

A Deep Dive into the Effectiveness of Recycling

Introduction:

The rise in popularity of recycling campaigns marked a significant shift in the relationship between Americans and their waste. Recycling became a widely accepted practice as it was marketed as a minimal lifestyle change that can make a positive impact on the earth's health. The reality is most Americans are unaware that their consumption and recycling habits are not adding up. Why is it easier to just assume an item will get recycled instead of minimizing consumption? Social psychologist Leon Festinger¹ identified two major factors that allow people to cling to false beliefs: the initial commitment to the idea and social support from external forces to maintain belief in that concept. It is easy to align with strong beliefs, even if the data has shown the truth to be false. Families will continue to buy single-use plastic water bottles in bulk with the mindset that their plastic waste will be recycled as long as it's placed in the blue bin. The reality is less than 10% of plastic waste is actually recycled and one of the largest reasons is economic impacts or losses from recycling, a very energy and cost-intensive process. The lack of transparency between the public and scientific consensus on plastics reveals the gaps in literature and research on plastics and the potential health impacts of microplastics as they become more prevalent in our atmosphere and food/water systems. This paper looks to clarify recycling technology processes, analyze the true effectiveness of recycling practices such as mechanical and chemical recycling, and visit how microplastics are framed in popular news outlets and their impact on human health.

Expectations vs Reality: The Public's Perception of Recycling:

In a study published by the Pew Research Center, a collection of surveys was introduced as evidence for the likeliness of the average American incorporating recycling into their lifestyle. 60% of adults who strongly encourage recycling to live in communities with more recycling options and either have curbside recycling or a recycling drop-off center. This stat shows that societal norms play a significant part in whether people will adopt recycling into their lifestyle or not; 28% of Americans actually admitted to having strong reuse and recycling habits due to their local community's push for recycling. The data also shows that people who live in areas that strongly encourage recycling were more likely in the survey to say that most types of items can be recycled. 59% of Americans and 81% of Americans from the 'strongly encourage recycling' group believe that most of their waste can be recycled. However, the Environmental Protection Agency estimated that only 27% of municipal waste was actually recycled or composed, based on data collected in 2013². The reality is a majority of Americans are completely unaware or have little idea of where their recycling is going and how much energy it takes to sort and process that waste. The first chapter of the scientific journal *Plastic Waste and Recycling*:

Introduction to Plastic Waste and Recycling, discusses the difficulty in spreading the different types of plastic most commonly used in single-use food/beverage packaging: PET (polyethylene terephthalate), HDPE (high-density polyethylene), PVC (polyvinyl chloride), LDPE (low-density polyethylene), PP (polypropylene), and PS (polystyrene)³. The plastic type of single-use item used can be identified on the packaging labeled with numbers 1-6 relative to the list mentioned prior. Plastic that is collected is organized by polymer type with tougher plastics being #4-#6 (LDPE, PP, and PS) not easily recycled. The sorted plastic is then shredded, washed, melted, and pelletized before being made into new products.

Recycling Technologies and a Glimpse into Life Cycle Assessment of Plastic Waste:

Why is recycling an industry lacking in general? Every product that gets sent to recycling facilities to be recycled loses value; the high energy, labor, and financial costs to recycle single-use plastics are what create such little incentive to improve current recycling models. The research paper, *Life Cycle Energy Comparison of Different Polymer Recycling Processes*, seeks to compare the efficiencies of plastic recycling technologies, with results that seek to quantify environmental benefits and cumulative energy use from recycling. In this study, five polymer-recycling processes were examined to create a uniform quantitative comparison of 1 kg PET bottles (100 single serving 0.5 L water bottles). Processes described in this study include direct use, 100% mechanical recycled content, depolymerization, and repolymerization of new resin and 100% to bottles, reclaiming energy value, and landfill⁴. It looks at the energy required from start to finish, from collecting and transporting the used plastics, to breaking them down, and finally, producing new plastic products. The goal is to determine which process uses the least amount of energy and therefore has the smallest carbon footprint. The conclusion is that the most energy-efficient method of recycling polymers is mechanical recycling, which involves melting down used plastics and reusing the resulting material. Chemical recycling, on the other hand, involves breaking down the plastic into its chemical building blocks and then using those blocks to create new plastic products. While this process can theoretically lead to a lower carbon footprint, the current technology for chemical recycling is still in its early stages and is often less energy-efficient than mechanical recycling. Science journalist RP Siegel is a strong advocate for chemical recycling technology claiming it to be "...a promising way to turn used products into new ones with a minimum of waste,"⁵. However, chemical recycling technology involves decomposing plastic to its basic components and down to even simpler compounds. This process transforms these compounds into a 'virgin plastic', one that is practically brand new. This process is more energy intensive than mechanical and can contribute more greenhouse gas emissions than its counterpart. The question that arises is if this technology is worth investing in, Siegel argues that unlike mechanical recycling, chemical recycling "...adds value to the waste rather than downgrading it," comparing the process to the likeness of alchemists turning lead into gold.

The General Consensus, Public Health, and Media Framing of Microplastics:

A recent survey conducted by YouGov in 2019 found that only 52% of Americans know the existence of microplastics. Despite this lack of knowledge, the most common action communicated by Americans to combat this issue was recycling, with 30% saying they would

now avoid buying food in single-use plastic packaging and drinks in single-use plastic bottles⁶. As highlighted by the findings from the Pew Research Center², societal pressures have a significant role in how Americans communicate their recycling habits; there may be a response bias in the YouGov survey due to a higher percentage of people stating they will avoid single-use plastic packaging. Sense of guilt aside, what other consequences of single-use plastic should Americans also be considering? According to the research study "On the Creation of Risk: Framing of Microplastics Risks in Science and Media," research on the impacts of plastic pollution on health is still in its early stages and has many unanswered questions and knowledge gaps. However, popular news sources such as The Huffington Post and The Guardian have framed microplastics as a risk to human health, implying that there is a high likelihood of harmful consequences from microplastics in the atmosphere, water, and food systems. This approach, "unsafe until proven safe," has triggered public concern, even though the scientific literature frames the risk of microplastics as hypothetical. The uncertainty surrounding the risk of microplastics on health has become a reality, highlighting the possibility of negative consequences and triggering societal and political actions, such as the ban on microbeads in rinse-off cosmetics and single-use plastic bags in some countries. However, the most common source of synthetic microplastics is synthetic textiles, such as polyester, but only 13% of Americans reported that they had stopped wearing and buying clothing made from this material. The fashion industry has been criticized for encouraging excessive consumerism, as people are buying 60% more clothes than they did 15 years ago, and using them less frequently, as evidenced by a report from McKinsey and Co. 45% of textile waste from the US alone gets exported to developing countries. Microplastics can end up in water systems through washing and drying these clothes, water consumption aside, there is likely an abundance of microplastics with every load of laundry the average American goes through. A relevant report by the National University of Ireland even found that 73% of deep-water fish in the northwest Atlantic have microplastics in their guts, further emphasizing the potential harm to our environment and health⁷. What research on the health impacts of microplastics currently looks like can be shown in the journal *Plastic and Microplastic in the Environment: Management and Health Risks: Microplastics in the Air and Their Associated Health Impacts*. The study finds that Microplastics in the air (MPs) can have serious health impacts on humans through inhalation and indirectly through the food chain. MPs were found to carry harmful chemicals and microbial contamination, leading to oxidative stress, cytotoxicity, immune function interference, neurotoxicity, and translocation to distant body tissues. They can also cause chronic inflammation and increase the risk of cancer. MPs can contain harmful contaminants such as bisphenol A (BPA) and phthalates, which are endocrine disruptors and can interfere with hormones, affecting the reproductive system, liver function, and brain function. Studies have also linked exposure to MPs with cancers, weakened immune systems, oxidative stress, and DNA damage. The translocation of MPs in the body has been confirmed in both test animals and humans. The possibility of microplastics is a significant threat to human health and has been detected in various areas including remote regions. The most common MP shape found in the atmosphere is fibers and fragments. Although research on atmospheric MPs is still in its early stages, further studies are needed for the development of sampling and characterization standards, to understand their sources and the risks associated with human exposure.

Conclusion:

In conclusion, recycling has become a widely accepted practice, with many people assuming that their waste will be recycled. However, the truth is that only a small portion of

plastic waste is actually recycled due to the high energy and financial costs associated with the process. Research has shown that the most energy-efficient method of recycling is mechanical recycling, where the plastic is melted down and reused as a material. Chemical recycling, while promising, is still in its early stages and requires further improvement in technology to be more energy-efficient. As shown in the Pew Research Center study, the perception of recycling among the American public is influenced by societal norms and a lack of awareness of the actual recycling process and its limitations. There is a need for greater transparency and education to bridge the gap between public perception and the realities of recycling technology.

Documentaries such as *Plastic China*⁸ bring to light the environmental degradation that the general public rarely sees. Films such as *Plastic China* shows the devastating effects of pollution, as well as the government's censorship and lack of action to address plastic accumulation and how it is impacting the health and well-being of China's marginalized groups. Cinematographer Wang Jiuliang was inspired to make this documentary after seeing the devastation to the landscapes of his village in the Shandong Province; "I spent my childhood summers catching locusts and fish. Now, where are they? Are there still tadpoles and frogs in the creek?"⁸ Wealthy and developed countries such as Japan, the United States, and Germany have been exporting their waste to underdeveloped countries, which exacerbates the blatant inequity in commonly adopted and neglectful waste management practices. In recent years, the textile and fashion industry has embraced the principles of upcycling and recycling as a means of promoting sustainability, which includes recycling, reuse, redesign, and repair. These practices not only help protect the environment by saving water and reducing waste and pollution but also play a role in reducing greenhouse gas emissions, which are major contributors to global warming. To address these challenges, market research, and awareness-raising efforts by academicians can play a vital role in promoting sustainable practices in the fashion industry.

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