Artificial Intelligence as an Aid: Regulating Plastic and Microplastic Pollution

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Abstract. This comprehensive article delves into the pressing issue of plastic and microplastic pollution, a global environmental crisis that has severe implications for human and marine life. The focus is on India, a major contributor to plastic waste, and the legal measures it has taken to manage and mitigate this issue. The article critically examines the effectiveness of initiatives such as the Swachh Bharat Abhiyan, legislation on plastic waste management, and the implementation of extended producer responsibility. It also highlights the health hazards posed by plastic pollution, particularly in densely populated slum areas. Furthermore, the article explores the global perspective on plastic pollution, emphasizing the need for international cooperation and stringent regulations. The latter part of the article introduces the potential of artificial intelligence (AI) as a tool to combat plastic pollution. It discusses how AI can aid in monitoring, detecting, analyzing, and ultimately reducing plastic and microplastic pollution, thereby supporting human efforts to address this environmental catastrophe while safeguarding human rights. The article argues for the integration of AI in environmental strategies, underscoring its potential to revolutionize the way we approach and handle plastic pollution.

Keywords: Microplastic Pollution, Swachh Bharat Abhiyan, Extended Producer Responsibility, Health Hazards, Artificial Intelligence and Environmental Strategies.

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1 Introduction

"On a highway to hell with our foot on the accelerator."

-UN secretary-general António Guterres, COP 27

Let's take a step back and look around us. Most of the things that are lying around us are made out of plastic or at least have some implementation of plastic-based components in it, including the device on which you are reading it right now. In the current world, it's almost impossible to imagine a world without plastic. By the time it will take you to read this article about 8 million single-use plastic bottles will be discarded. (Earth Day Organization, 2022) Almost every industry, firms or businesses in general have plastic as an integral part of their product, supply chain, and customer interaction.

According to a 2017 study on plastic pollution, there are around 8.3 billion tons of plastic waste swirling around the pool of pollution (Roland Geyer, 2017), outraging the modesty of nature in every way possible. That is, if we combine all this plastic and make one huge plastic bag, it will be able to encompass the whole earth in it. Around 76% of plastic ends up as waste and around 50% end up being used only once. (Roland Geyer, 2017) These are the numbers that should merit our attention on the pollution created due to plastic.

The worst part is that a "veneer of objectivity" around the productive use of plastic and our ignorance towards its harmful impact has led us to impact not just human life but also marine life, right now 100% microplastic pollution can be found in water samples and marine organism, 150-500 micrometre size of microplastic being the most dominant ones1 (Alfaro-Núñez, 2021). And it's going to get even worse thanks to those who hewn from the "crooked timber of humanity."

The first part of this article will deal with the legal framework for the regulation of plastic pollution in India, the second part of the paper will further delve into a global perspective and lastly, it will provide the readers with a nuanced understanding of how AI can help the world win the war against plastic pollution.

2 Plastic pollution in India and its regulation

According to a CPCB (Central Pollution Control Board) report on plastic waste, India alone is responsible for producing 3.5 million tonnes of plastic garbage annually out of the 8.3 billion tonnes of plastic that are now used worldwide. (CPCB, 2021) With 26.33 million plastics produced as of 2016 and a ranking of second among the nations

with the biggest amount of plastic garbage dumped into the ocean, India trails only America in terms of the world's plastic production. (World Population Review, 2022) Maharastra and Tamil Nadu are the top two states for plastic production among India's 35 states and union territories, according to the CPCB data for the 2019–20 year. (CPCB, 2021) Humans are exposed to plastic throughout their entire lifecycle through inhalation, digestion, direct skin contact, etc. Direct exposure to this can have negative effects on human health, including cancer, diabetes, and reproductive, and developmental toxicity. It affects the cardiovascular, renal, gastrointestinal, neurological, reproductive, and respiratory systems as well, as per the CIEL report on Plastic and health. (Centre for International Environmental Law, 2019) Over 100 million people in India live in slums (The Indian Express, 2022) and are exposed to all kinds of pollution possible, which has led to 2.3 million premature pollution-related deaths per year (Global Alliance on Health and Pollution, 2019). To mitigate plastic pollution India has taken many steps such as introducing Swachh Bahart Abiyan, legislation on plastic waste management and extended producer responsibility, ban on certain varieties of plastics etc.

The high court in the case of All India Plastic Industries Association Vs. The government of NCT of Delhi Department of Forests and Wildlife (All India Plastic Industries Association Vs. Government of NCT of Delhi Department of Forests and Wildlife, 2009) issued the following directions in 2009, "The respondents The government of the National Capital Territory of Delhi shall issue a proper notification setting the minimum thickness of plastic bags at 40 microns in place of the 20 microns currently required; shall take immediate action to close unlicensed recycling units operating from non-conforming areas by using questionable practises for recycling plastic bags; shall issue a proper notification prohibiting the use of plastic bags in major markets and local shopping centres aside from hotels, hospitals, and other institutions of higher learning." Further, to reduce plastic pollution and to promote the reusing of plastic MoEFC as of 30th September 2021, increased the size of plastic carry bags from 50 to 75 microns and again increased it to 120 microns as of 31st December 2022 (Ministry of Environment, Forest and Climate change, 2022).

It also banned certain plastic products such as earbuds with plastic sticks, plastic sticks for balloons, plastic flags, thermocol for decoration etc. (Ministry of Environment, Forest and Climate Change, 2022) According to the 2016 Plastic Waste Management Rules, the plastic packaging waste that is not covered by the phase-out of specific single-use plastic items must be collected and managed in a way that is environmentally sustainable under the Extended Producer Responsibility of the “Producer, Importer, and Brand Owner” (PIBO). The Plastic Waste Management Amendment Rules, 2021, have given legal force to the Extended Producer Responsibility Guidelines that have been released to execute Extended Producer Responsibility effectively. (Ministry of Environment, Forest and Climate Change, 2022) Although India may have robust environmental rules and regulations, their practical application has not yet been determined.

3 A global perspective: Regulating the plastic waste

Is the ocean made out of plastic? The obvious response is no, but given that 11 million metric tons (Winnie W.Y. Lau, 2020) of plastic have entered the ocean and that there is 1.6 million km2 of plastic floating around in the Pacific Ocean, or the Great Pacific Garbage Patch (Lebreton, 2018) , the answer to the aforementioned question may become "yes" very shortly. To resolve this issue or at least to delay the problems caused by plastic pollution many different conventions, NGOs, scientists, corporations etc. have suggested various ways. Promoting the use of bioplastic instead of fossil fuel-based plastic is one of them. However, according to a paper published in Yale Environmental Law Journal, the idea that bioplastic materials can just be discarded and will just decompose and disappear is untrue. Most of the bioplastic gets thrown down in landfills and without enough oxygen present in that environment, they can last for years and release methane, a potent greenhouse gas, which makes them no different than PET plastics. (Robbins, 2020) So just introducing alternatives to plastic is not enough, a diligent waste disposal mechanism is also the need of the hour. According to the PEW report called “Breaking the plastic wave” a large $600 billion revamp of the global plastic system that reuses and recycles plastic in a circular economy, together with other, smaller-scale reforms, including bioplastics, is the only way to address this growing issue. The Pew report claims that if its recommendations are implemented, plastic waste may be cut by 80% over the following two decades (The Pew Charitable Trust, 2020).

Further, on 2nd March 2022, the UNEA adopted a resolution to end plastic pollution where it called upon the member states to adopt circular economy approaches, develop and implement national action plans, and foster international action and initiatives under the national regulatory framework. (UNEA, 2022) Instead of placing the entire onus of plastic recycling and reuse on the government, UNEP also requires that its member nations implement Extended Producer Responsibility policies, which call for the manufacturers of plastic items to take the initiative in recycling and reuse. According to the UNEP study on "legal limits to the use of plastic and microplastic," (UNEP, 2018) the Extended Producer Responsibility, which includes policies like product take-back programmes, deposit refunds, and garbage collection, has been adopted by 63 nations as of right now.

4 AI's role in transforming the circular economy of plastic waste

"If we have ignorance we should use machine learning to fill in the gaps where the ignorance resides."

Edward Ott (Wolchover, 2018)

Away from eyes away from mind, is the global attitude towards plastic pollution. And by now it's explicitly clear that plastic pollution is way out of our hands and is chaotic. This Chaotic mess cannot be just controlled by humans setting up resolutions and treaties alone, effective actions need to be taken. So, thank god now the robots are here to help. Predictive analysis is the core of AI enterprises, as per the article published in Quanta magazine (Wolchover, 2018), the evolution of data systems now allows us to tame the chaos, which is much needed in terms of plastic pollution. As per the data analysed by a scientific journal, "data reveals that based on different types of plastics about 40–48% of annually produced plastics are non-recyclable. About 19–30% are potentially recyclable and nearly 20–27% fall under the complex or unknown category." (Chidepatil A, 2020) Additionally, the term "possibly recyclable" only refers to materials that may be recycled, depending on how they are treated after their useful lives.

Further, the aforementioned paper suggests the use of "Block Chain Smart contracts powered by multi-sensor artificial intelligence." The blockchain smart contract provides the platform to connect the plastic segregators to potential buyers. The information transacted through it typically contains information such as offer and bidding prices, supply & demand, and specification (quality). All this information is stored in a distributed blockchain ledger which allows security and transparency to the process. There are two types of smart contracts based on the stage of the raw material, the first type, is between the supplier of segregated plastic waste and the potential buyer (typically a recycler). The second type of contract is between the supplier of the recycled goods and the manufacturers. It further allows them to do efficient planning of supply chain operations and cash flow.

In terms of segregating plastic waste, the multi-sensor data fusion with the neural network helps in identifying different types of plastic and segregating them. "High-definition optical sensors are used to gather information about the object's shape, colour, and texture (cameras). For instance, it will allow the segregators to segregate specific shaped or coloured plastic bottles using this. Plastics' light absorption spectroscopy revealed new opportunities for optical sensing, especially in the 300 to 3000 nanometer [nm] wavelength region." Further, the use of different types of sensors such as visual (VIS), near-infrared (NIR), and far-infrared (FIR) sensors can also differentiate plastic when they are comingled among each other. So, this makes the herculean task way more efficient and accurate.

In addition, research released by NFSU, Gujrat, suggests using AI-powered tech by supervised and unsupervised machine learning to detect and categorise microplastics in a given sample to address the problem of microplastic pollution. (Hemen Dave, 2022) Even though there is no viable solution to microplastic pollution available a ray of hope lies in the Petri dishes of two American Universities. The development of microscopic "living robots" called Xenobots, which are produced from the cells of the "African clawed frog Xenopus laevis," may aid in the removal of microplastic waste from the ocean. (Sam Kriegman, 2020) These AI-designed organisms can be programmed to do the desired functions and the transferable design is further used to create living systems with predicted behaviours. Because xenobots are neither regular robots nor fully developed living things, the ethical discussion around their employment is tricky.

Other than the aforementioned solutions to fight plastic pollution, systems like *"autonomous waste collection, optimized packaged designing, discovering new waste disposal methods, reducing manufacturer waste"* (Amos, 2022) are also in the process.

5 Conclusion

In this paper, an attempt has been made to emphasize the commonly ignored plastic pollution issue. It describes how our society has recklessly polluted not just the human society but also the animal world. The first part of this paper focused on pointing out the sheer scale of plastic pollution and the repercussions we are facing because of it. Further, it discussed some of the provisions and regulations that are now in action to slow down plastic pollution, with an emphasis on reusing and recycling plastic waste instead of just creating alternatives. Lastly, it provides a viable solution to the silent chaos caused by plastic pollution by bringing artificial intelligence and machine learning into the picture. The purpose of this paper is to increase awareness and act as a ray of hope for the never-ending problem of plastic pollution.

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