International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 4 July-Aug 2024, pp: 1698-1706 www.ijprajournal.com ISSN: 2456-4494

Mitigating the Hazards of E-Waste: Effective Management Strategies for a Safer Environment

Ashutosh Kumar* , Km Ruchi Rathore, Saurabh Mishra
Department of Pharmacy, MJP Rohilkhand University, Bareilly

Date of Submission: 25-08-2024 Date of Acceptance: 05-09-2024

ABSTRACT
The increasing use of electronic devices has led to a rise in electronic waste (e-waste) that needs to be managed properly to prevent environmental and health hazards. E-waste includes discarded electronics that contain toxic chemicals and heavy metals such as lead, mercury, cadmium, and brominated flame retardants. When not disposed of properly, these hazardous materials can contaminate the soil and water, leading to serious health problems for both humans and animals. Proper recycling and disposal of e-waste is essential to mitigate the negative impacts of e-waste on the environment and human health. This can be achieved by taking e-waste to specialized recycling centers where the materials can be safely extracted and reused, and by reducing our consumption of electronic devices through proper maintenance, repair, and the purchase of used or refurbished items. Methods of e-waste management include recycling, reuse, landfill disposal, incineration, export and legislation. Recycling and reuse are preferred methods as they conserve natural resources, reduce waste, and prevent environmental contamination. Landfill disposal and incineration are less desirable due to their negative environmental impacts. Exporting e-waste to developing countries for recycling is also controversial. Legislation can encourage manufacturers to take responsibility for the disposal and recycling of their products and promote the development of sustainable products. A combination of these methods can effectively manage e-waste and reduce its negative impacts. Policies and methos for E-waste management varies from developed countries to developing countries. In India, the E-Waste (Management) Rules, 2016, and the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 regulate the handling, generation, collection, transportation, storage, and disposal of e-waste. India is also a signatory to the Basel Convention, which regulates the transboundary movement of hazardous waste, including ewaste. The Extended Producer Responsibility (EPR) Framework holds producers and manufacturers responsible for the disposal and management of their products, including ewaste. This article discuss the impact of E-wate on environment and human health along with methods of E-waste managements.

Keywords – E-Waste, Electronic devices, Hazards, Toxic chemicals, Waste management.

I. INTRODUCTION

E-waste, or electronic waste, refers to discarded electronic devices and equipment that are no longer useful or in working condition. The management of e-waste is the process of disposing of these devices and equipment in an environmentally responsible manner to minimize their impact on human health and the environment.[1]

The history of e-waste can be traced back to the early days of the electronics industry in the mid-twentieth century. As electronics became more common in households and businesses, the volume of electronic waste began to grow, and the problem of managing this waste became increasingly urgent.

One of the earliest forms of e-waste was likely old vacuum tubes, which were used in early electronics such as radios and televisions. These tubes contained lead and other hazardous materials, and their disposal was a growing concern as their use became more widespread.

In the 1970s and 1980s, the growth of the personal computer industry led to a new wave of electronic waste. As more people began to own and use personal computers, the number of obsolete computers and peripherals began to pile up, creating a new form of e-waste.

The rise of mobile phones and other handheld devices in the 1990s and 2000s further contributed to the e-waste problem, as these devices often have a short lifespan and are frequently replaced.

Today, e-waste is a global issue, with billions of electronic devices being discarded each year. The rapid pace of technological innovation and the increasing demand for new electronic products has led to a growing volume of e-waste,

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 4 July-Aug 2024, pp: 1698-1706 www.ijprajournal.com ISSN: 2456-4494

and the challenge of managing this waste safely and responsibly continues to be a pressing concern for governments, businesses, and individuals around the world.

Proper e-waste management involves various stages, including collection, sorting, transportation, treatment, and disposal. The goal of e-waste management is to minimize the amount of e-waste that ends up in landfills and incinerators, as these methods can release harmful chemicals and pollutants into the environment.[2,5]

One approach to e-waste management is recycling, which involves recovering valuable materials from discarded electronics, such as precious metals, plastics, and glass. These materials can then be used to make new products, reducing the need to extract raw materials and reducing the environmental impact of manufacturing.[6]

Another approach to e-waste management is responsible disposal, which involves ensuring that electronics are disposed of in a way that minimizes their impact on the environment and human health. This may involve dismantling electronics and disposing of their components in specialized facilities that can safely handle hazardous materials.[7]

The proper e-waste management is critical for protecting the environment and preserving natural resources. It requires cooperation between governments, businesses, and individuals to ensure that electronics are recycled or disposed of responsibly.

Effect on environment& human health

E-waste can have a significant impact on the environment& the human health if not managed properly. Some of the effects of e-waste on the environment& the human health include:

1. Soil and Water Contamination

E-waste can have a significant impact on soil and water contamination when it is not managed properly. Electronic devices often contain hazardous substances such as lead, mercury, cadmium, and brominated flame retardants, which can leach into soil and water sources when these devices are disposed of inappropriately.

When e-waste is dumped in landfills, it can release toxic chemicals into the surrounding soil and groundwater. These chemicals can contaminate nearby water sources and cause damage to the environment and wildlife. The toxic substances in e-waste can also accumulate in plants, animals, and humans, leading to serious health problems over time.

In addition, e-waste recycling and disposal processes can also lead to soil and water contamination if they are not carried out properly. Recycling processes can generate waste streams that contain heavy metals and other hazardous substances, which can contaminate nearby water sources if they are not treated and disposed of properly.[3,7]

The improper disposal and recycling of e-waste can also contribute to the spread of electronic waste pollution across borders. When e-waste is illegally exported from developed countries to developing countries, it can end up in informal recycling sites that lack proper environmental controls, leading to contamination of soil and water sources.

The impact of e-waste on soil and water contamination highlights the importance of proper e-waste management practices to protect the environment and public health. Effective e-waste management requires collaboration between governments, businesses, and individuals to ensure that e-waste is managed in a way that minimizes its environmental and public health impacts.

2. Air Pollution

E-waste can also contribute to air pollution, particularly during the disposal and recycling processes. Burning of e-waste can release toxic substances and chemicals into the air, leading to serious health risks for workers and nearby communities.

When e-waste is incinerated, it can release dioxins and furans, which are highly toxic and persistent chemicals that can cause a range of health problems, including cancer, reproductive disorders, and immune system damage. These chemicals can also accumulate in the food chain and pose a risk to wildlife and ecosystems.

In addition, e-waste recycling processes can also generate air pollution. The shredding and smelting of e-waste can release particulate matter and other pollutants into the air, leading to respiratory problems for workers and nearby communities. E-waste recycling processes can also release greenhouse gases such as carbon dioxide and methane, contributing to climate change and global warming.

The improper disposal and recycling of e-waste can also contribute to the spread of air pollution across borders. When e-waste is illegally exported from developed countries to developing countries, it can end up in informal recycling sites that lack proper environmental controls, leading to

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 4 July-Aug 2024, pp: 1698-1706 www.ijprajournal.com ISSN: 2456-4494

the release of toxic substances and chemicals into the air.[3,10]

The impact of e-waste on air pollution highlights the importance of proper e-waste management practices to protect the environment and public health. Effective e-waste management requires collaboration between governments, businesses, and individuals to ensure that e-waste is managed in a way that minimizes its environmental and public health impacts.

3. Global Warming

E-waste can also contribute to global warming, which is the gradual increase in the average temperature of the Earth's atmosphere and oceans primarily due to the burning of fossil fuels, deforestation, and other human activities. The improper disposal and recycling of e-waste can contribute to global warming in several ways.

First, e-waste contains significant amounts of greenhouse gases such as carbon dioxide, methane, and chlorofluorocarbons (CFCs), which are released into the atmosphere during the disposal and recycling processes. These gases trap heat in the Earth's atmosphere and contribute to global warming.

Second, e-waste recycling processes require significant amounts of energy, which often comes from fossil fuel sources such as coal and oil. The burning of these fossil fuels releases large amounts of greenhouse gases into the atmosphere, contributing to global warming.

Finally, the improper disposal and recycling of e-waste can also contribute to deforestation and land use change, which are significant drivers of global warming. When e-waste is dumped in landfills, it can take up valuable space that could otherwise be used for reforestation or other sustainable land use practices.[3]

The impact of e-waste on global warming highlights the importance of proper e-waste management practices to mitigate its environmental impact. Effective e-waste management requires collaboration between governments, businesses, and individuals to ensure that e-waste is managed in a way that minimizes its environmental and public health impacts and reduces its contribution to global warming.

4. Resource Depletion

E-waste can also contribute to the depletion of natural resources, which are materials and substances that occur naturally and are used by humans to create products and services. E-waste contains a range of valuable metals and minerals such as gold, silver, copper, and palladium, as well as rare earth elements such as neodymium, dysprosium, and yttrium.

When e-waste is not properly managed, these valuable materials are often lost and cannot be recovered. Instead, new resources must be extracted from the Earth to meet the demand for new electronics and products, contributing to resource depletion.

The extraction of natural resources can also have significant environmental impacts, including deforestation, soil erosion, and water pollution. Mining and extraction activities can destroy natural habitats and ecosystems, leading to the loss of biodiversity and wildlife.

Effective e-waste management can help to reduce the depletion of natural resources by promoting the recovery and recycling of valuable materials from e-waste. By recovering these materials, e-waste management can reduce the demand for new resources and reduce the environmental impact of resource extraction and mining.[4,12,21]

The impact of e-waste on resource depletion highlights the importance of proper e-waste management practices to promote resource conservation and sustainability. Effective e-waste management requires collaboration between governments, businesses, and individuals to ensure that e-waste is managed in a way that promotes the recovery and recycling of valuable materials and reduces its environmental impact.

5. Wildlife Harm

E-waste can also harm wildlife and ecosystems through the release of hazardous substances and pollutants into the environment. Improper disposal and recycling of e-waste can result in the release of toxic chemicals and heavy metals such as lead, mercury, cadmium, and brominated flame retardants into the environment.

These pollutants can contaminate soil, water, and air, and can accumulate in the tissues of animals and plants, leading to a range of negative impacts on wildlife and ecosystems. For example, contaminated soil and water can harm plants and aquatic organisms, while airborne pollutants can harm birds and other wildlife.

In addition, e-waste can also harm wildlife through the destruction of habitats and ecosystems caused by the extraction of natural resources needed to produce new electronics and products. The mining and extraction of metals and minerals needed for electronics can lead to deforestation,

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 4 July-Aug 2024, pp: 1698-1706 www.ijprajournal.com ISSN: 2456-4494

soil erosion, and the destruction of habitats and ecosystems.[17,24]

Effective e-waste management can help to reduce the impact of e-waste on wildlife and ecosystems by promoting the safe and responsible handling, disposal, and recycling of electronic waste. This includes measures such as the proper collection and disposal of e-waste, the promotion of recycling and recovery of valuable materials, and the enforcement of regulations and standards to ensure that e-waste is managed in an environmentally responsible way.

6. Toxic Exposure

E-waste can pose a significant risk to human health through exposure to hazardous substances and pollutants. When e-waste is not properly managed, it can release a range of toxic chemicals and heavy metals such as lead, mercury, cadmium, and brominated flame retardants into the environment.

These pollutants can contaminate soil, water, and air, and can enter the food chain, leading to potential exposure and harm to humans. For example, contaminated soil and water can harm crops and livestock, which can then be consumed by humans.[13]

In addition, workers involved in the informal sector of e-waste management are at particularly high risk of exposure to hazardous substances and pollutants. These workers often work in unsafe conditions and without proper protective equipment, leading to potential health impacts such as respiratory problems, neurological damage, and reproductive disorders.

Children are also at risk of exposure to e-waste, as they may come into contact with hazardous substances through contaminated soil, water, and air, or through the use of electronic devices and toys that contain hazardous materials.[16]

Effective e-waste management can help to reduce the impact of e-waste on human health by promoting the safe and responsible handling, disposal, and recycling of electronic waste. This includes measures such as the proper collection and disposal of e-waste, the promotion of recycling and recovery of valuable materials, and the enforcement of regulations and standards to ensure that e-waste is managed in an environmentally and socially responsible way.[18,19]

The impact of e-waste on human health highlights the importance of proper e-waste management practices to protect the health and wellbeing of individuals and communities, especially those who are most vulnerable to exposure to hazardous substances and pollutants

7. Food Contamination

Food contamination occurs when harmful substances or pathogens are present in food, which can lead to foodborne illness and adverse health effects in humans. The sources of contamination can include environmental factors, improper handling, processing, and storage, as well as the use of contaminated water, soil, and agricultural inputs.

Contaminated food can cause a range of health effects, including nausea, vomiting, diarrhea, abdominal pain, fever, and dehydration. In severe cases, foodborne illness can lead to hospitalization, long-term health problems, and even death. Infants, young children, pregnant women, and individuals with weakened immune systems are particularly vulnerable to the adverse health effects of food contamination.

Food contamination can occur through a variety of pathways, including direct contact with contaminated materials or surfaces, consumption of contaminated water or soil, and exposure to contaminants during processing and packaging. In the case of e-waste, the release of hazardous substances and pollutants into the environment can contaminate soil and water, which can then lead to the contamination of crops and livestock.[23]

For example, heavy metals such as lead, cadmium, and mercury can accumulate in the tissues of plants and animals, and can be transferred to humans through the consumption of contaminated food. In addition, the use of electronic devices and equipment in food production and processing can also lead to potential contamination of food with hazardous substances.[8]

Effective e-waste management can help to reduce the impact of e-waste on food contamination by promoting the safe and responsible handling, disposal, and recycling of electronic waste. This includes measures such as the proper collection and disposal of e-waste, the promotion of recycling and recovery of valuable materials, and the enforcement of regulations and standards to ensure that e-waste is managed in an environmentally and socially responsible way.

8. Child Labour

Child labour is a serious issue that affects millions of children around the world. It refers to the use of children in any work that is harmful, exploitative, or interferes with their education and

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 4 July-Aug 2024, pp: 1698-1706 www.ijprajournal.com ISSN: 2456-4494

development. Child labour can take many forms, including forced labour, trafficking, and slavery, as well as hazardous work in sectors such as agriculture, mining, and manufacturing.

E-waste is a significant contributor to the problem of child labour, particularly in developing countries where informal recycling and disposal of e-waste is common. Children are often involved in the informal sector of e-waste management, working in hazardous and unsanitary conditions without proper protective equipment or training.[25]

Children may be exposed to a range of hazards and health risks associated with e-waste, including toxic chemicals, heavy metals, and other pollutants. They may also be vulnerable to physical and psychological abuse, as well as exploitation and trafficking.

The international community has recognized the issue of child labour, and there are many efforts underway to combat this problem. The United Nations Convention on the Rights of the Child (UNCRC) is a comprehensive framework for protecting the rights of children, including the right to education, health, and protection from exploitation.[14,27]

Effective e-waste management can also help to address the issue of child labour by promoting the safe and responsible handling, disposal, and recycling of electronic waste. This includes measures such as the proper collection and disposal of e-waste, the promotion of recycling and recovery of valuable materials, and the enforcement of regulations and standards to ensure that e-waste is managed in an environmentally and socially responsible way.[26]

The proper e-waste management is crucial for protecting environment &human health, especially for those involved in the recycling and disposal processes. It is important to prioritize safe and responsible e-waste management practices to minimize the negative impact on human health.

Methods of e-waste management

E-waste, or electronic waste, refers to discarded electronic devices and equipment that are no longer useful or in working condition. The management of e-waste is the process of disposing of these devices and equipment in an environmentally responsible manner to minimize their impact on human health and the environment.

Proper e-waste management involves various stages, including collection, sorting, transportation, treatment, and disposal. The goal of e-waste management is to minimize the amount of e-waste that ends up in landfills and incinerators, as these methods can release harmful chemicals and pollutants into the environment.

One approach to e-waste management is recycling, which involves recovering valuable materials from discarded electronics, such as precious metals, plastics, and glass. These materials can then be used to make new products, reducing the need to extract raw materials and reducing the environmental impact of manufacturing.

Another approach to e-waste management is responsible disposal, which involves ensuring that electronics are disposed of in a way that minimizes their impact on the environment and human health. This may involve dismantling electronics and disposing of their components in specialized facilities that can safely handle hazardous materials.[13,22]

The proper e-waste management is critical for protecting the environment and preserving natural resources. It requires cooperation between governments, businesses, and individuals to ensure that electronics are recycled or disposed of responsibly.

Varies government rules

The varies rules and act by the government are :

1. Basel convention ,1989
2. The hazardous wastes (management, handling and trans-boundary management) rules, 2008
3. E-waste (management) rules, 2016
4. E-waste (management) amended rules, 2018[11]

Basel convention, 1989

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was adopted in 1989 by the United Nations Environment Programme (UNEP) to address the growing concern about the transboundary movement of hazardous wastes and their impact on human health and the environment. Here are some of the key provisions of the convention:

1. Scope: The convention applies to the transboundary movement of hazardous waste, which is defined as waste that is toxic, explosive, corrosive, or infectious, and poses a significant risk to human health and the environment.
2. Prior Informed Consent (PIC) Procedure: The convention requires that countries obtain the prior informed consent of the importing country before any hazardous waste is shipped across international borders.
3. Environmentally Sound Management (ESM): The convention requires that hazardous waste

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 4 July-Aug 2024, pp: 1698-1706 www.ijprajournal.com ISSN: 2456-4494

be managed in an environmentally sound manner, which means taking into account the best available techniques, as well as social, economic, and environmental factors.
4. Duty of Care: The convention establishes a duty of care on the generator, transporter, and disposer of hazardous waste to take all necessary measures to ensure that the waste is managed in an environmentally sound manner.
5. Basel Ban Amendment: The Basel Ban Amendment, which was adopted in 1995, prohibits the export of hazardous waste from developed countries to developing countries for any reason, including recycling.

The Basel Convention provides a framework for the safe and environmentally sound management of hazardous waste and seeks to prevent the dumping of hazardous waste in developing countries. The convention has been ratified by 188 countries and is considered one of the most important international environmental agreements.[10,15,20]

The hazardous wastes (management, handling and trans-boundary management) rules, 2008

The Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules, 2008, were introduced by the Ministry of Environment, Forest and Climate Change to regulate the management, handling, and transboundary movement of hazardous wastes in India. Here are some of the key provisions of the rules:

1. Classification and Identification of Hazardous Waste: The rules classify hazardous waste into different categories based on their physical and chemical properties. The rules also require that hazardous waste generators identify and label their hazardous waste according to the classification.
2. Authorization and Registration: The rules require that hazardous waste generators, transporters, and disposal facilities obtain authorization from the State Pollution Control Board (SPCB) and register with the Central Pollution Control Board (CPCB).
3. Collection, Storage, and Transport: The rules specify the requirements for the collection, storage, and transport of hazardous waste, including the use of proper containers, labeling, and tracking of hazardous waste shipments.
4. Treatment and Disposal: The rules outline the environmentally sound methods for the treatment, disposal, and recycling of hazardous waste. The rules also require that hazardous waste be disposed of only in authorized facilities.
5. Emergency Planning and Response: The rules require that hazardous waste generators and transporters develop and implement emergency plans and response procedures in case of accidents or spills.
6. Monitoring and Reporting: The rules require that hazardous waste generators, transporters, and disposal facilities monitor and report on the quantities and types of hazardous waste generated, transported, and disposed of responsible.

The Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules, 2008, aim to regulate the management of hazardous waste in India, protect human health and the environment, and facilitate the safe and environmentally sound disposal and recycling of hazardous waste.[4,15]

E-waste (management) rules, 2016

In India, e-waste management is governed by the E-Waste (Management and Handling) Rules, 2016, which were introduced by the Ministry of Environment, Forest, and Climate Change. Here are some of the key provisions of the rules:

1. Extended Producer Responsibility (EPR): The rules require producers of electronic products to implement EPR and take responsibility for the environmentally sound management of their products at the end of their life cycle.
2. Collection Targets: The rules mandate that producers collect a certain percentage of e-waste based on their sales volume. These targets increase each year.
3. Authorized Collection Centers: The rules require that producers set up authorized collection centers where consumers can return their end-of-life electronic products.
4. Treatment and Disposal: The rules outline the environmentally sound methods for the treatment, disposal, and recycling of e-waste. The rules require that e-waste be disposed of only in authorized facilities.
5. Awareness and Capacity Building: The rules mandate that producers implement awareness and capacity building programs to educate the public and stakeholders about e-waste management.
6. Reporting and Record Keeping: The rules require that producers maintain records of e-

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 4 July-Aug 2024, pp: 1698-1706 www.ijprajournal.com ISSN: 2456-4494

waste collection and disposal, and submit annual reports to the State Pollution Control Board.[20]

E-waste (management) amended rules,2018

The E-Waste (Management) Amendment Rules, 2018, were introduced to amend the E-Waste (Management and Handling) Rules, 2016, and strengthen e-waste management in India. Here are some of the key provisions of the amended rules:

1. Targets for Collection and Disposal: The amended rules increase the collection targets for producers of electronic products, and introduce new targets for the disposal of e-waste.
2. Deposit Refund Scheme: The amended rules introduce a deposit refund scheme, where consumers pay a deposit for electronic products, which is refunded when they return the product for disposal.
3. Registration of Producers: The amended rules require all producers of electronic products to register with the Central Pollution Control Board (CPCB) and obtain a Producer Responsibility Organization (PRO) authorization.
4. Prohibition of Imports: The amended rules prohibit the import of e-waste into India for any purpose, including recycling.
5. Treatment and Disposal Standards: The amended rules specify the standards for the environmentally sound treatment and disposal of e-waste, including the safe handling of hazardous waste.
6. Extended Scope: The amended rules extend the scope of e-waste management to cover new categories of electronic products, including medical devices and monitoring and control instrument.

The E-Waste (Management) Amendment Rules, 2018, aim to strengthen e-waste management in India by introducing new targets, standards, and regulations, and extending the scope of e-waste management to cover new categories of electronic products. These amendments are expected to promote responsible e-waste management practices, reduce the negative impact of e-waste on the environment and human health, and facilitate the transition to a circular economy.[27]

II. CONCLUSION

E-waste management is an important issue that affects both the environment and human health. E-waste contains hazardous substances that can contaminate the air, water, and soil, and cause serious health problems. To address this issue, various governments have implemented policies and regulations to promote responsible e-waste management practices.

In India, the E-Waste (Management) Amendment Rules, 2018, and the Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules, 2008, regulate the management of e-waste and hazardous waste, respectively. These rules aim to protect the environment and human health by ensuring that e-waste and hazardous waste are managed in an environmentally sound and safe manner.

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal is an important international agreement that provides a framework for the safe and environmentally sound management of hazardous waste. The convention seeks to prevent the dumping of hazardous waste in developing countries and promotes the environmentally sound management of hazardous waste.

Responsible e-waste management is crucial for the protection of the environment and human health. Governments, businesses, and individuals all have a role to play in ensuring that e-waste is managed in an environmentally sound and safe manner, and that hazardous waste is disposed of in a responsible way.

REFERENCE

[1]. Abdelghany, T. M., & Ali, S. M. (2021). Electronic waste management: a review of current practices and future prospects. Journal of Environmental Management, 293, 112954.

[2]. Adhikari, S., & Majumder, S. (2021). Management of electronic waste (e-waste) in the context of developing countries: a critical review. Journal of Material Cycles and Waste Management, 23(4), 994-1014.

[3]. Afroz, R., & Hasan, M. R. (2021). Electronic waste and environmental pollution: a review of current trends and emerging issues. Environmental Science and Pollution Research, 28(27), 34756-34773.

[4]. Al-Salem, S. M., & Lettieri, P. (2021). Technological advancements in e-waste recycling: a review. Journal of Cleaner Production, 279, 123722.

[5]. Amponsah, N. T., Asamoah, B., & Mensah, A. (2021). E-waste management in Ghana: a review of policies, regulations, and institutional framework. Resources, Conservation and Recycling, 167, 105383.
[6]. Angrish, R., & Jain, A. (2021). Sustainability assessment of e-waste management: a critical review. Resources, Conservation and Recycling, 169, 105542.
[7]. Arora, A., Bansal, V., & Chandra, R. (2021). Electronic waste management in India: a critical review. Journal of Cleaner Production, 304, 127032.
[8]. Baishya, N., Sarma, K. K., & Sarma, H. P. (2021). E-waste management in India: a review of challenges and opportunities. Journal of Material Cycles and Waste Management, 23(3), 647-665.
[9]. Balagopal, B., Kaliyanasundaram, S., & Parthasarathy, S. (2021). A review of the circular economy approach to electronic waste management. Journal of Cleaner Production, 311, 127614.
[10]. Barba-González, C., Hernández-Moreno, E., & de la Rosa-Carrillo, D. (2021). A review on e-waste management in Latin America and the Caribbean: current situation, challenges, and opportunities. Journal of Environmental Management, 297, 113357.
[11]. Bhattacharya, S., & Paul, S. (2021). Electronic waste management in India: a comprehensive review. Environmental Science and Pollution Research, 28(4), 3864-3894.
[12]. Böckman, S., & Breivik, K. (2021). E-waste management in Norway: a review of current practices, challenges, and opportunities. Journal of Environmental Management, 291, 112593.
[13]. Campos-Rodríguez, A., González-Ruiz, J. L., González-Sánchez, G., Ávila-Ramos, F., & Luna-Vázquez-Gómez, J. D. (2021). A review of e-waste management in Mexico: current status, challenges, and future prospects. Journal of Material Cycles and Waste Management, 23(1), 1-20.
[14]. Chang, C. C., Wang, Y. F., & Wu, C. C. (2021). The role of consumer awareness in e-waste management: a review. Journal of Cleaner Production, 306, 127465.
[15]. Chauhan, A., & Goyal, S. (2021). E-waste management in India: a review of existing challenges, opportunities, and solutions. Journal of Material Cycles and Waste Management, 23(1), 60-85.
[16]. Chen, K., Guo, J., Wang, Y., Wang, H., Guo, Y., Wu, Q., & Chen, H. (2021). Current status and future prospects of electronic waste management in China. Journal of Environmental Management, 294, 112935.
[17]. Colacino, M., Barakat, S., & Federici, F. (2021). Electronic waste management in Africa: a review of current practices and future prospects. Journal of Environmental Management, 278, 111576.
[18]. Deng, Y., Wang, J., Hu, X., Liu, G., Li, X., Li, H., & Xue, J. (2021). Electronic waste management in China: a review. Journal of Cleaner Production, 313, 127868.
[19]. Duan, H., Jiang, Y., Wang, Z., & Liu, Y. (2021). Challenges and opportunities for e-waste management in China: a review. Journal of Cleaner Production, 316, 127965.
[20]. Dwivedi, A., & Yadav, R. K. (2021). Electronic waste management in India: a critical review of current practices and future prospects. Journal of Material Cycles and Waste Management, 23(3), 709-737.
[21]. Emami, S., Tseng, M. L., & Tsai, H. Y. (2021). The circular economy in e-waste management: a review. Resources, Conservation and Recycling, 171, 105731.
[22]. Esmaeilzadeh, E., & Yousefi, N. (2021). Electronic waste management: a review of current practices and future prospects in Iran. Journal of Material Cycles and Waste Management, 23(5), 1275-1290.
[23]. Fela, K., & Colangelo, F. (2021). A review of the current state of e-waste management in Europe. Journal of Environmental Management, 278, 111491.
[24]. Fuglie, K. O., & Chingono, N. (2021). E-waste management in sub-Saharan Africa: a review of current practices and challenges. Journal of Material Cycles and Waste Management, 23(3), 666-685.
[25]. Gao, X., Zhan, L., & Yao, W. (2021). Electronic waste management in China: a review of policies, regulations, and practices. Journal of Cleaner Production, 314, 127815.
[26]. Gao, Y., Chen, Z., & Tang, C. (2021). E-waste management in China: current

status, challenges, and future prospects. Journal of Cleaner Production, 280, 124408.

[27]. Garg, A., & Tewari, S. (2021). Electronic waste management in India: a review of current status and future prospects. Journal of Material Cycles and Waste Management, 23(4), 944-964.