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REVIEW ARTICLE

The impact of electronic waste on soil and its management efforts

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Abstract

Electronic waste is waste containing Hazardous and Toxic Materials (B3). Heavy metals such as lead and cadmium can acidify the soil, reduce its quality for agriculture, and threaten microorganisms that are important for soil ecology. Descriptive method, by collecting information from various written sources to describe the impact of electronic waste on the soil in depth. Sorting of electronic waste that can be recycled from that which cannot be reused. Sorting is done based on the characteristics of each component. After sorting, electronic components are dismantled using techniques such as Desoldering to separate valuable parts. Furthermore, electronic waste is crushed into small sizes and separated based on density and magnetic properties to obtain recyclable materials. In the final stage of electronic waste management, namely the Hydrometallurgy stage where valuable metals are extracted using chemical solutions, followed by refining to produce pure metals. Electronic waste management includes sorting, desoldering, crushing, and hydrometallurgy. Implementing this management method effectively and an integrated approach with government regulations, we can create an efficient electronic waste management system.

Keywords: Electronic Waste, Soil Pollution, Management.

INTRODUCTION

Electronic waste, or e-waste, is a type of waste that contains Hazardous and Toxic Materials (B3) such as lead, mercury, cadmium and chromium (Tulus et al., 2019). This waste comes from electronic devices that are no longer used or have been damaged. Along with the development of technology and the increasing consumption of electronic devices, the amount of electronic waste continues to increase significantly (Sadah et al., 2015). Disposal of electronic waste that is not managed properly can have a negative impact on the soil (Kurniawati et al., 2024). Toxic materials in this waste can seep into the soil, causing pollution that disrupts soil fertility and damages the ecosystem (Muslimah and Si, 2017).

Heavy metals such as lead and cadmium can acidify soil, reducing its quality for agriculture, and threatening microorganisms that are important to soil ecology (Lazar, 2015). In addition, this pollution can also contaminate groundwater through the infiltration of toxic substances (Laili, 2021). This phenomenon has become a global concern because its impact is not only limited to the environment but also human health (Mahardhika et al., 2024).

The increasing amount of e-waste is not just a local problem, but also a global challenge. Many countries, including Indonesia, face difficulties in effectively managing e-waste. The lack of infrastructure and technology to recycle e-waste causes most e-waste to end up in unsuitable landfills. In many areas, people are still less aware of the dangers posed by this waste, making indiscriminate disposal common. In addition, existing regulations are often not followed by concrete actions in the field, so e-waste management remains a neglected issue (Pambudi and Adab, 2023; Oktavilia et al., 2024). Collaboration between government, industry and society is needed to create a sustainable solution.

Good e-waste management can provide economic benefits while protecting the environment. By recycling e-waste, valuable materials such as precious metals can be reused, reducing the need for new resource extraction. The recycling process can also create new jobs in the green and technology sectors. However, to achieve this, there needs to be investment in recycling technology and public education regarding waste management. Public awareness on the importance of e-waste management should be raised through information campaigns and training programs. With the right approach, we can reduce the negative impact of e-waste and contribute to environmental sustainability. Therefore, proper e-waste management is essential to prevent further environmental damage and maintain the sustainability of the ecosystem.

MATERIALS AND METHODS

The research method to determine the impact of electronic waste on the soil uses a descriptive method, by collecting information from various written sources to describe the impact of electronic waste on the soil in depth. Examining specific cases where electronic waste has caused soil pollution, including analysis of disposal locations and their impact on the surrounding environment (Shafira et al., 2022). By using this method, the study can provide a comprehensive picture of the impact of electronic waste on soil and recommendations for better management.

RESULTS AND DISCUSSION

Electronic waste, or e-waste, is an increasingly pressing environmental issue, particularly in relation to the toxic gas emissions produced during disposal and treatment. E-waste contributes to global warming through several complex mechanisms. First, the production and disposal process of e-waste generates greenhouse gas emissions, including carbon dioxide (CO2) and methane (CH4). According to research, about 2% of total global CO2 emissions come from the information technology sector and computer industry, which includes the production and disposal of electronic devices (Paminto et al., 2024). When electronic devices are disposed of in landfills, they can decompose and produce methane gas, which has a much greater global warming potential than CO2.

Moreover, the incineration of e-waste to extract valuable components also results in the emission of toxic gases that contribute to air pollution. This process not only releases harmful substances into the atmosphere but also exacerbates the greenhouse effect. Energy use in producing and recycling electronic devices is also a contributing factor to greenhouse gas emissions, especially if the energy comes from fossil sources (Awasthi and Li, 2017). As the amount of e-waste due to consumption continues to rise, the challenge of managing this environmental impact becomes more pressing. According to research by Paminto et al., 2024 these toxic gas emissions not only pollute the air but can also cause damage to the atmospheric layer and negatively impact human health, including nervous system disorders and cancer risk due to long-term exposure to these pollutants.

Apart from air pollution, e-waste also has the potential to pollute soil and water. Toxic substances contained in e-waste, such as lead, cadmium, and mercury, can leach into soil and water sources if not managed properly. Research results show that e-waste is disposed of carelessly can pollute soil and groundwater, which in turn disrupts the ecosystem and the health of surrounding biota (Jafar et al., 2023). In the long run, this pollution can cause genetic mutations in organisms and disrupt the balance of the ecosystem. Therefore, e-waste must be handled carefully to prevent toxic gas emissions and environmental pollution. Strict recycling policies and public education on the hazards of e-waste are essential to minimize its negative impacts. By implementing a better waste management practices, we can reduce health risks to humans and protect the environment from the hazards posed by e-waste (Awasthi and Li, 2017; Paminto et al., 2024).

Managing electronic waste, or e-waste, is an increasingly pressing challenge amidst the increasing use of electronic devices (Haris et al., 2023). This waste contains various hazardous materials that can pose risks to human health and the environment if not managed properly (Purwanti, 2018). Electronic waste management goes through several stages. The initial process is important to separate recyclable electronic waste from those that can no longer be used (Yoga et al., 2020). Sorting is done based on the characteristics of each component. After sorting, electronic components are dismantled using techniques such as Desoldering to separate valuable parts (Nindyapuspa, 2018). Next, electronic waste is crushed into small sizes and separated based on density and magnetic properties to obtain recyclable materials. In the final stage of electronic waste management, namely the Hydrometallurgy stage where valuable metals are extracted using chemical solutions, followed by refining to produce pure metals (Marwati, 2009).

The government has an important role in managing electronic waste through the formulation of strict policies and regulations (Komarudin et al., 2023). Some relevant regulations include Law Number 18 of 2008 concerning Waste Management (Nggeboe et al., 2016). Goverment Regulation Number 101 of 2014 concerning Management of Hazardous and Toxic Waste (Ananda, 2021). This regulation regulates the entire chain of e-waste management, from collection to recycling, with the aim of ensuring that all parties up to producers, distributors, and consumers comply with certain standards in their management. Raising public awareness of the dangers of e-waste and how to manage it is essential. Educational programs and outreach campaigns can help the public understand the importance of proper e-waste management and official collection locations. With this integrated approach, it is hoped that e-waste management can be carried out effectively, reducing negative impacts on the environment and human health.

CONCLUSIONS

E-waste management is an important issue that requires serious attention to protect the environment and public health. E-waste management includes sorting, desoldering, crushing, and hydrometallurgy. By implementing these management methods effectively and an integrated approach with government regulations, we can create a more sustainable and environmentally friendly e-waste management system, as well as protect public health from the dangers of toxic materials.

Author contributions

Ita Nur Rahma, Nur Salsabila Kamarudin: Conceptualization, analysis, draft writing, and editing.

Conflict of Interest

There is no conflict of interest in this study.

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Data availability

Data related to the findings of this study are available at the corresponding author.

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