

Chapter 17

Sustainable E–Waste Management: Present Situation, Emerging Solutions, and Future Trends

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ABSTRACT

E-waste, which is generated rapidly owing to technological advancements in information technology, has led to a significant rise in the utilization of electronic devices such as laptops, mobile phones, head-phones, and tablets. As these devices become outdated and less useful, they contribute to the growing volume of electronic waste and pose significant threats to the environment and human health. To mitigate the negative impacts of increasing global electronic waste (e-waste), it is crucial to implement proper e-waste management. However, these approaches require substantial labour and resources and are not considered perfect solutions. Fortunately, technological progress has provided new opportunities for more efficient e-waste management. Many countries are now exploring advanced methods, such as the internet of things (IoT) and artificial intelligence (AI), to manage e-waste. However, they face various challenges when implementing these technologies. This study aimed to portray the current situation, emerging trends, and future of smart e-waste management.

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INTRODUCTION

Electronic devices that are no longer in use, at the end of their lifespans, or damaged are referred to as e-waste. These include everyday items, such as computers, TVs, printers, and battery cells. Despite technological advancements leading to frequent upgrades, the longevity of electronic products is compromised by the presence of toxic substances, such as Polychlorinated Nickel Biphenyls (PCBs), lithium, cobalt, cadmium, lead, and copper. As a result, all Electronic and Electrical Parts (EEPs) eventually become unusable, resulting in e-waste (StEP Solving the E-Waste Problem - StEP Initiative, n.d.). E-waste, also known as technical waste or EEP waste, represents a specific category of discarded electronic and electrical components (Ganguly, 2014). The global accumulation of E-waste or Waste Electrical and Electronic Equipment (WEEE) is estimated to reach 30-50 million tons annually (Cucchiella et al., 2015). Although WEEE has significant recycling value, many of these items also contain hazardous substances that must be separated from the regular waste stream (Oguchi et al., 2011).

The responsibility for collecting and transporting waste materials or airborne particles from the streets falls on either municipal workers or private organizations. This responsibility includes the handling of waste from commercial, industrial, and residential sources. Waste is subsequently moved to the next phase of waste management for processing. During this process, waste is divided into many categories according to its qualities, such as recyclability, biodegradability, and non-degradability. Waste management is crucial for pollution reduction and ecosystem preservation; hence, its importance in environmental protection cannot be emphasized. Furthermore, it is an essential step in preventing threats to public health, as poor waste management may contaminate water and encourage the spread of pests that spread the illness. Waste management also promotes employment opportunities and local economic growth from the perspective of the economy.

The E-waste domain also serves as a platform for business ventures focused on extracting precious metals and harnessing energy through biochemical methods. Therefore, the identification, retrieval, and appropriate recycling of e-waste are important steps for a sustainable future. The growing problem of illegal e-waste exportation to developing nations to reduce recycling expenses is a significant concern in terms of self-sufficiency.

The disposal of e-waste in landfills is not advised because of its hazardous nature. Toxic substances and metal-containing components such as halogenated flame retardants in the nonmetal section are commonly present in e-waste. If it is dumped in a landfill, there's a chance that long-term metal leaching will occur. Leachates from this type of disposal could contain dangerous metals and other compounds that exceed permissible thresholds in the soil and water, endangering both human health and the ecosystem. This emphasizes the significance of appropriately handling this type of solid waste, which has been the focus of investigation and analysis in the study of solid waste management.

In the past few years, dedicated treatment and recovery facilities have emerged in certain countries established by politicians, policymakers, recyclers, producers, and other stakeholders. These facilities are specifically designed to gather and process e-waste from owners, ensuring that the waste is handled appropriately according to the specific needs of each case.

AI and other advanced technologies are widely used in various domains such as education and healthcare, and are relatively new in the environmental domain. Addressing environmental pollution effectively involves implementing an advanced waste management system that utilizes Deep Learning (DL), the Internet of Things (IoT), and Machine Learning (ML). This integrated approach can offer real-time waste information and optimize waste collection routes, ultimately reducing costs and time. Current

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