Decoding The Truth About Plastic: Progress With A Price

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Abstract—Today, Plastic is a part of our day-to-day life. Be it food package and domestic products or medical equipment and high-tech industries, it plays a crucial role in making life more convenient, affordable, and productive. Due to its durability, lightweight, and versatility, it has been one of the most commonly utilized materials in human history. But at the same time, these very characteristics qualities have produced long-term environmental issues. Because plastic does not degrade for hundreds of years, it accumulates in landfills, contaminates rivers and oceans, and kills marine and terrestrial animals. Micro plastics, tiny plastic particles have now entered into the air we breathe, the water we drink, the food we eat, with serious health implications. This paper attempts to find out the two sides of plastics- as a potential tool for development and as a growing threat to nature and human health. It also examines the steps that we can practically take to minimize the destruction, such as promoting eco-friendly alternatives, improving waste management, and pressing for better usage. The aim of the paper is not to abandon plastic, but to utilize it more intelligently, maintaining its advantages with minimum harm to the world. Ultimately, plastic turns out to be a blessing or a curse depends on how we choose to manage it.

IndexTerms— **Plastic, Plastic age, Plastic pollution, Sustainability, 3Rs.**

I. Introduction

Throughout history, human progress has often been defined by the materials we have mastered, from the Stone Age to the Bronze and Iron Ages. Today, we live in what many call the "Plastic Age", an era shaped by a material that has revolutionized modern life while rising pressing environmental concerns. Plastic, a synthetic polymer known for its flexibility and durability, is used in everything from packaging and electronics to medicine and transportation. Its versatility has made it indispensable, enabling innovations like sterile medical tools, lightweight vehicles, and affordable consumer products that have enhanced convenience and improved quality of life. Plastics are made from organic compounds, including synthetic and semi-synthetic substances like petrochemicals and partially natural materials. They generally fall into two categories: bio-based (or organic polymers) and engineered plastics. Engineered plastics are created from non-renewable resources like crude oil, natural gas, and coal, and around 4% of the world's fossil fuel supply goes into making them. On the other hand, bio-based plastics are developed using more sustainable sources such as carbohydrates, vegetable oils, natural fats, microorganisms, and other renewable materials. While engineered plastics offer durability and strength, bio-based options are gaining attention for being eco-friendlier and reducing environmental impact [1-2].

However, the convenience of using plastic comes with a high cost as plastic is non-biodegradable and can linger in the environment for centuries. Improper disposal of plastic has led to clogged waterways, polluted oceans, and alarming health risks. Micro plastics are now found in our food, water, and even the air we breathe, contributing to hormonal disruptions and genetic issues in both humans and animals. Globally, use of plastic is surging, almost 500 billion plastic bags are consumed annually, over a million every minute. India alone generates over 15,000 tons of plastic waste daily. While 60% is recycled, the rest often ends up polluting natural ecosystems. Banning plastic outright is not feasible in our modern, tech-driven world. The real solution lies in responsible usage: reducing, reusing, recycling, and adopting sustainable alternatives [3-4].Plastic is a double-edged sword, a brilliant invention that fuels progress, yet, if mismanaged, becomes a silent threat to our planet. Our challenge is not to eliminate plastics, but to use it wisely, with a conscious commitment to sustainability [5].

II. The History of Plastics

For over a century, plastics have played a transformative role in human progress. Their journey began with natural substances like amber and tortoiseshell, evolving into chemically modified materials such as rubber and nitrocellulose. The first real man-made plastic, "Parkesine," was developed by Alexander Parkes in 1862, and later came the discovery of celluloid, which opened the door for mass production. The 20th century witnessed a revolution in plastics. From Bakelite in 1907, used in radios and automobiles to the invention of flexible PVC (Polyvinyl Chloride), Nylon, Plexiglas, and Teflon, plastics rapidly became part of everyday life. During World War II, their lightweight and durable nature made them vital for military equipment, aircraft, and medical supplies. By the 1950s and 60s, plastics entered homes and wardrobes, revolutionizing design, fashion, and convenience. They became lighter, safer, and more cost-effective alternatives to traditional materials. The space race further boosted innovation, with plastics used in spacecraft for their resilience and low weight. Plastics became indispensable in electronics, medicine, transportation, and packaging in the subsequent decades. By the 1990s and 2000s, they supported innovations in energy efficiency, healthcare, communication, and environmental design and thus playing a key role in sustainability and modern living. Now, plastics are

ubiquitous, from the smart phones to the space suits, characterizing our era much like stone, bronze, and iron did long ago. Today, we are actually living in the Plastic Age [6-8].

III. Types of Plastics

Plastics are broadly split into three key families based on how they respond to heat and how they are used. They are thermoplastics, thermo sets, and biodegradable plastics. Each type has unique features that make it suitable for different industries and applications [9].

Thermoplastics

Thermoplastics are softened when heated and harden when cooled, this process can be repeated, which makes them recyclable and highly adaptable. They make up about 80% of the plastics used worldwide [10].

- **Standard Thermoplastics**

They are the most frequently used thermoplastics and we use them in every product we utilize in our daily activities, ranging from bags to carry grocery to containers and packaging. Examples are: PE (Polyethylene), which includes LDPE(Low-Density Polyethylene):used in cling films, milk carton linings, and cable insulation, LLDPE(Linear Low-Density Polyethylene): found in stretch wraps and industrial bags, HDPE(High-Density Polyethylene):used for containers, toys, pipes, and crates. PP (Polypropylene): used in food packaging, medical tools, luggage, and furniture, PVC (Polyvinyl Chloride): used in pipes, window frames, flooring, and wires, PS (Polystyrene):applied in toys, packages, and electronics, EPS (Expanded Polystyrene):light foam used in insulation and food packets, PET (Polyethylene Terephthalate):often used in drink bottles, food trays, and clothes fibers.

- **Engineering Plastics**

Engineering plastics are stronger and more heat-resistant than standard plastics. They are often used in automobiles, electronics, and machinery. Some examples include: ABS (Acrylonitrile Butadiene)-durable and used in electronics and home appliances, PA(Polyamide):commonly known as Nylon and used in fabrics and mechanical components, PC (Polycarbonate)-used in eyewear lenses, helmets, and safety gears. Other examples are: PBT (Polybutylene Terephthalate), POM (Polyoxymethylene), PMMA (Polymethyl Methacrylate), which are used in precision engineering and appliances.

- **High-Performance Plastics**

These plastics are designed to work in extreme conditions, such as high heat, chemicals, and mechanical stress. One example is PTFE (Polytetrafluoroethylene): widely known by the brand name Teflon, which is used in non-stick cookware and aerospace. Some other examples are: PI(Polyimide), PAI(Polyamide-imide), PEI(Polyetherimide), PSU(Polysulfone), PEEK(Polyether ether ketone), LCP(Liquid Crystal Polymer), PPS(Polyphenylene Sulfide), PPA(Polyphthalamide), which are used in high-tech industries like aviation, medical devices, and electronics,

Thermosets

Thermoset plastics create permanent chemical bonds when heated. They cannot be melted again after they have set, which provides them with strength and heat resistance. One example of thermoset plastic is Epoxy Resins, which is used in coatings, adhesives, electronics, wind turbine blades, and ship paints. Another example is Polyurethanes, which are found in furniture cushions, mattresses, refrigerators, insulation panels, and car interiors. Other examples are Phenolic, acrylic, vinyl ester, unsaturated polyester resins, used in construction, transport, and marine structures [9-10].

Biodegradable Plastics

Biodegradable plastics are made from natural sources like corn starch; these plastics are designed to decompose in composting environments, helping reduce plastic pollution. One example of biodegradable plastic is PLA (Polylactic Acid), which is used in disposable cups, bags, food containers, and agricultural films. They are ideal for single-use items, especially in food service, events, and farming [11].

IV. Applications of Plastics in Daily Life

Plastics play a vital role in our daily lives, offering lightweight, durable, and versatile solutions across various applications. The following fields of application highlight their importance:

Medical field

Plastics have transformed the medical profession with their incredible versatility, substituting for glass, metal, and wood in numerous applications. From disposable items that enhance hygiene and safety, such as latex gloves, IV (Intravenous) bags, dialysis tubing, and syringes to advanced innovations like micro needle patches, engineered tissues, and absorbable sutures, polymers have become indispensable in modern healthcare. Their low-cost, lightness, and mold ability has made it possible both for single-use and reusable medical devices, and this has dealt with public health issues including infection control, especially in the context of diseases like HIV(Human Immunodeficiency Virus) and hepatitis B. The introduction of auto-disable syringes that self-lock after use has also improved safety, particularly in areas where there is no proper waste management. Moreover, sterilizable plastic syringes have resolved issues of breakage and difficulty in cleaning associated with older metal and glass versions. Beyond these tools, plastics are central to cutting-edge treatments, used in biodegradable sutures that minimize surgical interventions, in polymethylmethacrylate bone cement for joint replacements, and in polymer-based scaffolds that support tissue regeneration. Even IV systems, which account for a significant portion of hospital waste, highlight how essential plastics are in delivering life-saving fluids and medications swiftly. Altogether, the integration of polymers into medicine has not only improved the efficiency and safety of patient care but also opened new frontiers in biomedical innovation [12].

Clothing and Footwear

Plastics have seamlessly integrated themselves into the fabric of contemporary life, literally. From the clothes we wear to the shoes on our feet, plastics play a vital role in comfort, performance, and durability. Whether it is the everyday polycotton T-shirts rich in PET (Polyethylene) plastic or the high-performance active wear crafted from polyester, fluoropolymers, and nylon, synthetic fibers dominate our wardrobes. Even warm fleece jackets, commonly composed completely of recycled PET, illustrate how plastics not only responsible for functionality but also for sustainability. Footwear also relies heavily on plastics, cushioning foot beds and tough outsoles are typically made of polyurethane or other flexible polymers, while uppers are also made of vinyl or similar synthetics. In addition to functionality, plastics have become integral to modern fashion, shaping trends that are comfortable, long-lasting, and innovative. From breathable active wear to weather-resistant outerwear, these adaptable materials are not just hidden components but silent partners in how we express ourselves, stay protected, and move confidently through our daily lives [13].

Transportation

With the rapid rise of technology and a growing global economy, transportation has become faster, more efficient, and widely accessible and plastics have been a quiet yet powerful force behind this transformation. From the smooth tires that keep vehicles grounded to the aerodynamic panels that cut through the air, plastics are present in nearly every corner of the transport industry. Cars, planes, ships, and trains all depend on plastic components for more than just aesthetics; they reduce weight, boost fuel efficiency, and enhance overall safety. PVC (Polyvinyl Chloride) is used in parts like flywheels and dashboards, while high-performance plastics strengthen bumpers, fuel tanks, interior trims, and even under-the-hood systems like cooling and wiring insulation. In aircraft and high-speed rail, plastics play a crucial role in minimizing load without compromising strength, making long-distance travel more energy-efficient [14].

Packaging

Plastics are a basic feature of contemporary packaging, used extensively in industries like food, drugs, cosmetics, detergents, and chemicals. Approximately 30% of global plastic production is utilized solely for packaging. Their popularity stems from a winning combination of qualities—lightweight, strong, water-resistant, and resilient against most microorganisms—making them a practical replacement for traditional paper and cellulose-based materials. Commonly used packaging plastics include polyethylene variants (LDPE, HDPE, etc.), polypropylene (PP), PET, PVC, and others [15].

Agriculture

The use of plastics in agriculture, particularly in the form of mulch films, has significantly transformed crop production by improving soil temperature, conserving moisture, suppressing weeds, and boosting yields. Globally, the demand for agricultural plastic films, used in mulching, greenhouses, and silage, has surged, with mulch films alone accounting for over 40% of usage. While conventional mulch films made from polyethylene offer many agronomic advantages, their poor biodegradability poses serious environmental challenges, often ending up in landfills or being burned due to contamination and recycling limitations. In response, biodegradable plastic mulches have emerged as a promising alternative, designed to be tilled into soil and broken down by natural organisms. However, their safety remains uncertain, as degradation standards fail to assess the presence of micro and nano particles that may persist in soil, potentially carrying harmful chemicals. As agriculture moves toward sustainability, these biodegradable options must undergo rigorous field testing across diverse climates to ensure they're not just effective, but also environmentally responsible [16].

Electronic devices

Plastics are now a key material in everything from everyday items like cables and kitchen appliances to high-tech gadgets like smart phones. Their flexibility and wide range of uses make them essential in the fast-moving world of electronics. Because of these valuable qualities, engineers and product designers regularly turn to plastics when creating modern electrical and electronic devices. These smart materials can be tailored to match the function and lifespan of a device, making them ideal for everything from medical implants that naturally break down in the body to environmental sensors that vanish after collecting data. As consumer electronics like smart phones, foldable displays, wireless ear buds, and smart watches become more advanced and disposable, the need for sustainable materials is more urgent than ever. Biodegradable plastics—smart polymers engineered to conduct, insulate, or degrade—are stepping in as an eco-friendly alternative. These materials can replace traditional plastics in key components such as flexible substrates, insulating dielectrics, and even semiconductors used in devices. For example, field-effect transistors (FETs), which power touch screens and processors in gadgets, can now be made using biodegradable semiconducting polymers without compromising performance. Imagine a phone case that composts naturally, or internal circuits in smart packaging and temporary wearable that dissolve after use. Materials like polylactic acid (PLA), cellulose, and silk are already proving their worth in creating flexible, high-performance parts that reduce e-waste. With biodegradable plastics, the future of consumer tech is not just smarter, it is greener too [17].

V. PLASTICS: A BOON TO SOCIETY

Plastics have become an essential part of our daily lives; it is a true boon for modern society. From the moment we wake up—brushing our teeth with a plastic-handled brush, sipping clean water from a safe bottle, or packing food in lightweight containers—plastics are there, making life simpler, safer, and more convenient. What makes plastics so valuable is their unique mix of strength, lightness, flexibility, and affordability. These qualities make them perfect for everything from building homes and roads to creating life-saving medical tools like syringes, implants, and IV bags. In fact, many of the tools that doctors use today wouldn't exist without plastics. Materials like PET and PBT can handle heat, pressure, and chemicals, making them reliable even in harsh conditions. Plastics also help the environment in ways people do not always realize—lighter cars and planes use less fuel; plastic

insulation keeps homes warmer in winter and cooler in summer, and solar panels and wind turbines so efficient due to their plastic components. In farms, plastics help to grow more crops through irrigation systems, nets, and silage covers. They even make play and comfort better—sports equipment, clothes, furniture, and toys are all more affordable and durable thanks to plastic. And while it is true that plastic waste is a growing concern, the material itself is not the enemy—it is how we use and manage it that matters. With thoughtful recycling and responsible choices, plastics can continue to support progress, innovation, and sustainability. When we see plastics not just as convenience, but as tools that protect lives, conserve resources, and bring comfort to millions, we begin to understand how deeply they have become a part of our world—not just as materials, but as silent enablers of modern living [18-19].

During the worldwide COVID-19 outbreak, the use of plastics in producing personal protective equipment (PPE) became a truly remarkable and life-saving application. As the virus spread rapidly across countries, the urgent need for protective gear grew stronger than ever. Plastics—lightweight, durable, and easy to shape—proved to be the perfect material for making face shields, gloves, masks, and gowns. These items became essential for doctors, nurses, and even everyday people trying to stay safe. While the world faced fear and uncertainty, plastic-based PPE offered a layer of hope and protection. This moment in history showed us how a simple material like plastic could become a powerful shield in the fight against a global health crisis. At the same time, it reminded us of the importance of using such materials wisely, balancing safety with sustainability for the future [20-21].

VI. Plastics: A Curse in Disguise

Though plastic has become an everyday necessity, we must recognize that our overdependence on it, is turning this convenience into a curse in disguise, fueling a massive global waste crisis. From polyethylene terephthalate (PET) in water bottles to polyvinyl chloride (PVC) in packaging and pipes, and high-density polyethylene (HDPE) in containers, plastics are cheap to produce but come at an enormous environmental cost. While some may degrade in a few hundred years, others take over 400 years to fully decompose, breaking down into micro plastics that invade our oceans, harm marine life, degrade soil quality, and even enter our food chain. Plastic manufacturing relies on toxic chemicals and synthetic dyes, and recycling, though promoted, is expensive and largely inefficient, only a small fraction is ever reused. The rapid growth in disposable plastic packaging, which makes up 15–35% of household solid waste, overwhelms waste systems and floods our planet with pollution. Worse still, burning plastic releases harmful gases like dioxins, and storing hot food in low-grade plastic containers may even pose cancer risks. Some plastics are structurally weak, prone to break under pressure, and due to their combustible nature, they can trigger fires if not properly discarded. With inadequate recycling infrastructure and poor waste management, especially in developing regions, plastic is leaking into every corner of the Earth—land, rivers, and seas—turning from a convenience into a global catastrophe. It's clear that unless we reimaging our reliance on plastic, this seemingly helpful invention will continue to haunt our environment for generations to come [22-23].

VII. The Responsibilities and the Use of Plastic

The convenience, versatility, and low cost of plastic, have made it a boon for modern living, but at the same time, unchecked use, careless disposal, and poor waste management, have turned it into a growing environmental curse. Now, we do not just need more action, we need smarter and more accountable action. While bans and recycling efforts show promises, their success often depends on public engagement, affordability, and real behavioral change. People are often hesitant to trust or buy recycled items due to perceived lower quality or lack of awareness. This hesitation shows how deep-rooted our habits are and how vital it is to reshape them through education and motivation. Responsibility for plastic use, is not just about picking the right bin, it is about the changing of how we think, consume, and act. The three Rs—Reduce, Reuse, Recycle, still remain as our strongest foundation. We must reduce plastic dependency by avoiding single-use items, reuse durable products to slow waste generation, and recycle smartly so plastic can live a second life instead of choking our land and oceans. Social media can also help people to understand about plastic pollution by sharing simple messages, pictures, and ideas to encourage eco-friendly habits [24].

But this should not be the end of our responsibility. Wherever possible, we should also embrace safer, longer-lasting alternatives, such as stainless steel. Unlike plastic, steel is durable, non-toxic, and recyclable without quality loss. Using steel water bottles, lunch containers, or straws can significantly cut down plastic waste over time and reduce exposure to harmful chemicals that plastic may leach into food [25].Governments must step in with stronger Extended Producer Responsibility (EPR) laws that hold manufacturers accountable from production to disposal. At the same time, businesses should design packaging with recyclability in mind and support the circular economy. All the individuals, each of us, must shift from convenience-driven habits to conscious choices that protect the environment and future generations [26].

Plastic, in itself, is not a villain. It is only our misuse that has turned it into one. But with smarter policies, responsible design, consumer awareness, and small yet powerful daily actions, like choosing to refill, reuse, and even replace, we can restore plastic to its original role, as a useful tool, not a toxic threat. If we can accept the boon, and act upon the curse, we can craft our future such that plastic is at our service, without choking the planet [24-26].

VIII. Conclusion

Today, in this modern digital world, plastic has become an integral part of our life. Now, plastic can be found everywhere in our life—in our kitchens, in our clothing, in our cars, even in the hospitals which save our life. Plastic has simplified many things in our lives easier, made them more affordable and safer. In many ways, it is such a material which represents human progress and creativity. But over time, our love for convenience has come with a heavy price. We have used plastic carelessly, creating a big waste problem which become a significant challenge towards our environment, wildlife, and even our own health. The use of plastic itself is not harmful. It depends on how we have used it and how we have failed to manage its waste, causing the damage. We, people are too dependent on single-use plastics, and too quick to throw things away without thinking about where they end up.

But still, it is not too late. We can reverse this situation by adopting small, daily changes, using reusable products, recycling correctly, opting for alternatives where possible, and patronizing businesses that value sustainability. Governments and industries also have a significant role to play in designing systems that make it simpler and more efficiency to deal with plastic waste. The future of plastic does not have to be a curse. It can still be the amazing invention it was supposed to be—if we all become more responsible with it. Ultimately, it is in our hand only. The more conscious we are, the better opportunity we have to save our planet for future generations.

REFERENCES

[1] P.G.C. Nayanathara Thathsarani Pilapitiya, Amila Sandaruwan Ratnayake, "The world of plastic waste: A review", Cleaner Materials (ELSEVIER), January 2024, https://doi.org/10.1016/j.clema.2024.100220

[2] Christopher Kuenneth, Jessica Lalonde, Babetta L. Marrone, Carl N. Iverson, Rampi Ramprasad, and Ghanshyam Pilania, "Bioplastic Design using Multitask Deep Neural Networks", Communications Materials (Springer Nature), vol. 3, no. 1, article 96, December 2022, https://doi.org/10.1038/s43246-022-00319-2

[3] Xinming Du, Shan Zhang, Eric Zou, "Marine Microplastics and Infant Health", NBER, October 2024, https://doi.org/10.48550/arXiv.2410.17391

[4] Archana Gupta, Jitendra kumar Gupta, "Disposable Plastics, A Boon or a Curse?", International Journal of Scientific and Research Publications (IJSRP), Volume 2, Issue 1, ISSN 2250-3153, January 2012

[5] Amit P. Gawande, "Economics and Viability of Plastic Road: A Review", Journal of Current Chemical & Pharmaceutical Sciences (JCPPS), vol. 3, issue 4, pp. 231-242, ISSN 2277-2871, September 2013

[6] Jade Stanley, David Culliton, Antonio-Jonay Jovani-Sancho and Adriana Cunha Neves, "The Journey of Plastics: Historical Development, Environmental Challenges, and the Emergence of Bioplastics for Single-Use Products", MDPI, Vol. 6, issue 1, January 2025, https://doi.org/10.3390/eng6010017

[7] David G Bucknalla, "Plastic Sustainability Challenges", Creative Circular Economy Approaches to Eliminate Plastic Waste: Plastics Research and Innovation Fund Conference, UK Circular Plastics Network, Plastics Research Innovation Fund Conference, pp. 8-13, June 2020, <https://www.ukcpn.co.uk/wp-content/uploads/2020/08/PRIF-Conference-Brochure-Final-1.pdf>

[8] Richard C. Thompson1, Shanna H. Swan, Charles J. Moore and Frederick S. vom Saal, "Our plastic age", Philosophical Transactions of The Royal Society B, Volume 364, Issue 1526, pp. 1973-1976, 2009, https://doi.org/10.1098/rstb.2009.0054

[9] Herve´ Millet, Patricia Vangheluwe, Christian Block, Arjen Sevenster, Leonor Garcia and Romanos Antonopoulos, "The Nature of Plastics and Their Societal Usage", Royal Society of Chemistry, vol. 47, pp. 1 - 20, 19 Nov 2018, https://doi.org/10.1039/9781788013314-00001

[10] Isiaka Oluwole Oladele, Christian Junior Okoro, Anuoluwapo Samuel Taiwo, Linus N. Onuh, Newton Itua Agbeboh, Oluwayomi Peter Balogun, Peter Apata Olubambi and Senzeni Sipho Lephuthing, "Modern Trends in Recycling Waste Thermoplastics and Their Prospective Applications: A Review", Journal of Composites Science (MDPI), volume 7, Issue 5, Article 198, 13 May 2023, https://doi.org/10.3390/jcs7050198

[11] Raju K. Chalannavar 1, Ravindra B. Malabadi 2, Divakar MS, Swathi, Komalakshi KV, Angitha B, Avinash A. Kamble, Kishore S. Karamchand, Kiran P. Kolkar, Karen Viviana Castaño Coronado and Antonia Neidilê Ribeiro Munhoz, "Biodegradable plastics-advantages and challenges: An update", Open Access Research Journal of Science and Technology, vol. 13, Issue 02, pp. 042-056, 2025, https://doi.org/10.53022/oarjst.2025.13.2.0036

[12] Emily J. North and Rolf U. Halden, "Plastics and Environmental Health: The Road Ahead", National Institute of Health (NIH), vol. 28, issue 1, 2013, https://doi.org/10.1515/reveh-2012-0030

[13] Anthony L. Andrady and Mike A. Neal, "Applications and societal benefits of plastics", Philosophical Transactions of The Royal Society B, vol. 364, pp. 1977–1984, 2009, https://doi.org/10.1098/rstb.2008.0304

[14] Jiamin Lu1, "Polymer Materials in Daily Life: Classification, Applications, and Future Prospects", ICEMEE, vol. 406, 2023, https://doi.org/10.1051/e3sconf/202340601034

[15] Aamer Ali Shah, Fariha Hasan, Abdul Hameed, Safia Ahmed, "Biological degradation of plastics: A comprehensive review", Biotechnology Advances, Volume 26, Issue 2, pp. 246-265, 26 January 2008, https://doi.org/10.1016/j.biotechadv.2007.12.005

[16] Henry Y. Sintim and Markus Flury, "Is Biodegradable Plastic Mulch the Solution to Agriculture's Plastic Problem?", Environmental Science & Technology, vol. 51, issue 3, pp. 1068-1069, January 12, 2017, https://doi.org/10.1021/acs.est.6b06042

[17] Vivian R. Feig, Helen Tran, and Zhenan Bao, "Biodegradable Polymeric Materials in Degradable Electronic Devices", ACS Central Science, vol. 4, issue 3, pp. 337−348, 6 February, 2018, https://doi.org/10.1021/acscentsci.7b00595

[18] Chada Jithendra Sai Raja, N.Sai Sampath, Ch.Suresh, A.Phani Bhaskar, A Review on Use of Plastic in Construction of Roads, Journal of Advancement in Engineering and Technology, Volume 7, Issue 4, May 2020, https://doi.org/10.5281/zenodo.3780333

[19] Peter Eyerer, Helmut Schüle and Peter Elsner, "Polymer Engineering - Developing or Improving Plastic Products- Are Plastics Boon or Bane?", Academic Journal of Polymer Science, Volume 4, Issue 3, August 2020, https://doi.org/10.19080/AJOP.2020.04.555639

[20] Tanveer M. Adyel, "Accumulation of plastic waste during COVID-19", Science, vol. 369, Issue 6509, pp. 1314-1315, 11 September 2020, https://doi.org/10.1126/science.abd9925

[21] Rumana Hossain, Md Tasbirul Islam, Riya Shanker, Debishree Khan, Katherine Elizabeth Sarah Locock, Anirban Ghose, Heinz Schandl, Rita Dhodapkar and Veena Sahajwalla, "Plastic Waste Management in India: Challenges, Opportunities,

and Roadmap for Circular Economy", Sustainability (MDPI), vol. 14, issue 8, article 4425, 8 April 2022, https://doi.org/10.3390/su14084425

[22] Avalon Diggle and Tony R. Walker, "Environmental and Economic Impacts of Mismanaged Plastics and Measures for Mitigation", MDPI journal Environments, vol.9, 21 January 2022, https://doi.org/10.3390/environments9020015

[23] B. Panthi, I. Koirala and N. Panthi3, "Plastic: A Boon but Also a Curse to the Environment", Journal of Nepal Physical Society (JNPS), Volume 9, Issue 1, pp.2738-9537, June 2023, https://doi.org/10.3126/jnphyssoc.v9i1.57544

[24] Domenico De Fano, Rosamartina Schena, Angeloantonio Russo, "Empowering plastic recycling: Empirical investigation on the influence of social media on consumer behavior", Resources, Conservation and Recycling, Volume 182, July 2022, https://doi.org/10.1016/j.resconrec.2022.106269

[25] Josiane Nikiema, Zipporah Asiedu, "A review of the cost and effectiveness of solutions to address plastic pollution", Environmental Science and Pollution Research (Springer), vol. 29, pp. 24547–24573, 23 January 2022, https://doi.org/10.1007/s11356-021-18038-5

[26] Filippo Corsini, Natalia Marzia Gusmerotti, Edoardo Bartoletti, Francesco Testa, Andrea Appolloni, Fabio Iraldo, "Addressing Plastic Concern: Behavioral Insights into Recycled Plastic Products and Packaging in a Circular Economy", Circular Economy and Sustainability, vol. 4, pp. 1961–1981,11 April 2024,