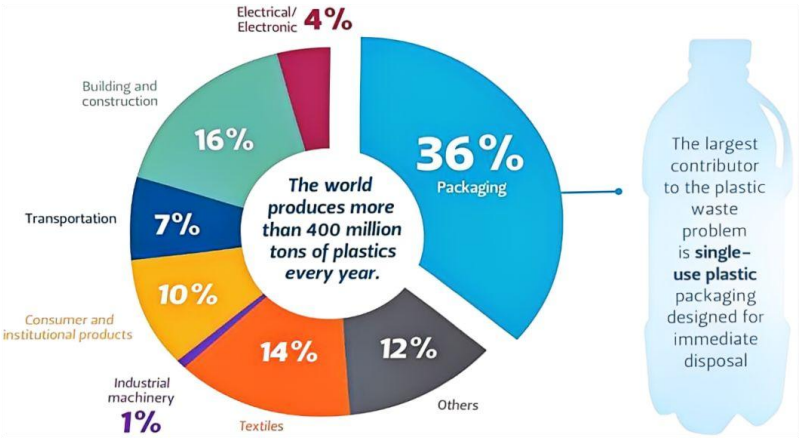

Fig. 1. Sources of plastic waste and single-use plastics (UNEP, 2018).

Indian scenario

India boasts a population exceeding 1.4 billion and generates a staggering 26,000 tons of plastic waste daily (Fig. 2). This volume is roughly equivalent to the weight of approximately 26,000 compact automobiles. Presently, a substantial proportion of plastic waste in India is relegated to landfills or escapes into the environment. Over the past five years, the nation has experienced a two-fold escalation in per capita plastic waste generation, attributable to burgeoning population growth and rapid urbanization. The adverse effects of plastic waste on the environment are increasingly pronounced and evident, drawing significant media and public scrutiny. The glaring disparity between the exponential surge in plastic consumption and the corresponding capabilities for recycling and disposal necessitates comprehensive efforts spanning from local communities to the global arena to tackle this pressing issue, underscoring the urgent need for the establishment and expansion of a circular economy for plastics.

The Government of India has instituted various policies and funding initiatives aimed at plastic waste management, including the Swachh Bharat Mission, Swachh Survekshan, Extended Producer Responsibility (EPR), the Plastic Waste (Handling and Management) Rules of 2016, and a prohibition on the use of single-use packaging plastics. Notwithstanding these regulatory frameworks, the transition from a linear to a circular economy for plastics demands substantial commitment from all stakeholders throughout the entire plastic value chain (Vaidya, 2023).

Management strategies for plastic waste in India

Management of plastic waste has emerged as a pressing concern. In many localities, a lack of awareness leads individuals to incinerate plastic, a practice that releases greenhouse gases and other detrimental pollutants into the atmosphere. These alarming issues have prompted environmentalists to advocate for the effective management of plastic waste. Several methodologies and strategies have been developed to address this challenge, including landfilling and recycling. Both developing and developed nations are increasingly prioritizing sustainable approaches—such as recycling, reuse, and replacement—to mitigate waste issues, as these methods are environmentally friendly and promote sustainability.

The Ministry of Environment, Forests and Climate Change (MoEF&CC) of the Government of India has instituted two pivotal regulations to combat plastic pollution. The Solid Waste Management Rule of 2016 concentrates on solid plastic waste as an integral aspect of municipal solid waste management, delineating a structured framework for municipalities to manage it effectively. Conversely, the Plastic Waste Management Rule of 2016 specifically addresses polyethylene bags and introduces the concept of extended producer responsibility (EPR) to curtail the proliferation of plastic bags. Furthermore, both waste recyclers and waste managers in Indian cities have devised innovative techniques for recycling and reusing collected plastic waste (Ahuja & Pandey, 2019).

The recycling of plastic is imperative, as it yields valuable products such as paver blocks and bricks, which possess advantageous properties, including thermal insulation and acoustic dampening. The advantages of recycling plastic waste are manifold: it is cost-effective, readily available, reduces manufacturing expenses, promotes economic efficiency, and contributes to environmental conservation.

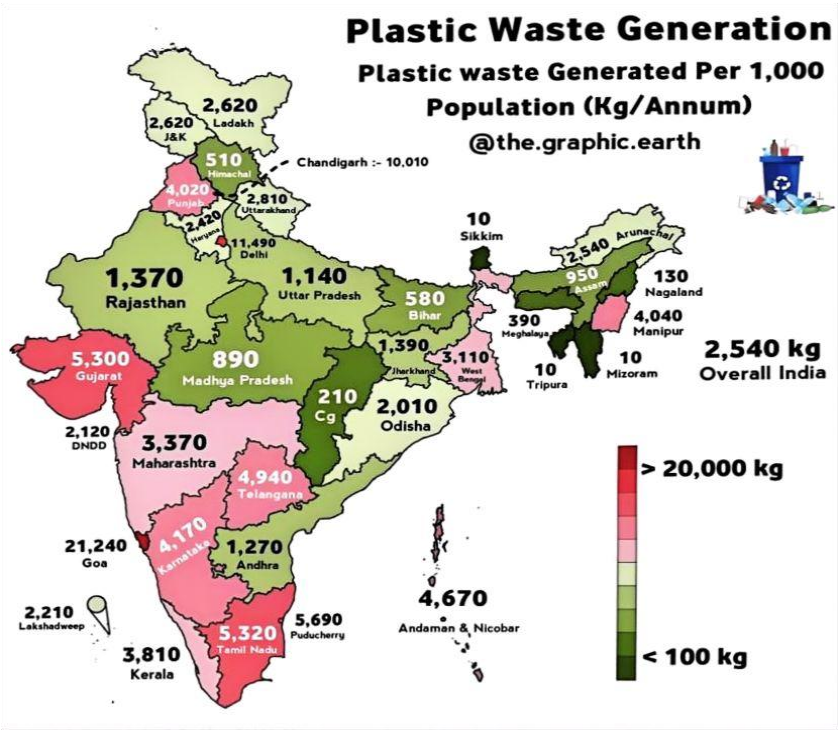

Fig. 2. Plastic waste generation in India

Techniques for recycling plastic waste

Landfilling

It is a linear approach to plastic waste management. Plastic waste is deposited in landfills in large quantities, making up 20–25% of landfill mass. This method harms the environment immediately and poses long-term risks of pollution through soil and groundwater contamination caused by plastic degradation.

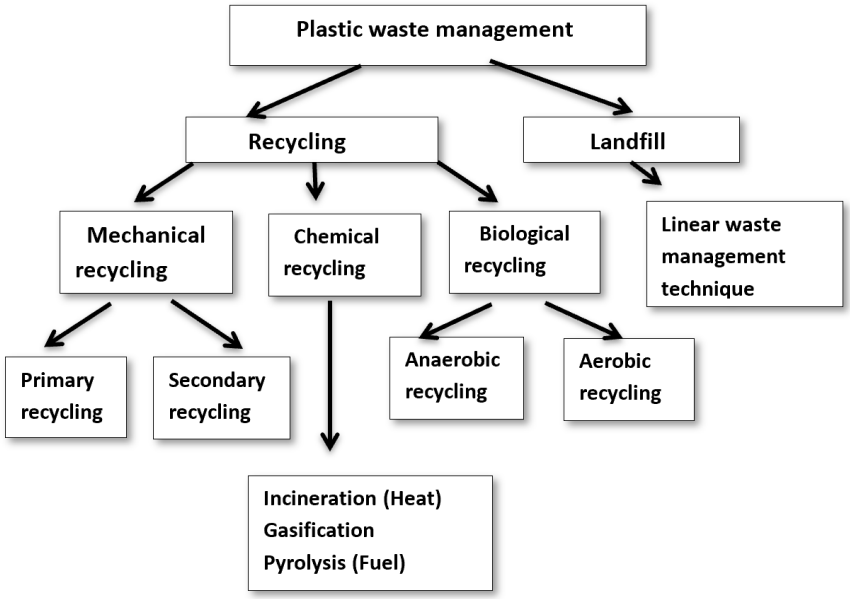

Fig. 3. Recycling Techniques for Plastic Waste

Recycling

Recycling is the process through which discarded materials are transformed into new and valuable components, either for the same application or for alternative uses. In essence, recycling entails "the creation of products that can be reprocessed and converted into raw materials for use in the

same or different products" (Prakash, 2002). Recycling encompasses various methodologies, such as:

- Mechanical recycling, which includes both primary and secondary recycling.
- Chemical recycling, which comprises incineration (the combustion of waste materials at extremely high temperatures ranging from 1000 to 1500 °C, resulting in minimal residue and gas emissions), gasification, and pyrolysis (Fig.3).

The Significance and Value of R's

Plastic waste has engendered profound repercussions on our natural environment, particularly contributing to marine pollution, and poses a significant threat to the stability of entire ecosystems. These pressing issues can be mitigated through the implementation of the four R's (Fig.4), which encompass Reducing, Recovering, Recycling, and Reusing materials, components, items, and parts in a continuous cycle (Arokiaraj, 2011). This approach not only proves economically advantageous but also yields substantial environmental benefits.

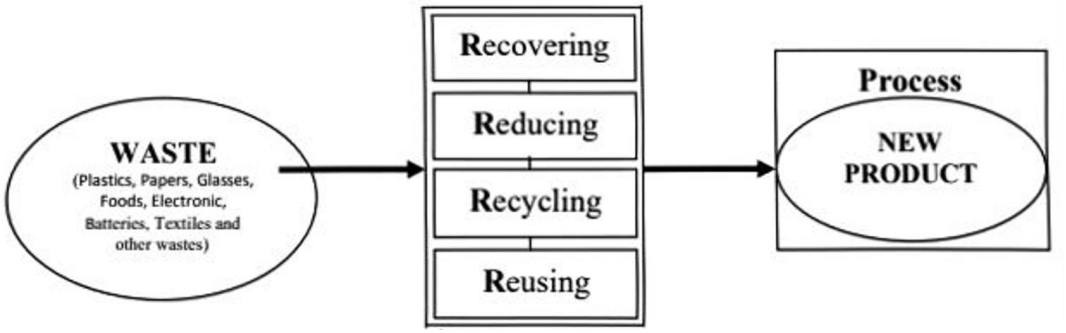

Fig. 4. The processing of plastic waste by the four Rs

Research on the recycling, reusing, replacement, and reduction (the four Rs) of plastic waste

Raghatate (2012) studied plastic bag remnants in concrete in India. Adding plastic fibers improves tensile strength but reduces compressive strength, addressing the plastic waste issue. Awasthi et al. (2017) analyzed plastic waste reutilization methods like landfill disposal, incineration, gasification, and hydrogenation. Recycling is crucial but has disadvantages. Manju et al. (2017) integrated plastic waste with bitumen for road construction using shredded plastic waste and heated bitumen. Substituting sand with plastic waste enhances durability. Estil (2019) examined plastic waste management in Haiti and Colombia. Plastic waste can be repurposed for sustainable housing construction, addressing housing challenges in developing nations. Patil et al. (2020) explored using plastic waste as a binding agent in flooring tile production. Plastic waste, alongside fly ash, results in superior tile properties compared to traditional ceramic tiles. Kumar et al. (2020) studied recycling plastic waste (PW) into fuel using mechanical and chemical processes. They also discussed the negative effects of plastic waste disposal on land and the environment. The study explained how PW can be converted into energy resources like RDF and RPF with various catalysts and agents (Fig.5).

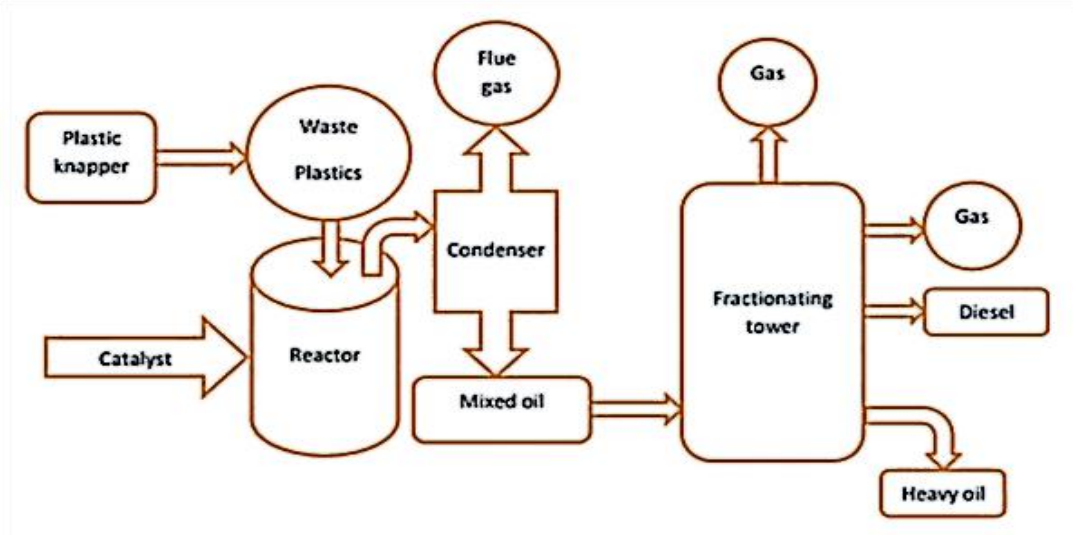

Fig. 5. Diagrammatic representation of the generation of fuel from plastic waste (Kumar et al., 2020).

Avanthi et al. (2022) studied plastic waste from COVID-19. They suggested upcycling, incineration, and pyrolysis for plastic treatment, focusing on face masks and shields. The research also explores biochar recovery from plastic waste using co-pyrolysis techniques to manage waste sustainably and protect the environment. Sina (2022) researched upcycling mask waste. The researchers found that propylene-based face masks can be transformed into valuable materials through mechanical reprocessing and chemical modification. The resulting face mask waste (FMW) has been used in green energy applications like batteries and superconductors. (Fig. 6).

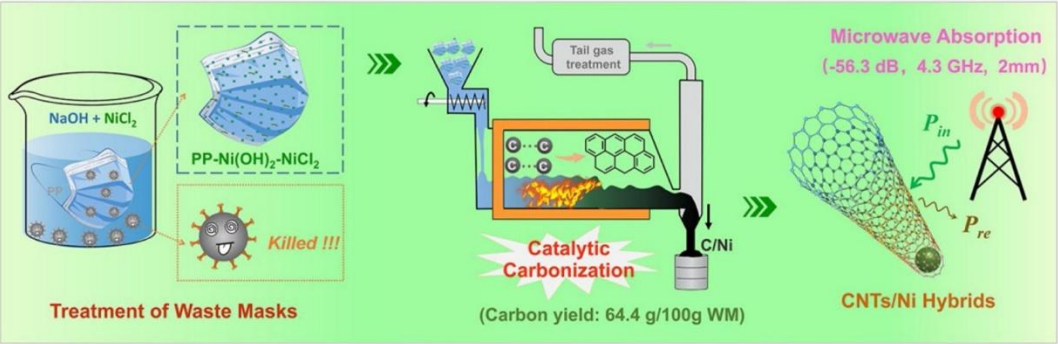

Fig. 6. Schematic representation of face mask waste (FMWs) catalytic carbonization into high-value CNTs/Ni hybrids (Sina, 2022)

Kumar et al. (2022) studied plastic waste as a biofuel source in Tamil Nadu, India. Plastic waste can be converted to biofuel via incineration, gasification, and pyrolysis, with emphasis on the pyrolysis method. Lai et al. (2022) focused on PET waste in India and Singapore, highlighting its economic value in producing TENGs. The management framework includes disposal site identification, waste collection, segregation, and treatment. Shabiimam et al. (2018) repurposed plastic and construction waste to create blocks and pavers using a combination of concrete and various plastic types. Shredded plastic replaces sand in concrete. (Table 1).

Sr.No	Property	Types of Plastic Waste Used		
		PE	PP	PVC
1	Density	910 -225	946	1380
2	Specific gravity	0.92	0.9	1.2
3	Melting point	105-115	85-195	100-260

Table 1. Properties of some plastic waste (Shabiimam et al., 2018)

Chaurasia and Gangwar (2019) found that plastic bottles are useful for construction due to their heat resistance and chemical stability. Preethi et al. (2019) repurposed PET bottles as eco-friendly bricks filled with sand and mud to reduce plastic waste. Lamba et al. (2021) studied transforming plastic waste into sustainable construction materials like PET, PVC, and LDPE. Gupta (2021) investigated repurposing multilayered plastic waste into pavers, bricks, and kerbstones without combustion. Uvanajan et al. (2021) explored reusing plastic pollution in construction materials to enhance structural strength. O'Rourke et al. (2022) analyzed polyethylene-based waste mixed plastics for product conversion through compression molding. Narancic and O'Connor (2019) discussed biodegradable polymers like PLA synthesized from bio-based sugar fermentation for packaging applications, emphasizing end-of-life management and the circular economy's role in reducing plastic waste (Fig. 7).

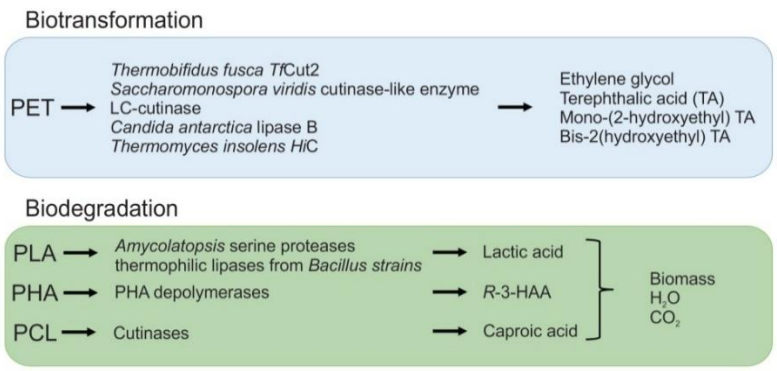

Fig.7. Degradation of plastics characterized by the presence of hydrolysable bonds. (Narancic and O'Connor, 2019)

Table 2. Alternatives for plastic waste

S. No.	Reference	Methods/ process to solve plastic problems
	RECYCLE	
1.	Raghatate (2012)	Plastic bags are used as constituent materials in concrete.
2.	Awasthi et al. (2017)	Plastic waste is collected, shredded, heated, mixed with fly ash, and poured into molds; after setting, converted into the final product.
3.	Manju et al. (2017)	
4.	Estil (2019)	Shredded and coated PW is mixed with hot bitumen for constructing pavement.
5.	Patil et al. (2020)	PET bottles filled with sand/ soil/ landfill dirt are used as bricks to construct houses.
6.	Kumar et al. (2020)	PW collected, shredded, heated, mixed with fly ash, and poured into molds; after setting, converted into the final product.
7.	Avanthi et al. (2022)	
8.	Sina (2022)	Thermal and chemical recycling (pyrolysis).
9.	Kumar et al. (2022)	Up cycling {thermal degradation, pyrolysis (biochar production)}.
10.	Lia et al. (2022)	Carbonization, pyrolysis, catalytic conversion, chemical treatment, mechanical reprocessing.
		Pyrolysis (converting waste into liquid/solid fuel).
		Catalytic, mechanical recycling (shredding, extraction, pelletization, material subtraction), pyrolysis, and incineration.
		Recycling, landfilling, incineration, gasification, hydrogenation.
	REUSE	
11.	Shubiimann (2018)	Shredding and burning plastic are used as a replacement for sand and act as a binding agent in concrete.
12.	Churasia & Gangwar (2019)	Plastic bottles filled with sand/mud/soil are used as bricks.
13.		
14.	Preethi (2019)	Collection of plastic bottles filled with mud/soil/landfill dirt is used in the construction of houses.
15.	Lamba et al. (2021)	PET, PE, HDPE plastics act as binders in concrete and replace clay and cement.
16.	Gupta (2021)	MLP is used with cement and converted into pavers or tiles.
17.	Uvanjan et al. (2021)	PW shredded, and plaques are made by compression molding.
	O' Rourke et al. (2022)	LDPE + PP products are used as aggregates, bonded with other components to make bricks.
	REPLACE	
18.	Narancic et al. (2019)	Fermentation, chemical synthesis, enzymatic polymerization, blending, extrusion.
19.		Bamboo fibers and sugarcane fibers blend to form tableware and add alkyl ketone dimer to improve the oil and water resistance of molded pulp.
20.	Liu et al. (2020)	
21.	Porta et al. (2021)	Replacing fossil feedstock with biomass, recycling (incineration).
	Aiduang et al. (2022)	Mycelial growth (fabrication, drying process), Post process (molding, cold processing, heat processing).
	REDUCE	
22.	Zheng and Suh (2019)	Microorganisms (Achromobacter sp., pseudomonas sp., Streptomyces sp.) used to degrade plastic.
23.		
24.	Dey et al. (2020)	Circular actions to mitigate PW, recycling (primary recycling, secondary recycling, tertiary recycling (pyrolysis and gasification).
25.	Lorenzo et al. (2023)	Collection, sorting, and washing of waste, then recycling.
	Ferronato et al. (2023)	Assessment, goal setting, research and innovation, education, and awareness.

Table 3. Plastic types and recycling processes (Avanthi et al., 2022; Singh and Ruj, 2016)

Plastic types	Soft/ Hard	Recycling process	Re-uses
PP (Polypropylene)	Hard	Mechanical and chemical modification.	Green batteries, semiconductors.
PS (Polystyrene)	Soft	Pyrolysis, incineration	Construction of pavement and biofuel.
PVC (Polyvinyl Chloride)	Soft	Pyrolysis, incineration	Biofuel and construction bricks
HDPE (High-density polyethylene)	Hard	Chemical recycling or feedstock recycling	Biofuel, construction of buildings.
LDPE (Low-density polyethylene)	Soft	Pyrolysis, compression molding.	Biofuel, construction of bricks.
PET (Polyethylene terephthalate)	Hard	Carbonization, incineration, pyrolysis.	Producing triboelectric nano generators.

Table 4. Bio-based plastics and their products (Narancic and O'Connor, 2019)

BIO plastic	Microbes/Enzymes involved Products
Starch based bioplastic	Amylase enzymes Cups, cutlery, pots (*Bacillus* sp. *Aspergillus* sp.)
Protein based bioplastic	Proteases Body panels of Ford. automobiles
Cellulose-based bioplastic	*Acetobacter, Rhizobium,* Packaging blister
PLA (Polylactic acid)	*Pseudomonas, Sarcina Ventriculi* Lactic acid bacteria Cups, bottles, mulch film (*Lactobacillus* sp.)
PHA (Polyhydroxyalkanoate)	*Cupriavidus necator* Used in the medical industry

Liu et al. (2020) studied sugarcane and bamboo fibers as plastic alternatives. Sugarcane bagasse is a sustainable material from sugar production. They combined bamboo and sugarcane fibers for tableware, replacing plastic in food production. Porta et al. (2021) researched microbes converting plastic into valuable products. Specific microbes decompose organic matter using enzymatic processes. Biodegradable plastics can be made from food and agricultural residues. Aiduang et al. (2022) explored biomaterials as plastic replacements. Fungal species can turn agricultural waste into mycelium-based composites (MBC) for various applications. MBCs offer fire safety advantages over synthetic insulation foams. Zheng and Suh (2019) discussed mismanaged plastic waste and the need for effective waste management. They highlighted recycling rates in different countries and the importance of various recycling technologies. Dey et al. (2020) investigated strategies to reduce single-use plastics (SUPs). They proposed recycling methods and alternative materials like biopolymers and edible plastics. Their roadmap focuses on curbing SUPs through different approaches. Vasallo et al. (2023) analyzed plastic pollution in the Mediterranean Sea and advocated for sustainable waste management through collaboration and legislative support. Ferronato et al. (2023) stressed minimizing waste generation by promoting sustainable production practices. They emphasized systemic change, sustainable consumption, and banning specific materials with high littering potential.

Conclusion

Plastic waste is increasing due to daily use, transforming into pollution. Plastic does not easily decompose, leading to environmental accumulation and crisis. The ramifications are profound, causing harm and degradation. This is a major concern requiring action. Various causes, consequences, and solutions exist to reduce plastic waste. Solutions include the R4 framework: Reuse, Reduce, Replace, Recycle. These strategies have advantages but may also have negative impacts. Each product has its own end-of-life stage; some components can be reused. Waste materials are recovered and recycled at the end of a product's life. Plastic recycling diminishes pollution, conserves resources, and transforms materials into new products, benefiting the environment and the economy. Enhancing recycling systems is crucial for effective plastic waste management. Various types of recycling exist - primary, secondary, and tertiary. Repurposing plastic reduces waste and environmental impact by preventing items from ending up in landfills and oceans. Innovative ways to repurpose plastic include creating hanging gardens and using plastic containers as organizers. Curbing single-use plastics, promoting alternative materials, and designing products with less plastic content can reduce plastic waste. Strategies for reduction include advocating for alternative materials and urging companies to design products with less plastic. Reduction is essential for a healthier planet. Use reusable shopping bags instead of single-use plastic. Carry a reusable water bottle to avoid disposable plastic. Use reusable straws made from stainless steel, glass, or bamboo. Choose products with minimal plastic packaging or cardboard rather than plastic.

Replacing plastics with bioplastics reduces environmental impact. Bioplastics are made from renewable sources like corn starch. Unlike traditional plastics, bioplastics grow quickly and can be replenished efficiently. Many bioplastics are engineered to decompose naturally, reducing persistence in the environment. Addressing plastic waste requires collective action. Strengthening waste management, embracing EPR, and promoting circular economy practices are crucial. It is never too late to make a positive change. Reducing plastic production, limiting single-use plastics, and using alternative materials can help. Encouraging corporations to innovate with less plastic is vital. Improving waste management and recycling systems boosts plastic waste management. Proper disposal and recycling prevent plastic from harming oceans and ecosystems. Global regulations and UN initiatives aim to combat plastic pollution. Low- and middle-income communities need protection from plastic production and pollution.

References

Aiduang W, Chanthaluck A, Kumla J, Jatuwong K, Srinuanpan S, Waroonkun T, Oranratmanee R, Lumyong S and Suwannarach N (2022) Amazing fungi for eco-friendly composite materials: A comprehensive review. Fungi 8: 842. https://doi.org/10.3390/jof8080842

APME (2006) An Analysis of Plastics Production, Demand, and Recovery in Europe. Association of Plastics Manufacturers, Brussels.

Arokiaraj D (2011) The green market: the way to save the world. Business Strategies 2(1): 41–44.

Arthur C, Baker J and Bamford H (2009) Proceedings of the International Research Workshop on the Occurrence, Effects, and Fate of Microplastic Marine Debris. NOAA Technical Memorandum 1–530.

Avanthi D, Igalavithana AY, Chammi P, Attanayake SW, Siming Y, Daniel CW, Tsang AN and Yong SO (2012) Sustainable management of plastic wastes in the COVID-19 pandemic: The biochar solution. Environmental Research 212: 113246. https://doi.org/10.1016/j.envres.2022.113246

Awasthi KA, Shivashankar M and Majumder S (2017) Plastic solid waste utilization technologies: A review. IOP Conference Series: Materials Science and Engineering 263: 022024. https://doi.org/10.1088/1757-899X/263/2/022024

Barnes DK, Galgani F, Thompson RC and Barlaz M (2009) Accumulation and fragmentation of plastic debris in global environments. Philosophical Transactions of the Royal Society B: Biological Sciences 364(1526): 1985–1998. https://doi.org/10.1098/rstb.2008.0205

Chaurasia A and Gangwar S (2019) Reuse of plastic bottles as a construction material. International Journal of Engineering and Technical Research 9(9): 25–30.

Dey A, Dhumal CV, Sengupta P, Kumar A, Pramanik NK and Alam T (2021) Challenges and possible solutions to mitigate the problems of single-use plastics used for packaging food items: A review. Journal of Food Science and Technology 58: 3251–3269.

Estil K (2019) From waste to housing: Using plastic waste to build sustainable housing in Haiti, Florida. Atlantic University, Boca Raton, pp. 22–41.

Ferronato N, Maalouf A, Mertenat A, Saini A, Khanal A, Copertaro B, Yeo D, Jalalipour H, Veuthey JR, Ulloa-Murillo LM, Thottathil MS, Shuaib N, Caplin R and Mohandas VJ (2024) A review of plastic waste circular actions in seven developing countries to achieve sustainable development goals. Waste Management & Research 42(6): 436–458. https://doi.org/10.1177/0734242X241237980

Gupta RK (2021) Experimental study on the reuse of multi-layered plastic waste in paver blocks, tiles, kerbstones, slabs, and light cover blocks. International Research Journal of Modernization in Engineering Technology and Science 3: 1221–1226.

Gregory MR (2009) Environmental implications of plastic debris in marine settings—entanglement, ingestion, smothering, hangers-on, hitchhiking, and alien invasions. Philosophical Transactions of the Royal Society B: Biological Sciences 364(1526): 2013–2025. https://doi.org/10.1098/rstb.2008.0265

Ilyas M, Ahmad WKH, Yousaf SK and Nazir S (2018) Plastic waste as a significant threat to the environment: A systematic literature review. Reviews on Environmental Health 33(4): 383–406. https://doi.org/10.1515/reveh-2018-0026

Kumar A, Dash SK, Ahamed MS and Lingfa P (2020) Study on conversion techniques of alternative fuels from waste plastics. In: Ghosh S (ed.) Energy Recovery Processes from Wastes, pp. 213–222. Springer, Singapore. https://doi.org/10.1007/978-981-15-0278-4_11

Kumar S, Babu JM, Harish V and Anbu M (2022) Waste plastic as a source of biofuel for stationary diesel engines: A critical review. International Journal of Ambient Energy 43: 8577–8591. https://doi.org/10.1080/01430750.2020.1839540

Lamba P, Kaur DP, Raj S and Sorowot J (2022) Recycling/reuse of plastic waste as construction material for sustainable development: A review. Environmental Science and Pollution Research 29: 86156–86179. https://doi.org/10.1007/s11356-022-22079-6

Lai WL, Sharma S, Roy S, Maji PK, Sharma B, Ramakrishna S and Goh KL (2022) Roadmap to sustainable plastic waste management: A focused study on recycling PET for triboelectric nanogenerator production in Singapore and India. Environmental Science and Pollution Research 29: 51234–51268. https://doi.org/10.1007/s11356-022-19487-2

Liu C, Luan P, Li Q, Cheng Z, Sun X, Cao D and Zhu H (2020) Biodegradable, hygienic, and compostable tableware from hybrid sugarcane and bamboo fibers as plastic alternative. Cell Reports Physical Science 1(6): 100079. https://doi.org/10.1016/j.xcrp.2020.100079

Manju R, Sathya S and Sheema K (2017) Use of plastic waste in bituminous pavement. International Journal of Chemical and Technical Research 10(8): 804–811.

Mato Y, Isobe T, Takada H, Kanehiro H, Ohtake C and Kaminuma T (2001) Plastic resin pellets as a transport medium for toxic chemicals in the marine environment. Environmental Science & Technology 35(2): 318–324. https://doi.org/10.1021/es001222n

Narancic T and O'Connor KE (2019) Plastic waste is a global challenge. Are biodegradable plastics the answer to the plastic waste problem? Microbiology 165(2): 129–137. https://doi.org/10.1099/mic.0.000755

Oehlmann J, Schulte-Oehlmann U, Kloas W, Jagnytsch O, Lutz I, Kusk KO and Tyler CR (2009) A critical analysis of the biological impacts of plasticizers on wildlife. Philosophical Transactions of the Royal Society B: Biological Sciences 364(1526): 2047–2062. https://doi.org/10.1098/rstb.2008.0242

O'Rourke K, Wurzer C, Murray J, Doyle A, Doyle K, Griffin C, Christensen BÓ, Brádaigh CM and Ray D (2022) Diverted from landfill: Reuse of single-use plastic packaging waste. Polymers 14(24): 5437. https://doi.org/10.3390/polym14245437

Pandey A, Ahuja S, Madan M and Asthana AK (2016) Bio-medical waste management in a tertiary care hospital: An overview. Journal of Diagnostic and Clinical Research 10(11): 01–03.

Patil AA, Nadaf NI, Mahedi SI and Bhusare MB (2020) Reuse of plastic waste into flooring tiles. International Journal of Advances in Engineering and Management 2(6): 77–83.

Porta R, Sabbah M and Di Pierro P (2002) Bio-based materials for packaging. International Journal of Molecular Sciences 23(7): 1–5.

Prakash A (2002) Green marketing, public policy, and managerial strategies. Business Strategy and the Environment 11: 285–297. https://doi.org/10.1002/bse.334

Preethi S, Prasannadevi R, Preethi RS and Banuchander TR (2019) Reuse of plastic bottles in the construction of buildings. International Research Journal of Engineering and Technology 6(3): 2225–2227.

Raghatate AL (2012) Use of plastic in concrete to improve its properties. International Journal of Advanced Engineering Research and Studies 1(3): 109–111.

Ryan PG, Moore CJ, van Franeker JA and Moloney CL (2009) Monitoring the abundance of plastic debris in the marine environment. Philosophical Transactions of the Royal Society B: Biological Sciences 364(1526): 1999–2012. https://doi.org/10.1098/rstb.2008.0207

Shabiimam MA, Pandey A, Ansari T and Chaurasia R (2018) Reusing plastic waste by manufacturing of paver and solid blocks. In: Construction Management Practices, pp. 154–162.

Sina P (2022) Upcycling of face mask waste generated during COVID-19 into value-added engineering materials: A review. Science of the Total Environment 851: 158181. https://doi.org/10.1016/j.scitotenv.2022.158181

Singh RK, Ruj B, Sadhukhan AK and Gupta P (2019) Thermal degradation of waste plastics under non-sweeping atmosphere: Part 1: Effect of temperature, product optimization, and degradation mechanism. Journal of Environmental Management 239: 395–406. https://doi.org/10.1016/j.jenvman.2019.03.057

Sydow Z and Bieńczak K (2018) The overview on the use of natural fibers reinforced composites for food packaging. Journal of Natural Fibers 16(8): 1189–1200. https://doi.org/10.1080/15440478.2018.1449710

Teuten EL, Saquing JM, Knappe DRU, Barlaz MA, Jonsson S, Björn A and Takada H (2009) Transport and release of chemicals from plastics to the environment and to wildlife. Philosophical Transactions of the Royal Society B: Biological Sciences 364(1526): 2027–2045. https://doi.org/10.1098/rstb.2008.0284

Thompson RC, Olsen Y, Mitchell RP, Davis A, Rowland SJ, John AWG, McGonigle D and Russell AE (2009) Lost at sea: Where is all the plastic? Science 304(5672): 838. https://doi.org/10.1126/science.1094959

Torres-Agullo A, Karanasiou A, Moreno T and Lacorte S (2021) Overview on the occurrence of microplastics in air and implications from the use of face masks during the COVID-19 pandemic. Science of the Total Environment 800: 149581. https://doi.org/10.1016/j.scitotenv.2021.149581

UNEP (2018) Single-Use Plastic: A Roadmap for Sustainability. United Nations Environment Programme.

Uvarajan T, Gani P, Chuan NC and Zulkernain NH (2021) Reusing plastic waste in the production of bricks and paving blocks: A review. European Journal of Environmental and Civil Engineering 26(14): 6941–6974. https://doi.org/10.1080/19648189.2021.1951845

Vaidya H (2023) Innovating to manage plastic waste. Outlook Planet, newspaper article.

Vassallo L, Appolloni A, Fantauzzi C and Frondizi R (2023) Reducing plastic pollution by recovery and recycling: Evidence from a "Blue Economy" project impacting policymaking in Italy. International Journal of Environmental Research and Public Health 20(8): 5423. https://doi.org/10.3390/ijerph20085423

Zheng J and Suh S (2019) Strategies to reduce the global carbon footprint of plastics. Nature Climate Change 9: 374–378. https://doi.org/10.1038/s41558-019-0459-z

Author Contributions
MB and MK conceived the concept, wrote and approved the manuscript.

Acknowledgements
Not applicable.

Funding
Not applicable.

Availability of data and materials
Not applicable.

Competing interest
The authors declare no competing interests.

Ethics approval
Not applicable.

Citation: Bala M and Kaur M (2025) Reviewing Sustainable Solutions to Plastic Waste: Strategies for a Cleaner Planet. Environmental Science Archives 4(2): 639-649.