The Global Crisis of the E-waste Tsunami

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INTRODUCTION

It has become more apparent throughout the years that electronics are not a choice but a necessity. Because manufacturers frequently update electronic devices with newer technology, the predecessors often have shorter lifespans and are commonly left to waste [2]. Many discard electronics without much consideration [4]. Reports from the United Nations [9] documenting electronic waste (e-waste) find that the land it will take will be more significant in the coming decade as the world produces 40 million metric tons yearly. An increase in e-waste could mean more contamination from landfills, the spread of disease-inducing toxins, and less general land for those to live in [5]. As the world faces the looming challenge of the "e-waste tsunami," [9] exploring ways to reuse or redesign electronics for more prolonged consumer use becomes increasingly vital.

This report examines the various challenges and potential solutions associated with e-waste. It begins by assessing the feasibility of recycling e-waste, focusing on material recovery, economic viability, and environmental impact. The report then explores the effects of device obsolescence, which is caused by both corporate practices and consumer behaviors, on the generation of e-waste. Additionally, it addresses the issues related to non-recyclable components, examining their limitations and reduction strategies. Finally, the report offers a forward-looking perspective, exploring future solutions such as modular design innovations, legislative advancements, and evolving institutional strategies for effective e-waste management.

FINDINGS

The E-waste Tsunami Problem

The United Nations [7] estimates that 53.6 million metric tons of e-waste was generated globally in 2019, 21 percent higher since 2014. This volume surpasses the combined weight of all adults in Europe, averaging 7.2kg of waste per adult [2]. On top of e-waste causing the acceleration of climate change and the endangerment of the environment and human life, it also significantly wastes resources that are commonly utilized but are not recycled [9]. E-waste contains roughly $57 billion of valuable minerals such as gold, copper, and iron [7]. China is the most significant contributor to e-waste, with the United States coming in second [9]. These two countries are also guilty of incorrectly recycling their e-waste [5]. For instance, Basel Action Network (BAN), a non-profit group that tracks discarded devices when handing them to be disposed of by recycling facilities, found that much of the waste disposed of was shipped to places in Asia, such as Hong Kong and eventually thrown into a landfill with other discarded electronics [5]. Additionally, in 2001, Guiyu, China, was found to be a hotspot for e-waste dumping and had many electronics containing lethal amounts of lead that were exposed to the children living within the area. This information is concerning since the expected global e-wase will almost double the 2014 level amount by 2030 [7]. Considering the severity of these alarming findings, it is crucial to take prompt action and promote extensive awareness to alleviate the upcoming e-waste emergency.

Feasibility of Recycling

Material Recovery and Resource Value

The United States Environmental Protection Agency (EPA) [6] considers e-waste a subset of reusable or recyclable electronics that can reduce waste in landfills in the U.S. and abroad. There are often two types of categorized electronics: high-value and low-value electronics. High-value electronics, such as smartphones, medical devices, and computers, are highly profitable. In contrast, low-value electronics, like microwaves, lamps, and radios, are cheaply replaceable appliances with less valuable materials. Metals in high-level e-waste are much more abundant than those in mining, garnering value in the reusability of high-value waste [6]. According to Stanford Ph.D. researcher Elaine Lui [6], recovering the gold from the central processing units (CPUs) of an estimated 100 million unused computers in the United States could yield 45,000 kilograms of gold and reduce carbon emissions by 740,000 tons. Understanding this information underlines the value of harnessing materials within electronics commonly thrown to waste.

Economic Viability and Environmental Impact

Despite the potential resourcefulness and environmental benefits of extracting valuable materials from e-waste, it is difficult to implement solutions at a low cost and large scale. This issue mainly comes from the safety concerns of handling high lead-traced electronics [5] and the strict consolidation of components, making it difficult to take apart [4]. Properly recycling e-waste through extraction is not aided by the fact that exporting e-waste is much cheaper than processing it domestically. For instance, the EPA commissioned a study [6] in Italy in which they found that it cost $64,000 to process and dispose of 15,000 tonnes of e-waste legally but only $5,000 when shipping that same amount in Asia. In terms of low-value e-waste, the devices have significantly fewer precious metals, making them worth recycling and a better option to dispose of in landfills elsewhere [6]. The economic reality of handling e-waste emphasizes the need for innovative solutions to make e-waste recycling environmentally and financially viable.

Impact of Device Obsolescence

Corporate Strategies and Contribution

may have noticed that their newer devices are not as long-lasting as some of their older devices; however, that could be by design. Over the years, newer devices have been cut shorter in their lifespan and performance [9]. One of the largest consumer electronics companies in the world, Apple, was found guilty of doing this in the late 2010s by sacrificing the lithium-ion battery life of the iPhone 6, 6s Plus, 7, and 7 Plus to attempt to retain those phones' performance [8]. Low performance and lower battery life in electronic devices lead consumers to purchase newer technology and dispose of their old electronics faster [9]. Janet Gunter, co-founder of the United Kingdom-based Restart Project, a social campaign pushing to reduce e-waste [2], believes that when consumers are not given a choice to repair their devices or feel in control, they are influenced to throw away their electronics in their entirety rather than repair them when faced with an issue. In large industries, such as consumer electronics and appliances, component selection and longevity standards may lack attention, as many companies aim to bring their products to the hands of consumers and grow profit margins as a business. Considering that a

longer-lasting and high-performing product could mean a lower consumer contribution to future products since their existing owned products are sufficient, it could be a repellent for many companies to consider their negative contribution to e-waste in this context.

Consumer Behavior and Contribution

After analyzing the consumer electronics market trends, it is clear that devices, especially smartphones, have a surprisingly short lifespan. People tend to replace their phones more frequently than they switch up their hairstyles, which is a cause for concern [10]. According to Gunter [2], if consumers are given a choice to repair broken devices more simply, that prevents them from changing them into something new and throwing away what was considered "old." Gunter states that the consumer is to blame for not being able to withhold feelings of yearning for more recent technology releases, making their existing technology seem obsolete. On the other hand, Justin McGuirk, Chief Curator of the London Design Museum and Design Researcher in achieving the United Kingdom's environmental goals, believes that consumers have been deceived into believing tech companies' green-promoting initiatives despite those companies' continuous hardware and software changes and updates that age their technology faster. However, both Gunter and McGuirk [2] agree that consumers may feel at a standstill due to modern technology making it difficult to upgrade them since there are certain parts to find, specific proprietary components not for sale, and challenging means to repair non-modular technology. Ultimately, companies and consumers should address the responsibility of fostering a more sustainable and responsible approach to technology consumption and disposal. Changing the minds of both companies and consumers could be challenging, given the potential of growing technological advancements that could distract from the problem of their waste.

Challenges of Non-recyclable Components

Inherent Limitations of Recycling

There is a plethora of recyclable electronics, such as computers, cables, keyboards, televisions, and audio systems, to name a few. However, many electronic devices today contain ubiquitous materials that cannot be recycled. For instance, lithium-ion, a primary power source for millions of wireless electronics, is nonreusable; home appliances like fridges, humidifiers, and air conditions contain freon, which has a significant trace of lead amounts is also very toxic and risky to recycle [1]. Even low-level appliances like microwave ovens hold potentially lethal electric charges that have built up while disposed of and are dangerous to humans [1]. Many commonly used electronics used daily have parts that are too unsafe to dispose of, making it challenging to recycle in the first place. Although recycling all material from electronics is ideal for combating growing e-waste, the materials used by design limit that possibility, and replacements for those commonly used materials can be hard to find. This problem brings attention to the promotion of longer-lasting components, which lower the amount of waste altogether.

Strategies for Minimizing Non-recyclable Waste

There may be merit in improving the quality of electronic components to avoid waste. Bill Schweber [4], an electrical engineer with over ten years of experience in both the semiconductor industry and technical writing, found that one of his digital alarm clocks, which he had for several years, suddenly began to dim. After looking inside the clock, he discovered that the electrolytic capacitor filtering the device's power supply had failed. Changing the component with the capacitor he had, the alarm clock was just as bright as when he initially bought it. This problem highlighted whether manufacturers should increase the industry standard for acceptable components. As the average consumer has little experience with electronics and may find it daunting to repair their devices, Schweber believes that the e-waste in landfills could decrease if there is a lessened likelihood of replacing and repairing electronic devices [4]. So, using resilient and longer-lasting components in manufacturing can increase longevity while decreasing the need to replace electronics. Therefore, paying more attention to the intricate world of electronics is a path that can be taken in manufacturing, design, and engineering to lessen e-waste.

Future Solutions

Advancing Modular Design and Repairability

There is some promise for the future of modularity within electronics design. Some experienced electrical engineers like Nirav Patel [2], who worked at large tech companies making products at Apple, Facebook, and Oculus, have worked to reframe the repairability of electronics with his company Framework. Framework aims to create fully modular laptops, enabling consumers to replace parts of their laptops in the comfort of their homes, allowing them to replace batteries, screens, keyboards, storage memory, and ports. Rather than purchasing a new laptop, the consumers are given the freedom to upgrade themselves. Companies can hold their design and innovation accountable for e-waste in this case. However, this is only one very successful company, which only means it is a sign of what is possible for the companies following in pursuit.

Legislative Developments

In addition to companies such as Framework providing more space to consumers while striving for fewer e-waste contributions, Green Alliance [2], an independent charity focused on leadership for the environment, managed to influence the European Parliament legislation to declare manufacturers of home appliances to make parts available for consumer purchase to allow them to repair appliances such as fridges, microwaves, and laundry machines for at least ten years. Despite the change in e-waste attitude, activists are still attempting to influence the enforcement of rules that will extend the lifespan of devices such as smartphones and laptops. So far, these activists have yet to get much success in their mission [2]. Some are taking the initiative to reduce waste slowly by giving consumers some sense of electronic freedom, although the significance it will hold for the future is unknown.

Evolving Institutional Approaches

Creating institutions to recycle existing manufactured electronics is also suggested to combat e-waste. In addition to the Green Alliance's influence in legislation in the European Parliament, they also strive to increase repair work and facilities that extract valuable parts from electronics. They believe that with this initiative, more than 450,000 people in the United Kingdom will find jobs in electronic recovery facilities by 2035 [2]. Furthermore, German faculty electrical material science researchers at Ansbach University of Applied Sciences have found flash ways to extract valuable e-waste using lasers to extract valuable copper from printed circuit boards, which are the building blocks of almost all modern electronics [3]. It is worth noting that some improvements are present in some parts of the world, but not others. The United States, for instance, despite being the second largest contributor of e-waste, lacks legislative guidelines or financial incentives to dispose of electronics found in other regions such as the European Union, United Kingdom, and parts of East Asia, which makes it difficult for Americans to adhere to any negative e-waste sentiment [2, 6]. In reality, it may depend on the influence of the economic incentive to pursue cooperation with other countries that follow proper environmental e-waste disposal procedures.

CONCLUSION

Addressing the growing global e-waste problem benefits the consumer and the environment; however, the benefit of preventing e-waste does not happen to outweigh the financial costs, companies' priorities, consumer wants, and changing the current recyclability in electronics manufacturing. On the other hand, the future shows that it may be viable to prevent the more significant wave of the e-waste tsunami by tackling the issues involved.

In an ideal world, there would be no global e-waste problem and no risk of encountering carcinogenic toxins, emitting carbon into the atmosphere, and wasting valuable resources. More innovative technological solutions, active legislation, and changes in standard handling procedures for e-waste are necessary to avoid this impending risk, especially in leading e-waste contributing regions. Everyone, from those experienced in electronics and electronics manufacturing to the average consumer, can become a voice of reason and change in addressing the e-waste problem and making it something of the past. Considering the growing dependence on electronics, initiatives to counteract the oncoming wave of the e-waste tsunami rely on how much individuals and corporations care about the environment and those who inhabit it.

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