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Effects and Solutions of Single use Plastic

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Abstract: ***This paper provides an overview on the harmful effects of single use plastic on our environment and its larger impact, if it goes unchecked. It also highlights the solutions that are being worked upon with varying degree of success by governments and scientists from across the world and its benefits in future with an aim to bring new methods in order to substitute the materials of plastic that are harmful for humans. The paper further focuses on highlighting the global nature of this issue which cannot be treated as a local and an isolated issue by any nation as the environment is not restricted by borders and in order to achieve this feat, people's participation is inevitable for solving this global phenomenon.***

Keywords: Single use plastic, environment, non-recyclable

1. Introduction

The modern fast paced life where everyone wants things to be convenient and ready to use has compounded the single use plastic consumption across the world. This has now become a global issue threatening our ecosystem with dire consequences. Due to the change in people's pattern of consumption, production has led to a significant increase in the plastic waste and this waste is causing harm to our health and environment which thus emphasises the greater need to reduce plastic (Chow, 2017). It has been observed that more than one tonne of plastic is being produced for every person born since 1950 and only one-tenth of it has been recycled. Furthermore, half the amount of plastic used for packaging is used only once and then is discarded without recycling or is non-recyclable. This has resulted in environmental destruction, sickness and loss of livelihood (Williams, 2019). Covid-19 forced the world to resort to plastics in a big way taking us back in all initiatives and advances made during pre-pandemic times. The situation has only worsened with single use medical plastic waste becoming an even bigger environmental hazard. Most countries saw a disruption in their plastic reduction policies due to which now there is a dire need to reinforce plastic policies (Silva, 2020). Plastics degrade extremely slowly and hence stay in the environment for longer periods of time causing prolonged long-term damage. Moreover, this slow degradation of single use plastic involves a process which breaks into Microplastics and is consumed by marine animals resulting in their death (Dey, 2021). Studies have shown that the rampant use of single use plastic continues to raise the maximum alarm. This easy-to-use plastic is used by practically every individual across the world with varying frequencies; some even use them multiple times daily for reducing their household chores as they can be easily disposed of. There are no proper or perfect systems yet discovered for disposal of single use plastic. Some countries are making serious attempts to combat this problem. Some have completely banned the use of single use plastic while others are seeking support from corporates to handle this menace. Lately, a new measure of putting the accountability of recycling on companies that produce this plastic has been introduced by states like California in the US. The effect of all these measures can only be evaluated in the future. It is observed in a study that single use plastic usage can be reduced by levying taxes on people, for example, when a charge was to be paid by people in Buenos Aires City, the people tended to use their own bags but when not asked to pay they preferred to use single use plastic bags (Jakovcevic, 2014). Another way to curb this menace is to implement the policy of banning single use plastic as shown in a study wherein a single-use plastic ban would decrease plastic marine pollution in the EU by 5.5% which would be equivalent to 0.06% decrease globally, however, doing so would increase the marine toxicity in EU by 1.4% and this suggests that imposing a ban or premium on plastic in general would help to reduce plastic pollution (Herberz, 2020). Another viable solution is Plastic Pollution Prevention and Collection Technology Inventory in which technologies are organised to prevent plastic pollution by collecting plastic from water and also providing insight on combining technology, policymaking, advocacy to prevent further plastic pollution, and its subsequent damage to aquatic ecosystems and human health (Schmaltz, 2020). Thus, all those who are concerned about this issue realise and want people to understand that success to combat this problem will require their cooperation and action to change their personal habits and lifestyle.

1.1 Single use plastic: a crisis

What started off as a product to make our lives more comfortable is fast becoming a threat to our existence. Worryingly, plastic is a threat to our ecosystem right from its production stage, being a by-product of fossil fuel. The extraction of this plastic along with its production process generates massive amounts of greenhouse gases that have a detrimental impact on our environment and has become a major contributor to climate change. It is estimated that just the extraction of these fossil fuels, to create plastic, and their transportation to plastic factories emits 12.5 to 1.5 million metric tons of greenhouse gases(Vasarhelyi, 2021). Sadly, once disposed of they find their way into landfills and oceans. This not only impacts the marine and other wildlife, which is practically choking with plastic debris in some places, but also finds its way back into our food chain. While disposing them of in landfills and oceans, we forget that it takes approximately 1, 000 years for a plastic bag to degrade. Unfortunately, it NEVER degrades fully and in the process breaks down into Microplastics that seeps into the water, air, and earth affecting life. These microplastics contain dangerous chemicals and react with other environments, impacting all life including that of humans. Experts believe that the rising cases of hormonal imbalance, cancer and reproductive ailments could be attributed to this menace. According to UNEP our planet is facing

unprecendented pollution from plastic. Around the world, over 300 million tons of plastic is produced every single year, with approximately half of it being spent on producing single-use plastic. Worldwide, one million plastic bottles are purchased every minute, while up to five trillion plastic bags are used worldwide every year. In total, half of all plastic produced is designed for single-use purposes – used just once and then thrown away – and only 10 percent of the 7 billion tons of plastic is recycled (UNEP, 2018). The ironic part is that while experts believed that COVID 19 virus is a direct result of the disruption of natural habitat, they warned that climate change is likely to increase the risk of pandemics. The people during the pandemic witnessed considerable increase in single use plastic as they thought it was more medically hygienic to use it for personal and medical care. Moreover, use of disposable gloves, masks, PPE kits, syringes and other equipment forced governments to ease regulations regarding single use plastic making matters worse and taking us back in efforts to control this form of plastic.

1.2 Developed countries vs Developing countries

There has always been a tug of war between the developed and the developing countries regarding who should take the blame for the situation we are in and who should take greater responsibility for reversing the damage and committing to lead the change. The truth is that for decades developed Western countries shipped plastic waste, most of which was not recyclable to countries like Malaysia and Vietnam which allowed cheap dumping for landfills. With no viable alternatives, many of these plastics were burned or land filled. Others ended up in local waterways, many of which led to the sea. Now it is convenient to blame developing countries, but it is not entirely their fault. At the global level this problem must be resolved. Countries like India and China which are the leading users of plastic along with the USA, choose to accuse the USA of not doing enough but when confronted with their own contributions to plastic pollution, used the excuse of their own developmental goals for not making serious efforts. The UN's main challenge will be to address global disparities across developed and developing countries. The world bodies like the UN must ensure that this inequality between nations is addressed and every country is forced to take initiatives as this crisis is now a universal problem. Natural resources like water and air are not restricted by borders and pollution thus has become a global issue.
The statistics for every country producing plastic is shown.

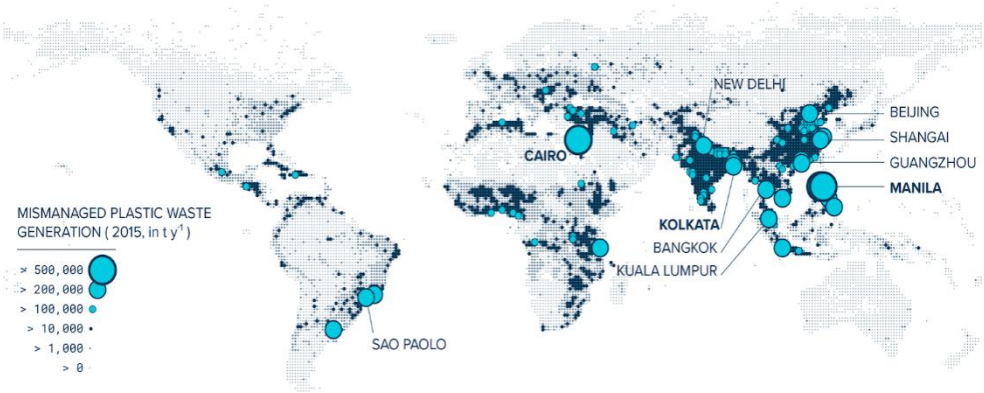

Figure 1: Mismanaged plastic generation

Figure 1 shows that every country is responsible for plastic pollution and instead of pointing fingers at other countries, every country should take responsibility for preventing plastic waste from increasing as it is a globally pressing problem. If plastic is not dealt with today, it can have adverse impacts in future. The figure below shows the predicted increase in marine plastic in the upcoming years.

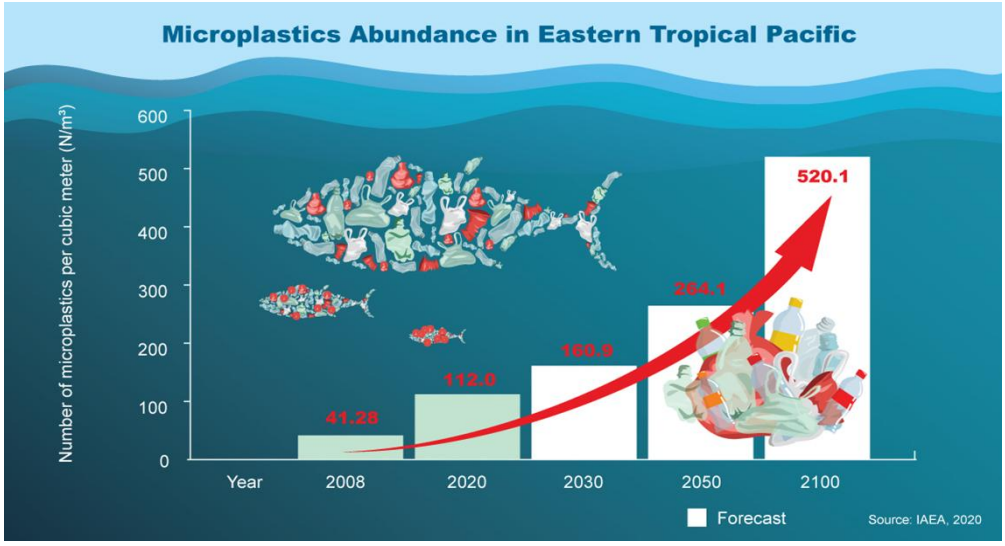

Figure 2: Shows the predicted increase in microplastic through the years.

Figure 2 shows clearly that if we continue to produce and consume single use plastic at the same rate, the resultant increase in microplastic would lead to endangering marine life. It is revealed by a study that the main types of microplastic consumed by marine animals are fibre and fragments, polypropylene, polyester and polyamide particles are under-estimated (de Sá, 2018)[8]. If a marine animal consumes this microplastic, it either dies and contaminates the water or ends up on our food plate. Since one animal eats another, the microplastic moves through the food chain. There is no escaping the cycle of nature.

1.3 Impact of covid-19

The COVID-19 pandemic caused a considerable spike in the consumption of single use plastic as governments were forced to ease existing regulations (if any) with regard to plastic usage. The increase was necessitated because of demand for personal protective equipment (PPE i.e., gloves, masks), single use medical equipment, disposable bottles and other take away cutlery etc. as people got increasingly nervous of the virus staying on surfaces.

It is estimated that the plastic waste generated worldwide since the outbreak is estimated at 1.6 million tonnes/day and approximately 3.4 billion single-use face masks/face shields were discarded daily, globally. "Our comprehensive data analysis does indicate that COVID-19 will reverse the momentum of years-long global battle to reduce plastic waste pollution" (Benson.N, 2021)[9]. According to a report published by the National Center for Biotechnology Information (NCBI), some countries like China saw an increase of nearly 350% in single use plastic. As the virus was deemed as extremely contagious with an ability to stay alive on surfaces, most of the hospital waste was destroyed under high temperatures and the residual ash was left in landfills which further raised the problem of microplastic. Countries like India had no formal guidelines for medical waste disposal which was then mixed with regular plastic waste in some of its cities. The table below shows plastic waste generated by different countries.

Table 1: Shows face masks discarded and plastic waste generated by different countries

Rank	Country	Estimated daily facemask discarded	Total estimated plastic waste (tonnes)
1	China	70, 23, 90, 002	10, 79, 49, 283.20
2	India	38, 64, 01, 228	10, 35, 00, 328.90
3	United States	21, 97, 85, 760	2, 48, 25, 198.80
4	Brazil	14, 02, 89, 215	1, 59, 41, 956.30
5	Indonesia	12, 25, 38, 579	2, 05, 14, 271.10
6	Japan	9, 30, 86, 675	94, 85, 734.58
7	Russia	8, 63, 93, 201	1, 09, 45, 084.70
8	Mexico	8, 12, 27, 634	96, 69, 956.48
9	Nigeria	7, 50, 34, 810	1, 54, 60, 469.20
10	Pakistan	6, 18, 49, 855	1, 65, 66, 925.50
11	Bangladesh	5, 13, 83, 087	1, 23, 51, 703.70
12	Turkey	5, 12, 78, 153	63, 25, 430.03
13	Iran	5, 10, 67, 713	62, 99, 471.18
14	Germany	5, 09, 40, 637	62, 83, 795.65
15	United Kingdom	4, 50, 76, 311	50, 91, 450.83
16	France	4, 28, 19, 423	48, 95, 513.33
17	Philippines	4, 12, 02, 485	82, 18, 580.85
18	South Korea	3, 36, 32, 585	38, 45, 188.88
19	Italy	3, 33, 74, 928	45, 34, 636.95
20	Argentina	3, 15, 24, 052	33, 89, 683.05

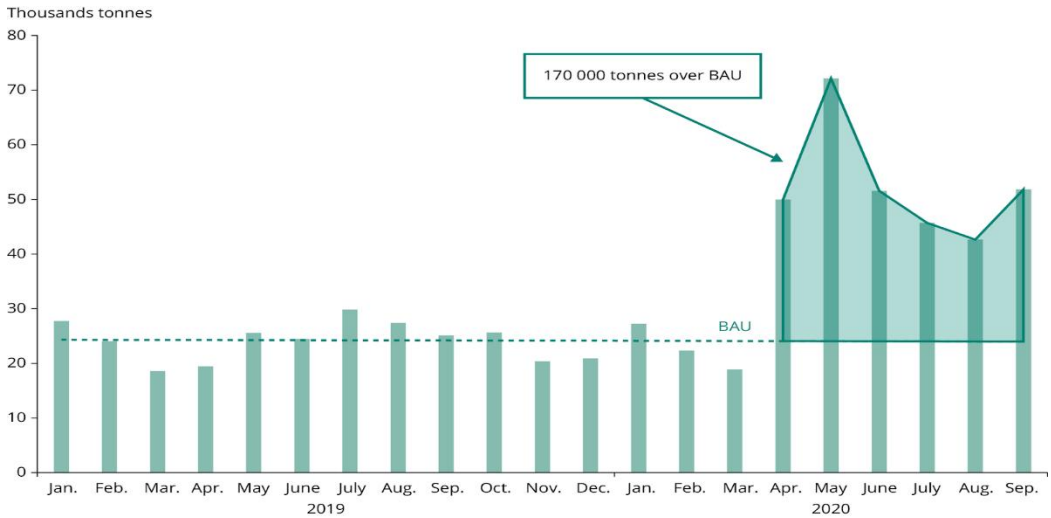

Figure 3: Face mask imports to 27 EU Member States from the rest of the world from January 2019 to September 2020

From this figure we can clearly see that the face mask imports alone increased to nearly 170, 000 tons over BAU. All this eventually will land up in landfills or will get dumped into the oceans. Therefore, now it is more imperative for us to control plastic waste by using plastic only when required and even increase our efforts to recycle what we manufacture..

1.4 Types of Plastic

To understand the effects of plastic, it is important for us to know which plastic is used at which place and its production rate so that we can implement certain policies and guidelines to control plastic and prevent the use of those substances and its alternatives, otherwise, they will get grouped together and no effective solution would be found. This would favour the plastic manufacturers as when plastic would not be

separated, no solution would be found to reduce different types of plastic which is why manufacturers would argue its benefits for industrial use.

Table 2: Shows name of plastic polymers, their production, and their uses[11]

Plastic Polymers	Name	Production (in million of tons)	Uses
PET	Polyethylene Terephthalate	33	Plastic drinks bottles, cooking oil bottles, peanut butter and salad dressing containers
HDPE	High Density Polyethylene	52	Detergent bottles, milk jugs, water pipes
PVC	Polyvinyl chloride	38	Plastic pipes, Outdoor furniture, shrink wrap, water bottles, salad dressing containers
LDPE	Low Density Polyethylene	64	Dry cleaning bag, produce bags, food storage containers
PP	Polypropylene	68	bottle caps, drinking straws, food tray, outer containers
PS	Polystyrene	25	packaging pellets, cups, food trays
Other	others	16	Additional plastic polymers not listed under 1-6 above, certain types of food containers including tupperware

From this table we can notice that Polypropylene is produced the most. So any plastic control initiative will only succeed if we reduce the consumption of items like bottle caps, drinking straws, food trays etc. which use this type of plastic. It is important that we understand the different types of plastic and then plan measures to reduce the ones which we can do so easily.

1.5 Solutions

There is not one single solution to a problem of this magnitude and hence we need to understand the various alternatives that can be worked on:

1.5 (a) Case in favour of Biodegradable plastic:-

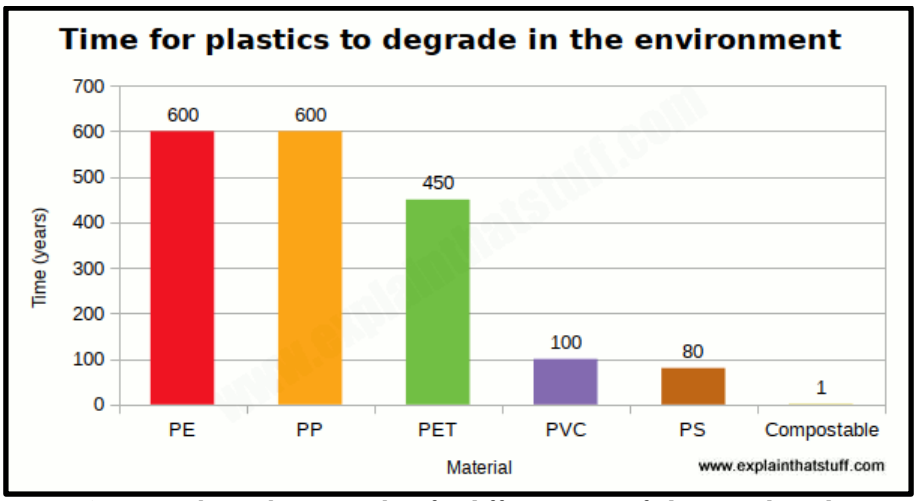

Figure 4: Shows the Time taken for different types of plastic to degrade

From this figure we can see that compostable or biodegradable plastic only takes about 1 year to degrade while other types of plastic take several years. Therefore, biodegradable plastic can be a viable solution to prevent excess plastic. A solution that I propose would be to convert plastic into pellets (a smaller and an environmentally friendly version of plastic) which can be converted to tiles and bricks. This would make the plastic hard and durable and can be used to make walkable paths in parks or malls which will sustain for more than 200 years and then could be recycled again.

1.5 (b) Governmental intervention to prevent plastic waste:

Governments across the world will have to set up stricter laws and other regulatory measures to compel people to give up or reduce the use of single use plastics as it has become an integral part of their lifestyle and very few people are intrinsically motivated. Governments have moved forward in this direction by adopting following measures in varying degrees:

- Imposing heavy fines on single use plastics and their disposal for personal usage. Buenos Aires has led by example by levying a surcharge and taxes on its usage (Jakovcevic, 2014). Denmark and Portugal have also seen significant success by imposing tax on plastic. Portugal saw a decrease of 74% plastic bag consumption.
- Encourage industries that produce biodegradable plastic by incentivising them with tax cuts and subsidies.
- Government can also assign the producers to look after the plastic waste through extended producer responsibility programs which would ensure the proper reusability and recoverability of plastic for its whole life cycle like in California where a recent law proposes to set up an exclusive organisation supported and composed of Industry representatives to establish recycling collection and processing units. The same organisation

will be required to keep aside over $500m a year for expanding on a new plastic pollution mitigation fund to conduct research on the environmental and health impacts of plastics and their solutions. In 2021, Maine became the first US State to introduce a revolutionary law to put the responsibility of packaging waste on companies creating an "extended producer responsibility" program. This means that companies will have to take responsibility for collecting and recycling cardboard boxes, plastic containers and other packaging materials as well as for disposing of non recyclable packaging. "This new law assures every Maine community that help with recycling and lowering the property tax burden is on the way, " the bill's sponsor, Rep. Nicole Grohoski (Sellers, 2021), said in a statement.

- Involving corporations to help set the trend. Corporate like Unilever have introduced measures to reduce their single use plastic while helping cities collect plastic waste for recycling in multiple countries like India, Vietnam, Indonesia etc. who have very poor infrastructure for waste disposal. They do this through direct investment and partnerships in waste gathering and recycling. In Indonesia, a country that has been used as a plastic dumping ground, Unilever set up a Google search app which allows residents to locate a waste bank closest to their location where they can dump their plastic waste for coupons that can be redeemed at their (Unilever) stores.
- Countries like India have experimented with building plastic roads. Scientist and chemistry professor Rajagopalan Vasudevan introduced the use of plastic as a binder for gravel and the country has made 6, 000 miles of road in the first trial (The guardian).
- In 2019, New York State banned polystyrene used to make non recyclable Styrofoam and disposable coffee cups.
- Washington DC banned the use of plastic straws in all restaurants.
- Two-island nations of St Kitts and Nevis started the "Plastics Be Gone" initiative as they felt that the single use of plastic is littering their prided beaches. They launched a "Plastic Free July" program to encourage residents to shun single use plastic for a month so as to inculcate a change in attitude towards the same by making them aware of the hazardous effects of climate change, which is severely affecting the island nations.
- The UK has also started imposing strict regulations by banning the sale of beauty and hygiene products that contain plastic microbeads, which on being used enter the sea through the city drainage.
- Kenya has a very strict ban on plastic usage and has strict enforcement with fines up to $40, 000 for lawbreakers using, selling or manufacturing plastic bags. It bans tourists from carrying plastic bottles, cups and other food packaging into their iconic wildlife sanctuaries as a respect to their national natural treasures.
- Bangladesh became the first country to ban plastic carrying bags in 2002, after devastating flooding of their cities caused primarily by clogging of the city drainage by plastic waste.

1.5 (C) Mechanical solutions to prevent plastic waste

- Scientists have designed reusable nano-sized reactors - called nanocoils - that can help in breaking down the microplastic that as discussed earlier cause the maximum harm to our environment. These nanocoils have the ability to convert 50 microplastics to carbon dioxide and water (PBS).
- Scientists from the United Kingdom, the Kingdom of Saudi Arabia, and China have collaborated to develop a novel catalytic method for converting plastic waste to clean fuel and high-value solid carbon.
- Using natural materials instead of plastic waste like Jute, flax and hemp that are biodegradable will be good alternatives to plastic and should be encouraged by all governments across the world.
- Incineration is also used to burn plastic and is useful to reduce plastic such as polyolefins which is a source to generate fuel. A consortium of petrochemical and consumer-goods companies called the Alliance to End Plastic Waste, including Exxon, Dow, Total, Shell, Chevron Phillips, and Procter & Gamble, are committed to spending $1.5 billion over a period of five years to promote technologies that convert plastic to fuel or energy. Though some scientists have criticised funding to make these plants more sophisticated, setting up of the plants would ensure minimising the impact of plastic on the environment. According to the World Energy Council, a U.N. accredited network that represents a range of energy sources and technologies, the waste-to-energy sector is likely to witness steady growth in coming years, especially in the Asia Pacific region. China already has some 300 waste-to-energy plants operating.
- Another option called pyrolysis in which plastics are minced and melted at lower temperatures though intense heat with less oxygen, break down plastic polymers into hydrocarbons that can be used in diesel fuel.
- Using rubber latex as an alternative is also being explored on a war footing.
- Biodegradable plastic should be used imperatively as it is environmentally friendly.
- Plant-based hydro-biodegradable plastic, including polylactic acid (PLA), which decomposes into water and carbon dioxide a lot more easily at high temperatures, may be another good alternative.

Single use plastic is impacting our environment by entering the waterways and killing marine animals. It is being produced at an alarming rate by manufacturers and very little is being done to control it. The marine animals which have consumed the microplastic enter our plate leading to health problems. If we do not take action now, the plastic would multiply by four times the amount it is today. Governments are striving tirelessly to reduce plastic by imposing taxes, implementing programs to bestow responsibilities on the producers to recycle single use plastic and organising campaigns like 'Plastic Free July' to reduce single use plastic. Methods are also being used to convert plastic to fuel, water and carbon dioxide. Single use plastic is also being converted to tiles to make it reusable. The governments and scientists across the world are trying their best to reduce the impact and effect of single use plastic in

the society through these series of steps but it would only be able to achieve this feat if people are intrinsically motivated to make this change. These steps though could take time and might not be easy to implement but would go a long way in helping our ecosystem.

2. Conclusion

Single use plastic is a menace to society. It has created a cascading problem for the environment by posing threat to marine animals which die and enter our food system causing serious ailments, hormone-related cancers, infertility and neuro-developmental disorders like ADHD and autism. Governments and scientists are grappling to find solutions to the problem of single use plastic but no major change can happen unless people change their attitude towards its use and its harmful effects on their lives. It's like any pandemic. Let's take the example of COVID 19. Imagine a situation where people would continue to live life normally, not maintain social distancing and refuse to wear masks or take vaccinations and then expect the Government and the medical teams to resolve the crisis. The problem of single use plastic is comparable to a pandemic threatening to destroy our ecosystem. With this crisis pressing ever more than before we have to look at better ways to solve this problem and this paper provides the solutions for the same.

In order to combat this problem media attention and campaigning can be undertaken to increase the public visibility of an issue. The media should treat it like a pandemic. As during the times of COVID 19 pandemic we had data of all cases of countries being flashed across the media which helped highlight the magnitude of the problem. It was being discussed on an hourly basis and news channels were focusing on solutions and question answer sessions with experts to make people aware of the problem. Single use plastics is also to be dealt with in the same manner as being a slow poison, it is corroding our environment bit by bit and hour by hour and despite repeated warnings enough is not being done. Now faced with this alarming situation, measures have to be taken by the Governments to enforce stricter policies and taxes and while doing so they can also incentivise companies aiding to reduce single use plastics. Further, extended producer responsibility programs (EPR) would ensure the proper reusability and recoverability of plastic for its whole life cycle. Mechanical solutions like converting plastic to fuel can have a significant impact in reducing plastic. Microplastic which can be converted to carbon dioxide and water by the help of nano-sized reactors is also a viable solution. Using alternatives like Jute and flax can reduce the harmful effect of single use plastics as well.
Countries across the world are coming together as one to tackle this glaring problem. India have experimented with building plastic roads, New York State has banned polystyrene used to make non recyclable Styrofoam and disposable coffee cups, Washington DC has banned the use of plastic straws in all restaurants. This shows that if we show the determination to make the change, we can. These initiatives would have had an impact on the behaviour of the people also as they would see how hard someone is working to prevent single use plastic and inventing other alternatives of creating and using recyclable materials, and on seeing this a lot of people would have made a change in their behaviour too. Involvement of the local community members is another facet as to how collective efforts can make a big difference and drive the change by encouraging people to adapt to use recyclable plastic. Now a lot of cities across the world are adopting these varied models and have helped avoid millions of single use plastic bags from going into landfills and oceans. It not only helped the environment but brought community members closer. These initiatives undertaken by countries have shown that when the community gets involved as a group then people are both inspired and forced to make the change, or they feel left out.

A sense of participation has to be instilled in every individual to countenance this universal phenomenon. In environmental problems, most people feel that a small change by them is not good enough and is not going to make a difference. A lot must be done to change this attitude. The corporates and small businesses should take pride in being the change makers rather than seeing the change as harmful for their businesses. They should talk about their concern and revolutionise people to realise this glaring problem of plastic and bring a change. Governments should invest in encouraging businesses that use single use plastic by giving them financial incentives that can be passed on to the customer. For e.g. grocery stores can give a financial incentive to people carrying their own reusable bags. This is not always possible if grocery stores pay from their pockets for the plastic bag. Instead of having their advertisement hoardings, top brands should be encouraged to make the environment a cause and a fashion statement that will make people think of giving up single use plastic as being trendy and hip. This is where help can be given by brands and governments collectively to make this change surreal. This paper provides suggestive steps that can help reduce single use plastic and make our environment greener and safer.

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[19] Table 1: Benson, N., Bassey, D., & Palanisami, T. (2021). COVID pollution: impact of COVID-19 pandemic on global plastic waste footprint, 7(2).
[20] Table 2: (2010). INTRODUCTION TO ZIEGLER-NATTA POLYMERIZATION 1.1 INTRODUCTION TO POLYOLEFINS Classical polymers such as polyethylene, polypropylene and polystyrene are of great interest for science and industry. Polyolefins are today among the most important commodity polymers. Due to the discovery of Ziegler-Natta.