

STUDY OF USE AND ADVERSE EFFECTS OF PLASTICS ON THE ENVIRONMENT



A PROJECT WORK

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CERTIFICATE OF APPROVAL

This project entitled “**Study of use and adverse effects of plastics on the environment**” by **Creation Duwal** under the supervision of **Mr. Sanjit Shah**, Chemistry Lecturer, here submitted for the partial fulfillment of work of grade 11 has been accepted.

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ABBREVIATIONS

MPP

Marine Plastic Pollution

ABSTRACT

The growing use of plastics in the modern-day use demands extensive attention and management techniques. It is no secret that plastics, ever since their invention, have been growing exponentially in use, in a way that is unignorable detrimental to the environment and the ecology. This report aims to uncover the toll exacted on the environment by the extensive use of plastics in the modern-day world, and suggest methods that could help influence the necessary scrutinization of the use of plastics and their regulation.

Keywords:

Circular Plastic Economy

Marine Plastic Pollution

LITERATURE REVIEW

Anthony L., *et al* in their book **“Plastics and the Environment”** explore the impacts of the use of plastics on the environment and how modern industrial polymerization techniques have allowed the development of versatile polymers with properties so modifiable that it has been able to find its use in many aspects of daily life. Depending on the required area of application, the polymers can be stiff or soft, transparent or opaque, *conducting or insulating*. They conclude that plastics (polymers) have become an indispensable part of modern life as they provide a high-quality life for all humankind, at least in the short term. The crises brought by the rising use of plastics have become highly apparent today, as we have had to face them multiplying in magnitudes far more than predicted. (Andrady, 2003)

Agenda I, in their report titled, **“The New Plastics Economy: Rethinking the Future of Plastics”** published by the World Economic Forum in 2016, delves into the innovative approaches and strategic implications of plastics in an idealized system. Extensive research on where the plastic waste that we produce ends up has allowed insightful conclusions. The report points out the flaws in the current plastic economy and suggests reforms that could significantly reduce the toll produced by plastics today. The report also brings light on the expected state of plastic production, use, and waste, if the growth projection is to remain constant. (World Economic Forum, 2016)

INTRODUCTION

The growing use of plastics in the modern-day world is undeniably apparent. From the packaging of the smallest of cottage/industry products to their use in highly critical mechanical devices, plastics have been able to have themselves strongly integrated into the areas. Different types of plastics that we use in different sectors find different uses in our day-to-day lives, and they too have varying tolls on the environment. Different kinds of plastic may require different kinds of disposal techniques. Failure in the proper management and disposal of such plastics causes adverse effects on the environment and ultimately human beings.

2.1 Plastics

Plastics are defined as synthetic materials made from a wide range of organic polymers such as polyethylene, PVC, nylon, etc. that can be molded into shape, and then set into rigid or slightly elastic forms.

2.2 Development of Plastic

The first form of fully synthesized plastic is credited to be *Bakelite* invented in New York in 1907 by Leo Baekeland, who also had coined the term *plastic*. Further improvements had been made before the industry-scale production of plastic took place. Soon after, World War I took place and the production of plastic in the USA practically quadrupled. Soldiers wore durable plastic helmets, aircraft, and carriers included bulletproof plastic materials like *plexiglass*, soldiers used nylon-based materials as parachutes. The industries whose production had been concentrated on military equipment shifted to the production of consumer products.

With the introduction of a method known as injection molding, it became possible to mass produce plastics inexpensively and rapidly. Today, the most used form of plastic is polyethylene, whose presence in our daily lives, spans from, grocery bags, to shampoo bottles to bulletproof vests.

OBJECTIVE

The primary objectives of this project report are:

- i. To analyze the rise in the use of plastics in the world.
- ii. To analyze the effect of plastic on the environment and identify reliable measures for the impedance of the growing unmanaged deposits of plastics.
- iii. To analyze the methods taken to solve the issues at hand.

EXTENSIVE APPLICATIONS OF PLASTIC

Plastics have become an integral part of our lives due to their versatility, durability, and cost-effectiveness. For any industry, the usage of plastics makes production faster and allows the formation of stable business models for otherwise impossible products economically. Their applications span across many of these industries. Some of the industries where plastics are highly integrated are presented below.

Packaging

The most visible application of plastics is in packaging. Unsurprisingly most of the plastic that we produce goes into packaging. Packaging using plastic is suitable for most kinds of consumer products. They also help extend the shelf life of food items and act as barriers against oxygen, moisture, and contaminants.

Automotive Industry

In the automotive industry, plastics are widely acclaimed to have been the major reason behind the reduction in vehicle weight, which in turn improves fuel efficiency, and reduces greenhouse gas emissions. Almost 50% of the volume of a vehicle today is plastic and only accounts for about 15% of the mass. (Ortego, 2023). This particular feature of plastic also spans other fields of engineering.

Medical Field

Plastics have revolutionized the medical field with their application in disposable syringes, prosthetics, blood bags, etc. Their sterility is one of many reasons why they are suitable for use in the medical field.

These and many more other fields have been highly advanced by the use of plastics allowing the inception of different and effective ways to get to a defined solution. However, it is definitely not to be ignored that their environmental impact is of critical concern. The primary goal at hand should be the improvement along with the proper scrutinization of plastics used in these diverse fields.

THREATS OF PLASTIC

5.1 Production of Plastics

Plastics have been in use widely because of their versatile nature and their applicability in many fields. In the last half-century, the use of plastics and polymers of different kinds has skyrocketed. 9.2 billion tonnes of plastic are estimated to have been made between 1950 and 2017. The fact that more than half of this number of plastics were manufactured after 2004 is also not to be ignored in any way. (Wikipedia, n.d.)

Plastics are produced by a process known as polymerization, which refers to the combination of monomers in a chain-like link, which is almost always petrochemical in nature. Due to the development of technologies like injection molding, plastics are being produced in mass numbers in desirable numbers and with desirable characteristics. They have found their use in many areas all around the world.

5.2 Degradation due to Plastic— Molecular Point of View

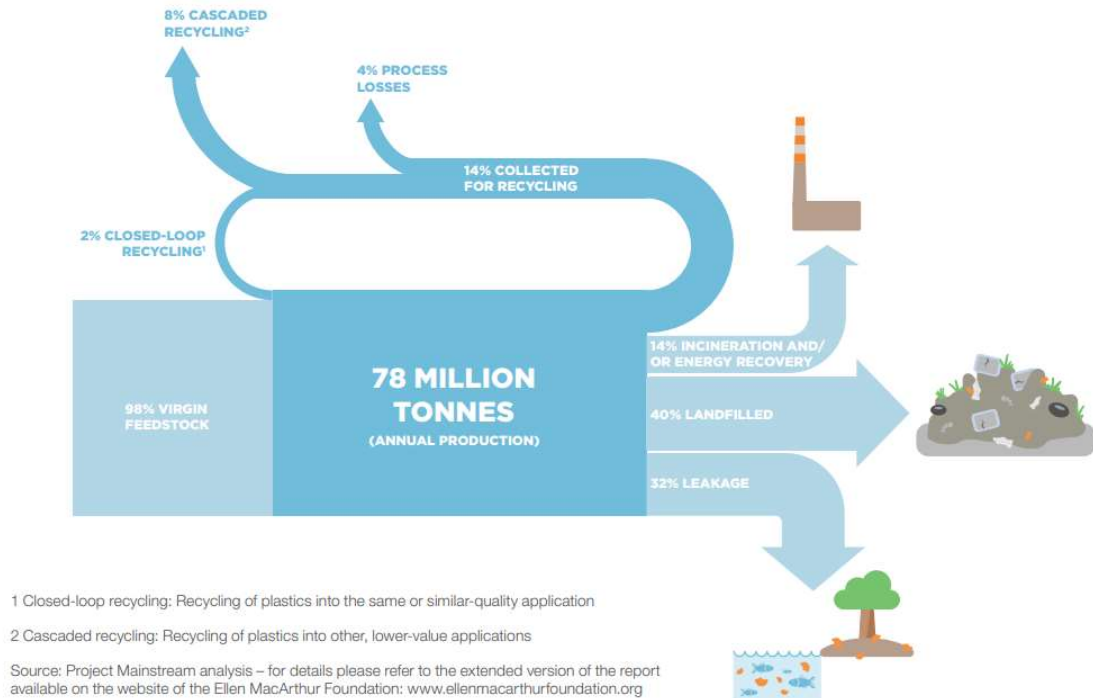
The plastics or polymers that we produce that many decades and even centuries to decompose fully. The most dangerous fact about plastics is that even though plastics don't decompose over long periods, they do get broken down into particles known as microplastics. These types of plastics are typically harmful to marine life as most plastics end up either in oceans or other water bodies. Water is also what causes these plastics to break down into microplastics. Further, these plastics also release toxic products in the process, causing severe challenges for the disposal of plastic waste.

5.3 Degradation due to Plastic— Wider Aspects

Many sources prove that plastics have become the biggest environmental threat of this century. It is found that only 9% of the plastic that we produce, ever gets recycled. All the others share the *same fate* ultimately which shall be discussed in a separate section. Most of the plastic trash humans produce ends up in garbage patches in all of the world's oceans as they follow the paths of water currents and end up in those garbage patches stationarily.

A study undertaken by the World Economic Forum, *The New Plastic Economy*, has shown how a staggering 32% of the 78 million tonnes of annual plastic packaging

material escapes the collection systems, meaning wastes equivalent to a garbage truck capacity find their way into the oceans and other unrecognized dump sites **every minute**. If the rates are to remain constant, this is expected to increase to two garbage trucks every minute by 2030 and four by 2050. (World Economic Forum, 2016)



(World Economic Forum, 2016)

5.4 Fate of all Plastic

All plastic share one of four fates. They find their way in one of the following places,

1. Landfill sites
2. Recycling facilities
3. Considered Leakage: Unrecognized garbage heaps / Oceans (garbage patches)
4. Incineration Facilities or Incineration by Consumers

Landfill Sites

In most developed in developing countries, the plastic waste that gets produced gets sent to places designated to collect such waste. It is to be considered that these landfill sites are only of limited capacity and alternatives to them have to be sought. Landfill sites are typically farther away from human settlements. The water that accumulates in

these landfill sites due to rain may cause the absorption of the water-soluble compounds in these wastes which are more often than not, highly toxic. Together the absorption leads to the production of a harmful stew called leachate, which can move into groundwater, soil, and streams.

Recycling facilities

Plastics reach recycling facilities in many ways, the waste that is to be dumped into landfill sites may be filtered to separate recyclable materials. The waste that ends up here may be processed again for the formation of new polymers.

Leakage; Garbage Heaps, Ocean

In most countries that cannot afford waste management via landfill or recycling facilities, there may be no option but to discard their waste with no further human-guided processing. Such wastes end up in officially unrecognized garbage heaps, most often in the inhabited areas themselves, or they end up in the ocean garbage patches via rivers with the flow of the current, leading them all to a single patch.

Incineration

Incineration, whether in controlled facilities or by the consumers themselves, also takes up a large portion of where plastic wastes end up. In controlled facilities, the incineration is made as less toxic as possible, and the highest form of precautions are taken to ensure that the gas emitted has the least traces of toxic constituents. Uncontrolled incineration by consumers, however, is indeed dangerous and should not at all be practiced, but due to the lack of knowledge in individuals, such actions are done which ultimately harm the environment even more. T

ORGANIZATIONAL EFFORTS FOR MITIGATION OF PLASTIC-INDUCED DEGRADATION

The following are a few of the organizational initiatives that have helped extensively in the mitigation of plastic-induced degradation. These organizational initiatives plan on drastically improving the current plastic economy and meanwhile cleaning up after the pollution that has already been caused.

6.1 The Ocean Cleanup Initiative

The Ocean Cleanup Initiative is a nonprofit organization founded by Boyan Slat in 2013 with the primary goal of leading the development of advanced technologies to rid the ocean and water bodies of plastic. It aims to reduce 90% of floating plastic from the oceans.

Their research has found that 80% of the plastic leakage, that ends up in oceans and other water bodies, originates from 1% of the rivers (~1000). (The Ocean Cleanup, n.d.) Their initiative utilizes a system of floating barriers and processing platforms designed to concentrate and collect the plastic from those rivers. Large floating machines terms as “Interceptors” developed by the Ocean Cleanup Organization have been in active use in many countries, especially those requiring immediate waste management systems.

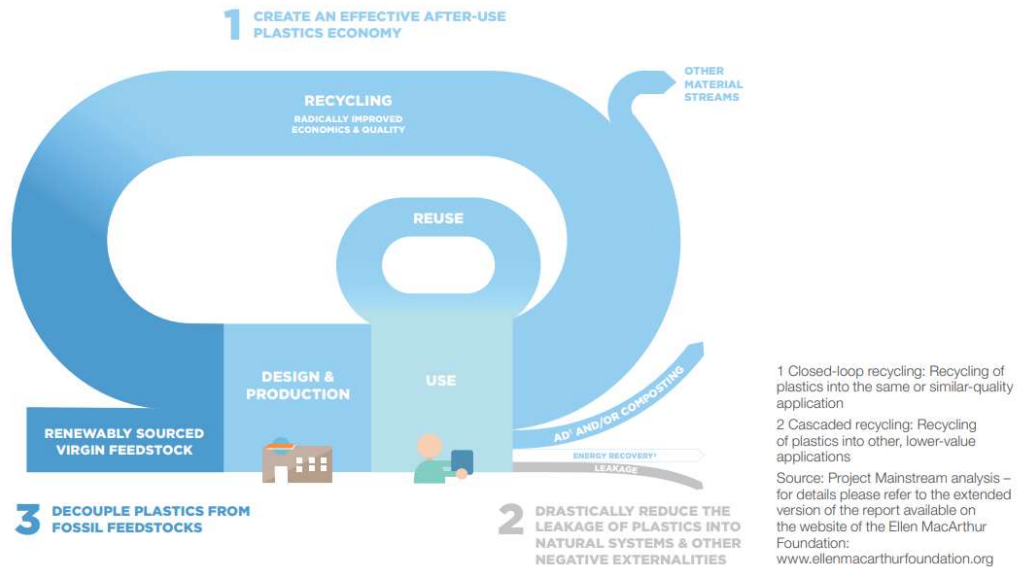
The ocean cleanup initiative has also come up with initiatives and has been actively involved in those initiatives in the cleanup of garbage patches.

The *Team Seas* campaign is widely credited with having funded the campaign through their goal of gathering 20 million US Dollars in 2021.

6.2 The G20 Member Initiative

The members of the G20, account for the production of about two-thirds of global plastic waste. With this in consideration, preventive measures for the mitigation of marine plastic pollution (MPP) have been one of the primary goals of the G20, since the expansion of the overall agenda of the association. The implementation of a circular

plastic economy that can sustain itself with a minimum toll on the environment has been sought.



(World Economic Forum, 2016)

The model of a circular plastic economy is as such as described in the report “*The New Plastics Economy*” by the World Economic Forum.

Here, the leakage of plastic into natural systems is theorized to be minimal, most of the produced plastic stays in the loop, thus the name, circular plastic economy. Such a system benefits not only the economy but also has a minimum effect on the environment.

RESULTS AND DISCUSSION

The following results can be obtained from the above report.

Plastic

The rise in the use of plastic in the last half century is substantial. Plastics have been able to provide great benefits and have led to many advancements in the modern world. However, their growing use also comes with a huge downside which is their equivalently substantial effect on the environment.

Plastics on the Environment

Different types of plastics are applicable in different industries and fields, and yet the most common aspect of all those plastics is the pollution they cause and the pollution that they can potentially cause if not handled well. At present, studies have shown that less than 10% of plastic waste that we produce ever gets recycled corresponding to an ever-growing quantity of waste.

Initiatives for Plastic Management

Many organizational initiatives have been taken in the last few decades and extensive research has also been done as to how effective plastic management can be done. Organizations like the Ocean Cleanup and Associations like the G20 have been putting in active efforts to rid the world of the problems of plastic. The problem at hand is still a huge issue and it is not going to resolve in a few years.

Long-term planning, for both the cleaning up of the waste that has been created and the mitigation of further degradation is necessary.

CONCLUSION

While plastics have undeniably contributed to advancements in various fields, their environmental footprint cannot be ignored. At present, the advancements led by plastic may be imperative for the technology being that has been developed and under development, however, if the management of plastic is not equivalently given attention then we might have more pressing issues to deal with. The findings of this report highlight the immediacy and urgency of a multi-faceted approach to the plastic crisis.

Only through collaborative efforts can we hope to overcome the challenges posed by plastic pollution and pave the way towards a more sustainable and eco-friendly future.

SUGGESTIONS FOR FURTHER RESEARCH

- The long-term ecological impact can be further deduced from historical data on pollution and degradation caused by plastic.
- The health implications of the plastic crisis on humans and life on earth can be analyzed.
- Alternatives to the form of plastic in present use can be studied.
- A study on the effectiveness of existing policies and legislation on reducing plastic waste and promoting sustainable practices can be done.

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