

Enhancing E-waste Management in Kenya for a Cleaner Environment

Kariuki Muigua

Enhancing E-waste Management in Kenya for a Cleaner Environment

Kariuki Muigua*

Abstract

Electronic garbage, the fastest-growing household waste globally, has increased due to technological innovation. High consumption, limited lifespans, and unrepairable things cause this. A lot of electrical trash from Western countries is now being sent to Africa, which produces 53.6 million metric tonnes of waste every year. This could double to 120 million tonnes by 2050 if it is not stopped. Only 17.4% of electrical waste is disposed of properly around the world.

Kenya faces environmental risks from e-waste, or old electronics. It makes up 1% of solid trash in rich nations, 1–3% in the US, and 16–28% in the EU every five years. Underdeveloped countries generate 0.01% to 1% of urban solid waste.

Electronic trash is dangerous because it contains non-biodegradable lead, mercury, cadmium, and other metals. When poor countries do not properly deal with electrical waste, it can do a lot of damage to the planet earth. Kenya makes about 3,000 tonnes of e-waste every year from electronic devices. This can damage underground water sources, putting people who depend on natural water sources and the area's wildlife at risk.

This paper offers a critical discussion on how Kenya, as a developing country, can effectively manage e-waste as a way for safeguarding the environment for a cleaner and healthy environment for sustainability.

1. Introduction

The exponential advancement of technology has resulted in an increase in the production of electronic waste, which is now the most rapidly rising kind of household waste worldwide.¹ This phenomenon is driven by elevated rates of consumption, short life

**PhD in Law (Nrb), FCI Arb (Chartered Arbitrator), LL. B (Hons) Nrb, LL.M (Environmental Law) Nrb; Dip. In Law (KSL); FCPS (K); Dip. In Arbitration (UK); MKIM; Mediator; Consultant: Lead expert EIA/EA NEMA; BSI ISO/IEC 27001:2005 ISMS Lead Auditor/ Implementer; Advocate of the High Court of Kenya; Prof. at the University of Nairobi, Faculty of Law [June, 2024].*

¹ AfricaNews (2023) *Entrepreneurs in Nairobi find a way to tackle electronic waste*, Africanews. Available at: <https://www.africanews.com/2023/03/07/entrepreneurs-in-nairobi-find-a-way-to-tackle-electronic-waste/> (Accessed: 17 June 2024).

cycles, and items which cannot be repaired.² Africa has emerged as a destination for the disposal of electronic waste from Western countries, resulting in an annual production of 53.6 million metric tonnes.³ If not controlled, this might increase double to 120 million tonnes by 2050. Just 17.4% of electronic trash is handled properly on a worldwide scale.⁴ The combination of rapid innovation and cost reduction has resulted in greater availability of electronic items and digital technology, thus leading to a rise in the utilisation of electronic devices and equipment.⁵ Consequently, there has been a significant increase in the accumulation of electronic and electrical waste, sometimes referred to as e-waste.⁶ E-waste has become the most rapidly expanding category of garbage globally, reaching around 50 million tonnes in 2018.⁷

Electronic Waste (E-waste), defined as discarded electronic goods that are no longer working and approaching the end of their useful lifespan, presents substantial environmental hazards to Kenya.⁸ It refers to outdated electronic gadgets that have

² Ibid.; see also Palanivel, T.M. and Sulaiman, H., 2014. Generation and composition of municipal solid waste (MSW) in Muscat, Sultanate of Oman. *APCBEE procedia*, 10, pp.96-102.

³ Ibid.

⁴ Ibid.; UN report: *Time to seize opportunity, tackle challenge of e-waste* (2019) UN Environment. Available at: <http://www.unep.org/news-and-stories/press-release/un-report-time-seize-opportunity-tackle-challenge-e-waste> (Accessed: 17 June 2024); *The world's e-waste is a huge problem. It's also a golden opportunity* (2019) World Economic Forum. Available at: <https://www.weforum.org/agenda/2019/01/how-a-circular-approach-can-turn-e-waste-into-a-golden-opportunity/> (Accessed: 17 June 2024); *Closing the Loop on the World's Fastest-growing Waste Stream: Electronics* (no date) Baker Institute. Available at: <https://www.bakerinstitute.org/research/closing-loop-worlds-fastest-growing-waste-stream-electronics> (Accessed: 17 June 2024); Seif, R., Salem, F.Z. and Allam, N.K. (2024) 'E-waste recycled materials as efficient catalysts for renewable energy technologies and better environmental sustainability', *Environment, Development and Sustainability*, 26(3), pp. 5473–5508. Available at: <https://doi.org/10.1007/s10668-023-02925-7>.

⁵ United Nations E-waste Coalition, 2019. A new circular vision for electronics: time for a global reboot. World Economic Forum. Available at https://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf

⁶ Ibid.

⁷ Ibid.

⁸ 'E-waste management in Kenya: Regulatory landscape and what companies can do to safeguard the environment – Vellum Kenya' (no date). Available at: <https://vellum.co.ke/e-waste-management-in-kenya->

reached the end of their lifespan and are no longer useful.⁹ E-waste is a term that cannot be precisely defined or limited to a comprehensive list of specific products or devices.¹⁰ This is because electronic components are now being incorporated into a wide range of goods that were not traditionally computerized, but still qualify as e-waste. This includes almost any discarded household or business item that contains circuitry or electrical components.¹¹ Electronic garbage, often known as E-waste, is a major concern in the worldwide economy. In advanced economies, electronic trash (E-waste) comprises 1% of the whole amount of solid waste.¹² In the United States, it comprises 1 to 3% of the overall production of municipal garbage. Electronic garbage in the European Union grows at a rate of 16-28% every five years, which is three times faster than the average yearly rise in municipal solid waste.¹³ In underdeveloped nations, the percentage of total municipal solid trash creation often falls between 0.01% and 1%.¹⁴

The toxicity of electronic waste (E-waste) stems from the presence of several non-biodegradable and toxic components, including lead, mercury, cadmium, and other inorganic elements that are also harmful.¹⁵ In order to tackle this problem, several

regulatory-landscape-and-what-companies-can-do-to-safeguard-the-environment/ (Accessed: 17 June 2024).

⁹ Ngethe, D., 2021. Influence of Electronic Waste Management Systems in Kenya. A Critical Literature Review. *Journal of Environment*, 1(1), pp.45-60.

¹⁰ *Closing the Loop on the World's Fastest-growing Waste Stream: Electronics* (no date) Baker Institute. Available at: <https://www.bakerinstitute.org/research/closing-loop-worlds-fastest-growing-waste-stream-electronics> (Accessed: 17 June 2024).

¹¹ Ibid.

¹² Ngethe, D., 2021. Influence of Electronic Waste Management Systems in Kenya. A Critical Literature Review. *Journal of Environment*, 1(1), pp.45-60.

¹³ Ibid.; Hossain, Md.S., Al-Hamadani, S.M.Z.F. and Rahman, Md.T. (2015) 'E-waste: A Challenge for Sustainable Development', *Journal of Health & Pollution*, 5(9), pp. 3–11. Available at: <https://doi.org/10.5696/2156-9614-5-9.3>.

¹⁴ Ibid.; Chen, D.M.-C. *et al.* (2020) 'The world's growing municipal solid waste: trends and impacts', *Environmental Research Letters*, 15(7), p. 074021. Available at: <https://doi.org/10.1088/1748-9326/ab8659>.

¹⁵ Ibid.

European nations prohibited the disposal of electronic trash in landfills throughout the 1990s and introduced the trash Electrical and Electronic Equipment directive in 2002.¹⁶ The inadequate handling of electronic trash in poor nations has the potential to cause significant environmental damage. Approximately 40% of the lead present in soil may be traced back to e-waste.¹⁷

According to the Waste Electrical and Electronic Equipment Centre (WEEE Centre), Kenya produces around 3,000 tonnes of electronic garbage (e-waste) per year from electronic gadgets.¹⁸ Hazardous substances, such as beryllium, cadmium, mercury, and lead, have the potential to seep into the soil and pollute underground water sources, so endangering the health of those who rely on natural water sources and the biodiversity of the area.¹⁹

This paper offers a critical discussion on how Kenya, as a developing country, can effectively manage e-waste as a way for safeguarding the environment for a cleaner and healthy environment for sustainability.

2. Electronic waste Management: Challenges and Prospects

It has been correctly noted that although there are many research works on the management and disposal of electronic waste (e-waste), only a limited number of studies

¹⁶ Ibid.

¹⁷ Rauf, A.U., 2024. Electronic Waste Problem in Developing Nations: Mismanagement, Health Implications, And Circular Economy Opportunities. *Journal of Environmental Health*, 16(1).

¹⁸ 'E-waste management in Kenya: Regulatory landscape and what companies can do to safeguard the environment – Vellum Kenya' (no date). Available at: <https://vellum.co.ke/e-waste-management-in-kenya-regulatory-landscape-and-what-companies-can-do-to-safeguard-the-environment/> (Accessed: 17 June 2024); *The art of recycling used electronics to make the planet greener* (2023) Nation. Available at: <https://nation.africa/kenya/health/the-art-of-recycling-used-electronics-to-make-the-planet-greener-4347064> (Accessed: 21 June 2024).

¹⁹ Ibid.; see also Lebbie, T.S., Moyebi, O.D., Asante, K.A., Fobil, J., Brune-Drisse, M.N., Suk, W.A., Sly, P.D., Gorman, J. and Carpenter, D.O., 2021. E-waste in Africa: a serious threat to the health of children. *International Journal of Environmental Research and Public Health*, 18(16), p.8488.

have specifically examined African nations, which are significant receivers of e-waste.²⁰ Electronic waste is a significant environmental problem worldwide, especially in poor regions such as Africa.²¹ The African continent's rapid economic expansion has resulted in a rise in the imports of electronic and electrical items and the use of information and communication technology.²² Insufficient infrastructure and lack of law enforcement result in the discharge of dangerous chemicals.²³ However, e-waste presents some advantageous prospects such as the retrieval of valuable metals, job creation, ecological restoration, equipment refurbishing, and the use of recovered metals instead of mineral extraction. The management of electronic waste in Africa is impeded by the absence of well-defined strategies and insufficient infrastructure.²⁴

Due to the lack of awareness about the health and environmental risks associated with E-waste, little attention is being paid to the issue, particularly in African nations. As a result,

²⁰ Andeobu, L., Wibowo, S. and Grandhi, S., 2023. Informal E-waste recycling practices and environmental pollution in Africa: What is the way forward? *International journal of hygiene and environmental health*, 252, p.114192.

²¹ Asante, K.A., Amoyaw-Osei, Y. and Agusa, T., 2019. E-waste recycling in Africa: risks and opportunities. *Current Opinion in Green and Sustainable Chemistry*, 18, pp.109-117.

²² Ibid.; *Africa's rising information economy* (2011) *Africa Renewal*. Available at: <https://www.un.org/africarenewal/magazine/april-2011/africas-rising-information-economy> (Accessed: 21 June 2024); Onyeneke, R.U., Chidiebere-Mark, N.M. and Ayerakwa, H.M. (2024) 'Impact of Information and Communication Technologies and Renewable Energy Consumption on Carbon Emissions in Africa', *Carbon Research*, 3(1), p. 53. Available at: <https://doi.org/10.1007/s44246-024-00130-3>; *Information Technology in Sub-Saharan Africa* (no date). Available at: https://www.africa.upenn.edu/Comp_Articles/Information_Technology_117.html (Accessed: 21 June 2024); Aniyie, I. (2009) 'The Influx of Used Electronics into Africa: A Perilous Trend', *Law, Environment and Development Journal*, 5; Owolabi, O.A. et al. (2023) 'Do Information and Communications Technology (ICT) and financial development contribute to economic diversification? Evidence from sub-Saharan Africa', *Journal of Economic Structures*, 12(1), p. 5. Available at: <https://doi.org/10.1186/s40008-023-00299-7>; Kala, E.S.M. (2023) 'Challenges of Technology in African Countries: A Case Study of Zambia', *Open Journal of Safety Science and Technology*, 13(4), pp. 202–230. Available at: <https://doi.org/10.4236/ojsst.2023.134011>; Ponelis, S.R. and Holmner, M.A. (2015) 'ICT in Africa: Enabling a Better Life for All', *Information Technology for Development*, 21(1), pp. 1–11. Available at: <https://doi.org/10.1080/02681102.2014.985521>.

²³ Ibid.

²⁴ Ibid.

the uneducated young in these countries are more susceptible to the harmful effects of hazardous substances.²⁵

A 2019 report titled "A New Circular Vision for Electronics: Time for a Global Reboot" by the United Nations E-waste Coalition and the World Economic Forum emphasizes the immediate need of a worldwide overhaul in the electronics sector.²⁶ The research emphasizes the substantial difficulties encountered by the existing manufacturing and consumption system, which generates almost 50 million tonnes of electronic and electrical trash each year, comparable to the total number of commercial aeroplanes ever manufactured.²⁷ Merely 20% of garbage undergoes official recycling procedures, and without intervention, the quantity of waste would almost double by the year 2050.²⁸

Significant quantities of obsolete electronics have been sent to underdeveloped nations, where less stringent environmental regulations and labour circumstances make the recycling of electronic trash more financially advantageous.²⁹ The expansion of the Information Technology industry in developing nations has been accelerated by the acquisition of second-hand equipment from affluent industrialised countries, whose customers are eager to find purchasers for it.³⁰ Consequently, several brokers and firms have emerged to facilitate the transfer of old equipment from wealthier regions in the North to less affluent regions in the South. This trade is sometimes justified as a means

²⁵ Bimir, M. (2020) 'Revisiting E-Waste Management Practices in Africa: Selected Countries' Cases', *Journal of the Air & Waste Management Association*, 70. Available at: <https://doi.org/10.1080/10962247.2020.1769769>.

²⁶ United Nations E-waste Coalition, 2019. A new circular vision for electronics: time for a global reboot. World Economic Forum. Available at https://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf

²⁷ Ibid.

²⁸ Ibid.

²⁹ Ngethe, D., 2021. Influence of Electronic Waste Management Systems in Kenya. A Critical Literature Review. *Journal of Environment*, 1(1), pp.45-60; Ferronato, N. and Torretta, V. (2019) 'Waste Mismanagement in Developing Countries: A Review of Global Issues', *International Journal of Environmental Research and Public Health*, 16(6), p. 1060. Available at: <https://doi.org/10.3390/ijerph16061060>.

³⁰ Ibid.

of reducing the gap in access to digital technology, often referred to as 'bridging the digital divide'.³¹

Moreover, electronic sources account for 70% of the heavy metals detected in the soil. The disposal of computers and their accessories in poor nations exacerbates the waste management issue, since these countries often lack the necessary resources and infrastructure to effectively safeguard human health and the environment.³²

The existing cross-border transfer of electronic garbage to developing nations in Africa, together with the accompanying improper handling and disposal, worsens the already significant environmental contamination in the region.³³ The absence of efficient laws and

³¹ Ibid.; *What Is the Digital Divide and How Is It Being Bridged?* (no date) *WhatIs*. Available at: <https://www.techtarget.com/whatis/definition/digital-divide> (Accessed: 17 June 2024).

³² Chalana, A., Singh, K., Sharma, S., Bhardwaj, V. and Rai, R.K., 2023. E-waste management: prospects and strategies. In *Microbial technology for sustainable e-waste management* (pp. 303-318). Cham: Springer International Publishing.

³³ Modekwe, H.U. *et al.* (2024) 'Electronic Waste Management in Developing Countries—The Sub-Saharan Africa Experience', in, pp. 1–12. Available at: <https://doi.org/10.1002/9781119891543.ch1>; Maes, T. and Preston-Whyte, F. (2022) 'E-waste it wisely: lessons from Africa', *Sn Applied Sciences*, 4(3), p. 72. Available at: <https://doi.org/10.1007/s42452-022-04962-9>; Moyen Massa, G. and Archodoulaki, V.-M. (2023) 'Electrical and Electronic Waste Management Problems in Africa: Deficits and Solution Approach', *Environments*, 10(3), p. 44. Available at: <https://doi.org/10.3390/environments10030044>; *EAC bans dumping of electronic waste, calls for recycling* (2021) *The East African*. Available at: <https://www.theeastafrican.co.ke/tea/news/east-africa/eac-bans-dumping-of-electronic-waste-calls-for-recycling-3633632> (Accessed: 21 June 2024); Bimir, M.N. (2020) 'Revisiting e-waste management practices in selected African countries', *Journal of the Air & Waste Management Association*, 70(7), pp. 659–669. Available at: <https://doi.org/10.1080/10962247.2020.1769769>; Park, J. *et al.* (2017) 'Effects of Electronic Waste on Developing Countries', *Advances in Recycling & Waste Management*, 02. Available at: <https://doi.org/10.4172/2475-7675.1000128>; Lebbie, T.S. *et al.* (2021) 'E-Waste in Africa: A Serious Threat to the Health of Children', *International Journal of Environmental Research and Public Health*, 18(16), p. 8488. Available at: <https://doi.org/10.3390/ijerph18168488>; Yee, A. (2019) 'Electronic Marvels Turn Into Dangerous Trash in East Africa', *The New York Times*, 12 May. Available at: <https://www.nytimes.com/2019/05/12/climate/electronic-marvels-turn-into-dangerous-trash-in-east-africa.html> (Accessed: 21 June 2024); *Toxic trash dumps Africa in the danger zone* (no date) *ENACT Africa*. Available at: <https://enactafrica.org/enact-observer/toxic-trash-dumps-africa-in-the-danger-zone> (Accessed: 21 June 2024).

methods to address electronic waste in most African nations exposes the continent to risks linked to e-waste.³⁴

Public institutions neglect to take into account the long-term impacts of procuring Electrical and Electronics Engineering equipment under the Public Procurement and Disposal Act.³⁵ Public institutions are required to form bonds and seek competitive bids for the sale of their assets, which leads to a protracted bureaucratic procedure and a significant accumulation of outdated computers and trash equipment at these institutions.³⁶

The proliferation of the digital economy, the widespread use of electrification, and the advancements in new technologies in the energy, automotive, data storage, and cryptocurrency sectors are leading to the generation of untracked electronic waste.³⁷

Although the presence of e-waste poses environmental and societal difficulties, it also

³⁴ Ibid.; see also *E-waste it wisely: lessons from Africa | Discover Applied Sciences* (no date). Available at: <https://link.springer.com/article/10.1007/s42452-022-04962-9> (Accessed: 22 June 2024); Shahabuddin, M. *et al.* (2023) 'A review of the recent development, challenges, and opportunities of electronic waste (e-waste)', *International Journal of Environmental Science and Technology*, 20(4), pp. 4513–4520. Available at: <https://doi.org/10.1007/s13762-022-04274-w>; Maphosa, V. and Maphosa, M., 2020. E-waste management in Sub-Saharan Africa: A systematic literature review. *Cogent Business & Management*, 7(1), p.1814503; *Turning e-waste into gold: the untapped potential of African landfills* (2018) UNEP. Available at: <http://www.unep.org/news-and-stories/story/turning-e-waste-gold-untapped-potential-african-landfills> (Accessed: 22 June 2024); Abalansa, S., El Mahrad, B., Icely, J. and Newton, A., 2021. Electronic waste, an environmental problem exported to developing countries: The GOOD, the BAD and the UGLY. *Sustainability*, 13(9), p.5302; *Electronic waste (e-waste)* (no date). Available at: [https://www.who.int/news-room/fact-sheets/detail/electronic-waste-\(e-waste\)](https://www.who.int/news-room/fact-sheets/detail/electronic-waste-(e-waste)) (Accessed: 22 June 2024); Asimwe, E.N. and Åke, G., 2012. E-waste management in East African community. In *Handbook of research on E-Government in emerging economies: adoption, e-participation, and legal frameworks* (pp. 307-327). IGI Global; Njoku, A., Agbalenyo, M., Laude, J., Ajibola, T.F., Attah, M.A. and Sarko, S.B., 2023. Environmental Injustice and Electronic Waste in Ghana: Challenges and Recommendations. *International Journal of Environmental Research and Public Health*, 21(1), p.25; Lundgren, K., 2012. The global impact of e-waste: Addressing the challenge. International Labour Office. *Programme on Safety and Health at Work and the Environment (SafeWork)*.

³⁵ 'eWaste Kenya – eWaste Kenya' (no date). Available at: <https://www.ewaste.go.ke/> (Accessed: 17 June 2024).

³⁶ Ibid.

³⁷ *Closing the Loop on the World's Fastest-growing Waste Stream: Electronics* (no date) Baker Institute. Available at: <https://www.bakerinstitute.org/research/closing-loop-worlds-fastest-growing-waste-stream-electronics> (Accessed: 17 June 2024).

offers opportunity to generate value and explore new economic pathways, despite the unidentified origins of this waste.³⁸

Kenya has obstacles in managing its e-waste production, including the presence of used equipment, the disposal of waste by industrialised countries, insufficient legislative frameworks, and the limited capabilities of government institutions.³⁹ While e-waste does provide employment opportunities for impoverished individuals, it also presents significant hazards to both human health and the environment. This underscores the urgent need for enhanced legislation and regulations.⁴⁰

It has been observed that E-waste is often disposed of by incineration or landfilling, or it is transported globally to be manually disassembled or burnt by the world's most impoverished individuals, resulting in negative impacts on both health and the environment.⁴¹ Nevertheless, this same electronic trash poses a significant prospect. The material value alone is estimated to amount to \$62.5 billion (€55 billion), which is three times more than the yearly production of silver mines worldwide and exceeds the GDP of most nations.⁴²

Moreover, the process of extracting minerals from recycled electronics results in much lower carbon dioxide emissions compared to mining activities in the Earth's crust.⁴³

³⁸ Ibid.

³⁹ 'eWaste Kenya – eWaste Kenya' (no date). Available at: <https://www.ewaste.go.ke/> (Accessed: 17 June 2024).

⁴⁰ Ibid.

⁴¹ United Nations E-waste Coalition, 2019. A new circular vision for electronics: time for a global reboot. World Economic Forum. Available at

https://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf

⁴² Ibid.

⁴³ Ibid.; see also Aramendia, E. *et al.* (2023) 'Global energy consumption of the mineral mining industry: Exploring the historical perspective and future pathways to 2060', *Global Environmental Change*, 83, p. 102745. Available at: <https://doi.org/10.1016/j.gloenvcha.2023.102745>; bpreston (2024) 'Does the extraction of minerals contribute to carbon emissions?', *MAJR Resources*, 7 June. Available at: <https://majrresources.com/does-the-extraction-of-minerals-contribute-to-carbon-emissions-4/> (Accessed:

Arguably, functional electronic goods and components possess a higher value than the raw materials they include.⁴⁴ Consequently, prolonging the lifespan of products and repurposing components yields an even greater economic advantage.⁴⁵

Additionally, there is a potential to establish a more circular electronics system, wherein resources are not just harvested, used, and discarded, but rather appreciated and reused in ways that provide respectable and sustainable employment opportunities.⁴⁶

Essentially, we need a fresh perspective on the field of electronics.⁴⁷

21 June 2024); Massonini Ngoma, R.G.T., Abraham Mahanga Tsoni, C.G., Meng, X. and Bashiru Danwana, S., 2023. The impact of the mining equipment, technological trends, and natural resource demand on climate change in Congo. *Sustainability*, 15(2), p.1691.

⁴⁴ Ibid.; see also Lab, I. (2024) 'The Electronics Value Chain and Its Raw Materials: An Overview', *Medium*, 11 May. Available at: <https://infinitalab.medium.com/the-electronics-value-chain-and-its-raw-materials-an-overview-01fd4c6b7b5c> (Accessed: 21 June 2024); Chynoweth, A.G. (1976) 'Electronic Materials: Functional Substitutions', *Science*, 191(4228), pp. 725–732; Zeng, X., Mathews, J.A. and Li, J. (2018) 'Urban Mining of E-Waste is Becoming More Cost-Effective Than Virgin Mining', *Environmental Science & Technology*, 52(8), pp. 4835–4841. Available at: <https://doi.org/10.1021/acs.est.7b04909>; *The circular economy in detail* (no date). Available at: <https://www.ellenmacarthurfoundation.org/the-circular-economy-in-detail-deep-dive> (Accessed: 21 June 2024); Tofail, S.A.M. *et al.* (2018) 'Additive manufacturing: scientific and technological challenges, market uptake and opportunities', *Materials Today*, 21(1), pp. 22–37. Available at: <https://doi.org/10.1016/j.mattod.2017.07.001>.

⁴⁵ Ibid.; see also Montalvo, C., Peck, D. and Rietveld, E., 2016. A longer lifetime for products: benefits for consumers and companies; Kaddoura, M., Kambanou, M.L., Tillman, A.M. and Sakao, T., 2019. Is prolonging the lifetime of passive durable products a low-hanging fruit of a circular economy? A multiple case study. *Sustainability*, 11(18), p.4819. Available at: <https://doi.org/10.3390/su11184819>; storbyuniversitetet, O.- (no date) *Extending product life yields a greater environmental impact than any other measure*. Available at: <https://www.oslomet.no/en/research/featured-research/the-most-effective-environmental-measure-is-rarely-ever-used> (Accessed: 21 June 2024); Kirchherr, J., Yang, N.H.N., Schulze-Spüntrup, F., Heerink, M.J. and Hartley, K., 2023. Conceptualizing the circular economy (revisited): an analysis of 221 definitions. *Resources, Conservation and Recycling*, 194, p.107001.

⁴⁶ Ibid.; see also *Circular Electronics Initiative* (no date). Available at: <https://tcocertified.com/circular-electronics-initiative/> (Accessed: 21 June 2024); Valavanidis, A. (2018) 'Concept and Practice of the Circular Economy'; Joshi, A. (2022) *Advancing E-Waste Recycling*, CIL. Available at: <https://www.circularinnovationlab.com/post/advancing-e-waste-recycling> (Accessed: 21 June 2024).

⁴⁷ Ibid.

Ultimately, the 2019 report by the United Nations E-waste Coalition and the World Economic Forum highlights the need of a worldwide reset in the electronics sector to tackle the difficulties presented by limited resources, extraction, and emissions.⁴⁸ By prioritizing the implementation of the circular economy model and fostering employment creation, the global community can strive towards a more environmentally sustainable future for the electronics sector.⁴⁹ It advocates for the adoption of a new circular approach to the manufacturing and use of electronic and electrical products.⁵⁰

3. Regulatory Framework on E-waste Management

The primary law in Kenya that regulates the handling of electronic trash is the Environmental Management and Coordination Act 1999⁵¹, which was revised in 2015. Additionally, the Waste Management Regulations of 2006⁵² also play a role in this matter. These laws prohibit the processing, transportation, and disposal of garbage without proper licences granted by the National Management Authority (NEMA).⁵³ Prior to renewing their licences, electrical and electronic equipment dealers are mandated by the

⁴⁸ Ibid.; United Nations E-waste Coalition, 2019. A new circular vision for electronics: time for a global reboot. World Economic Forum. *Op. cit.*

⁴⁹ Ibid.; see also Bargavi, N., Irfana, S., Ramana, A.V., Shankar, G., Nagpal, P. and Dhote, S., 2024. Circular Economy Towards Sustainable Businesses: Exploring Factors Shaping Adoption and Implementation Barriers. *Educational Administration: Theory and Practice*, 30(3), pp.813-819; Sánchez-García, E. *et al.* (2024) 'Revolutionizing the circular economy through new technologies: A new era of sustainable progress', *Environmental Technology & Innovation*, 33, p. 103509. Available at: <https://doi.org/10.1016/j.eti.2023.103509>.

⁵⁰ Ibid.

⁵¹ Environmental Management and Coordination Act, No. 8 of 1999, Laws of Kenya.

⁵² Environmental Management and Co-ordination (Waste Management) Regulations, Legal Notice No. 121 of 2006, Kenya Gazette supplement No 69 29th September, 2006.

⁵³ 'E-waste management in Kenya: Regulatory landscape and what companies can do to safeguard the environment – Vellum Kenya' (no date). Available at: <https://vellum.co.ke/e-waste-management-in-kenya-regulatory-landscape-and-what-companies-can-do-to-safeguard-the-environment/> (Accessed: 17 June 2024).

Enhancing E-waste Management in Kenya for a Cleaner Environment

National ICT policy to demonstrate preparedness in mitigating environmental consequences.⁵⁴

The National E-Waste Guidelines, established by NEMA in 2010, provide clear instructions on how to safeguard the environment, raise awareness about environmental issues, classify different types of e-waste, use treatment technology, and implement proper disposal methods.⁵⁵ The primary objective of Kenya's National E-Waste Strategy 2019-2024 is to tackle the issue of e-waste management by focusing on the establishment of policies, guidelines, and standards.⁵⁶ The Ministry of ICT, Innovation and Youth Affairs is partnering with the Ministry of Environment and Forestry to effectively implement the National E-waste Management plan for the period of 2019-2023/24.⁵⁷

The Sustainable Waste Management Act, 2022⁵⁸ was enacted to establish the legal and institutional framework for the sustainable management of waste; ensure the realisation of the constitutional provision on the right to a clean and healthy environment and for connected purposes.⁵⁹

The Act provides precise definitions for several terms, such as the term "recovery" which is defined as the controlled extraction of a material or retrieval of energy from waste in order to produce another product.⁶⁰ "Recycle" refers to the process of reclaiming materials from waste for further use as products, raw materials, or inputs in the production process.⁶¹ "Re-use" is the action or practice of using something again. "Sustainable waste

⁵⁴ Ibid.

⁵⁵ Ibid.

⁵⁶ Ibid.

⁵⁷ 'Kenya enhances e-waste management strategy to mitigate climate change – Kenya News Agency' (2022), 4 March. Available at: <https://www.kenyanews.go.ke/kenya-enhances-e-waste-management-strategy-to-mitigate-climate-change/> (Accessed: 20 June 2024).

⁵⁸ Sustainable Waste Management Act, No. 31 of 2022, Laws of Kenya.

⁵⁹ Ibid., Preamble.

⁶⁰ Ibid., sec. 2.

⁶¹ Ibid.

management" involves using material resources efficiently to reduce waste generation, deposit, or disposal in the environment.⁶²

Generally, the legislation provides a comprehensive explanation of waste management in Kenya, with a specific emphasis on the proactive measures taken to avoid the presence of hazardous materials and the systematic process of reusing and repurposing waste materials.

Waste is defined as any substance, material, or item that is meant to be disposed of, including municipal, residential, agricultural, construction, commercial, and industrial trash.⁶³ The waste hierarchy refers to the prioritization of resource utilisation and pollution reduction in an effective manner.⁶⁴ Waste management facilities are authorized locations where garbage is accepted, collected, stored, processed, recycled, treated, stored, and disposed of.⁶⁵

The Act aims to achieve several goals, including the promotion of sustainable waste management, enhancing the health of Kenyans through the maintenance of a clean and healthy environment, reducing pollution in the air, land, fresh water, and marine ecosystems, ensuring efficient waste service delivery, fostering employment opportunities in the green economy, establishing a sound infrastructure and system for sustainable waste management, encouraging circular economy practices for sustainable growth, integrating resource efficiency principles into sustainable consumption and production practices, and fostering responsible public behaviour towards waste and the environment.⁶⁶

⁶² Ibid.

⁶³ See s. 2.

⁶⁴ S. 2.

⁶⁵ S. 2.

⁶⁶ S. 3.

Enhancing E-waste Management in Kenya for a Cleaner Environment

The Act's fundamental tenets include the promotion of the right to a clean and healthy environment, the application of the precautionary principle, the implementation of the polluter pays concept, payment for ecosystem services, the adherence to the zero waste policy, and the payment for ecological services.⁶⁷

The objective of these principles is to minimise the quantity and harmfulness of trash and materials, preserve and reclaim all resources, and avoid incinerating or burying resources. The Act also underscores the need of advocating responsible public conduct regarding garbage and the environment.

The Cabinet Secretary is responsible for formulating policies regarding sustainable waste management in collaboration with county governments, formulating regulations in collaboration with the Authority and county governments, ensuring compliance with international obligations, and supervising the implementation of this Act.⁶⁸

The Cabinet Secretary is to establish a Waste Management Council within one year of the Act coming into effect.⁶⁹

The Council's responsibilities include improving coordination between government entities to achieve sustainable waste management, assessing the progress made in implementing the national strategy, proposing recycling and recovery targets for waste management, coordinating the development of waste management infrastructure, securing funding for the waste management sector, fostering partnerships between counties for waste management, and suggesting incentives to encourage sustainable waste management practices. The Cabinet Secretary is to formulate rules for the implementation of the Council within one year of its establishment.

⁶⁷ S. 4.

⁶⁸ S. 5.

⁶⁹ S. 6(1).

Enhancing E-waste Management in Kenya for a Cleaner Environment

The Authority is to develop regulations and recommendations regarding sustainable waste management, distribute and share waste-related information, enforce laws on waste management, grant permits for waste management operations, conduct research, raise awareness, and provide training on sustainable waste management.⁷⁰ Additionally, the Authority will create a national waste information system to record, collect, manage, and analyse data.⁷¹ The Authority will provide comprehensive analytical reports and assistance on waste management to ministries, agencies, and counties, functioning as the central hub for national knowledge and information management in the dissemination of sustainable waste management information.⁷²

County governments are tasked with carrying out the decentralised role of waste management and setting up the necessary financial and operational requirements to ensure efficient performance.⁷³ They are required to verify that the law on waste management at the county level is in compliance with this Act within one year of its implementation.⁷⁴ County governments are required to establish central collection centres for recyclable materials, develop waste management infrastructure, keep records of waste management activities, integrate waste management into county planning and budgeting, oversee designated disposal sites and landfills, and maintain a register of all waste service providers operating within their jurisdiction.⁷⁵

The Sustainable Waste Management Act 2022 requires county governments to create laws within two years after its enforcement. The requirements include garbage management, waste categorization and segregation, as well as investment in sustainable waste

⁷⁰ S.8(1).

⁷¹ Ibid.

⁷² S. 8(2).

⁷³ S. 9.

⁷⁴ Ibid.

⁷⁵ Ibid.

Enhancing E-waste Management in Kenya for a Cleaner Environment

management.⁷⁶ Both public and private sector organisations must separate non-hazardous trash into organic and non-organic categories, and appropriately label and colour code the separated garbage. Waste service companies are required to collect, manage, and transport separated garbage in accordance with the legislation.⁷⁷

Public bodies have the responsibility of managing trash in conformity with the Act.⁷⁸ Accounting officers have the responsibility to ensure that individuals who are in charge of a facility or premises take steps to reduce waste generation and minimise waste.⁷⁹ This can be achieved by implementing cleaner production practices, such as improving production processes to conserve raw materials and energy, eliminating the use of toxic materials, reducing toxic emissions and waste, monitoring the product life cycle, properly collecting and segregating waste, transferring waste to authorized transporters, cleaning up and restoring sites, developing a waste management plan, and providing waste receptacles for organic, plastic, and general dry waste.⁸⁰

Every county government is required to create and submit a comprehensive county waste management plan every five years, which must be included in the integrated county development plan.⁸¹

According to the Act, private sector firms are required to develop a waste management strategy for a period of three years and submit an annual monitoring report to the Authority.⁸² This report must include precise details on the exact amounts of trash

⁷⁶ S. 11.

⁷⁷ S.12.

⁷⁸ See also National Environment Management Authority's Environmental Sustainability Guidelines for Ministries, Departments and Agencies (MDAs). Available at https://www.nema.go.ke/images/featured/Environmental_sustainability_guidelines_for_MDAs.pdf

⁷⁹ S. 16.

⁸⁰ S. 19(4).

⁸¹ S. 18.

⁸² S. 19.

produced by the organisation, the waste management techniques used by the organisation, and any other information mandated by the Authority.⁸³

There are provisions for incentives to encourage the use of locally manufactured and imported sustainable waste management equipment and materials. Additionally, efforts are made to boost private investment in activities related to materials recovery and recycling.⁸⁴ These incentives are applicable to individuals or organisations involved in importing sustainable waste management equipment, private investors looking to increase their investments in waste recycling and promote the circular economy, and private operators of certain types of waste management equipment.⁸⁵

An individual who fails to properly handle waste in compliance with the legislation is obligated to remediate and restore the location where the trash was being dealt with to its original condition. In the event that the individual does not comply, the Authority will issue a directive for the restoration of the site.⁸⁶ Individuals or organisations that are harmed by the denial of a licence, the imposition of conditions or limits on a licence, or the issuance of a restoration order have the right to appeal to the National Environment Tribunal.⁸⁷

The Cabinet Secretary, in collaboration with the Authority, has the authority to establish rules to effectively implement the provisions of the Act. These rules include several facets of trash management, including take back programmes, waste segregation, waste transportation vehicles, materials recovery facilities, collection schedules, importing and exportation of garbage, e-waste management, and national colour coding systems.⁸⁸

⁸³ Ibid.

⁸⁴ S.25.

⁸⁵ Ibid.

⁸⁶ S. 30.

⁸⁷ S. 31.

⁸⁸ S. 33.

Enhancing E-waste Management in Kenya for a Cleaner Environment

The Draft E-waste Regulations of 2013 were drafted in line with the Environmental Management and Coordination Act No. 8 of 1999. The Regulations encompass a wide range of e-waste management areas, such as registration, producer accountability, electrical and electronic equipment registry, disclosure, licensing, recycling, repairers/refurbishers, transportation, collection centres, control and handling, importation of electrical and electronic equipment, prohibitions, environmentally sound management (ESM), reporting, incentives, and transfer of responsibility.⁸⁹

The regulations outline various sections, encompassing application forms, registration certificates, annual compliance certificates, product categories, application forms for owning/operating recycling facilities, reporting formats for e-waste recycling facilities, establishment of collection centres, export permits, principles of environmentally sound management, producer obligation calculation, and fees.

The regulations also specify the responsibilities of producers, generators, manufacturers, and producers in the management of e-waste.⁹⁰ Producers have a choice to bring new and previously owned equipment into the market using different approaches, whilst recyclers are engaged in the recycling or reprocessing of existing equipment. Refurbishers and repairers have the task of repairing, disassembling, and enhancing electronic waste in order to prolong its operational lifespan.⁹¹

Ultimately, the primary objective of the 2013 proposed E-waste legislation is to guarantee the implementation of responsible and ecologically sustainable procedures for managing electronic waste.⁹² They provide rules for manufacturers, collectors, and other parties involved to guarantee the appropriate management and disposal of electronic waste.

⁸⁹ Environmental Management and Coordination Act No. 8 of 1999, Draft E-waste Regulations, 2013. Available at <https://www.nema.go.ke/images/Docs/Regulations/Draft%20E-waste%20Regulations-1.pdf>

⁹⁰ Regulations 6-14.

⁹¹ Ibid.

⁹² Schedule 11(Sect. 6(2)).

Enhancing E-waste Management in Kenya for a Cleaner Environment

The e-waste management regulation in Kenya include all types of electrical and electronic equipment, as well as the facilities involved in their transportation, recycling, re-use, and recovery. Producers planning to bring new or used equipment into Kenya must apply for registration with the Authority within 60 days of the regulation's implementation.⁹³ The Authority has the power to either accept, seek further details, or reject applications. Upon approval, the Authority grants a registration certificate to the producer.

In order to obtain an annual compliance certificate, producers are required to declare the weight of electrical and electronic equipment introduced in the market in the previous year, categorized by product type.⁹⁴ They must also provide an evidence note from a licensed treatment facility, along with a valid contractual agreement with said facility.⁹⁵ Additionally, producers must pay the prescribed fee. Producers are required to disclose the items they launched into the market in the preceding year and report estimated imports of any electrical and electronic equipment products.⁹⁶ In addition, they are required to provide recyclers with instructions on how to disassemble their product when it reaches the end of its lifespan, as well as the precise whereabouts of any hazardous materials or components included inside the product.⁹⁷

Producers are required to provide financial assistance for the collection and treatment of problematic fractions of e-waste. This support should be given to licensed treatment facilities in order to guarantee the efficient return and treatment of e-waste. The treatment charge specified by the Authority must be paid by them, which is calculated based on the producer's market share. Producers or their representatives must guarantee that

⁹³ Regulation 4.

⁹⁴ Regulation 5.

⁹⁵ Ibid.

⁹⁶ Ibid.

⁹⁷ Regulation 6.

electronic trash returned via individual take-back programmes is not discarded at county disposal sites.

The Authority is to operate an electrical and electronic equipment registry for the purpose of receiving and evaluating registration applications, issuing registration certificates and numbers, calculating individual producer responsibility based on market share for problematic fractions, and maintaining a record of the amount and categories of e-waste collected and processed by licensed treatment facilities.⁹⁸ The register is managed with the involvement of stakeholders from several sectors and is required to be accessible to the public during official business hours. The Authority cannot reveal confidential information to other parties unless compelled to do so by court orders or other legal provisions.⁹⁹

The licensing criteria for e-waste recycling plants in Kenya are outlined in the Environmental Impact Assessment and Audit (EIA) Regulations of 2003 and the Environmental Management and Coordination (Waste Management) Regulations of 2006.¹⁰⁰ Recyclers have the responsibility of accepting and disassembling discarded electrical and electronic equipment in an ecologically appropriate way. They ensure that components that cannot be recycled locally are properly handled and collect and manage e-waste in accordance with the rules set by the Authority.¹⁰¹

Recyclers are required to regularly provide the electrical and electronic equipment registry with detailed information on the amount of e-waste received, categorized by weight.¹⁰² This includes data on the components that have been reconditioned for reuse, the materials that are recycled and recovered inside the facility, and the precious metals

⁹⁸ Regulation 7.

⁹⁹ Regulation 8.

¹⁰⁰ Regulation 9.

¹⁰¹ Regulation 10.

¹⁰² Regulation 10(3).

that have been extracted.¹⁰³ In addition, it is essential to give priority to the restoration of used equipment in order to extend its operational lifespan before proceeding with recycling, material recovery, or reprocessing.¹⁰⁴

Transporters of electronic waste must get requisite licences from the Authority via application, maintain tracking papers, and guarantee that the transportation method used adheres to Regulation 8 of the EMC Regulations of 2006.¹⁰⁵ Collection centres are required to inform the authorities by using the specified form.

The Authority has a mandate to create a system for cooperation among African countries for the importation of electronic trash, with imports limited to recycling, refurbishing, and material recovery purposes.¹⁰⁶ Importers of electrical and electronic equipment that incorporate Cathode Ray Tubes must get the required authorizations from the Authority.¹⁰⁷ Every piece of imported equipment must have a label that clearly states the year and country in which it was manufactured.

Prohibitions on e-waste disposal encompass activities such as incineration, improper disposal in non-designated waste containers, burial, dumping in unauthorized locations, improper treatment of Cathode Ray Tubes, extraction of valuable metals using acidic substances, burning of equipment at recycling facilities, and leaving e-waste outside of designated collection centres and licensed recycling facilities.¹⁰⁸ Noncompliance with these restrictions may lead to financial penalties, imprisonment, or a combination of both.

¹⁰³ Ibid.

¹⁰⁴ Ibid.

¹⁰⁵ Regulation 13.

¹⁰⁶ Regulation 15.

¹⁰⁷ Regulation 16.

¹⁰⁸ Regulation 17.

Effective management of electronic waste is a vital component of regulatory measures.¹⁰⁹ Refurbishers and recyclers are required to keep detailed records of electronic waste that is sent to collection centres.¹¹⁰ These records should include information such as the amount and kinds of materials that were recovered, the recycling methods used, the quantity of trash that was exported for further recycling, and any certifications of disposal recovery.¹¹¹ The Authority is to implement a system to provide rewards to participants in the e-waste value chain, with a minimum collecting value of KES100,000. Certain electronic trash may lack a favourable recovery value because the expenses associated with processing it exceed the money obtained.¹¹² The recycler will recoup these expenses from manufacturers according to their market share in the specific product category, so order to discourage selective collection of just high-value electronic trash.

Producers that plan to stop their activities must inform the Authority in writing six months before and give proof of agreements for other companies to take on their responsibilities during the compliance period.¹¹³ The offences and corresponding penalties encompass the act of bringing in e-waste and near end-of-life electronic equipment from outside Africa into Kenya, the act of introducing electrical and electronic equipment without obtaining registration from the Authority, the failure to fulfil obligations, the improper disposal of e-waste by county governments, the submission of false information or the failure to provide information upon ceasing operations, the handling of unauthorized e-waste shipments, and the violation of general penalties.¹¹⁴

¹⁰⁹ Regulation 18.

¹¹⁰ Regulation 19.

¹¹¹ Ibid.

¹¹² Regulation 20.

¹¹³ Regulation 21.

¹¹⁴ Regulations 22-29.

These regulations are supplementary to any applicable laws and standards established under any other legislation.¹¹⁵

4. Enhancing E-waste Management in Kenya for a Cleaner Environment

As already pointed out, on a global scale, only 20% of electronic trash is handled in a proper manner by society. There is little information available on the fate of the other 80%, which often ends up in landfills or is disposed of by informal labourers under unfavourable circumstances.¹¹⁶ Nevertheless, with the appropriate combination of policies and effective management, the industry has the potential to provide a substantial number of high-quality employment on a global scale.¹¹⁷ The effectiveness of waste management relies on precise data on the volume and composition of trash, which is crucial for making informed choices about the most suitable waste management system.¹¹⁸ An analysis of solid waste is necessary to determine its source, production rates, waste type, and content in order to enhance waste management systems.¹¹⁹ This information is essential for the design and operation of functional components, such as waste creation, handling, storage, collection, transport, processing, recovery, recycling, reuse, treatment, and disposal.¹²⁰

Electronic gadgets have the potential to both exacerbate and alleviate the issue of growing digital connection. They may expedite progress towards the UN Sustainable

¹¹⁵ Regulation 30.

¹¹⁶ United Nations E-waste Coalition, 2019. A new circular vision for electronics: time for a global reboot. World Economic Forum. Available at https://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf

¹¹⁷ *ibid.*

¹¹⁸ Palanivel, T.M. and Sulaiman, H., 2014. Generation and composition of municipal solid waste (MSW) in Muscat, Sultanate of Oman. *APCBEE procedia*, 10, pp.96-102.

¹¹⁹ *Ibid.*

¹²⁰ *Ibid.*

Enhancing E-waste Management in Kenya for a Cleaner Environment

Development Goals and provide unparalleled possibilities for developing countries.¹²¹ Companies may mitigate electronic waste by advocating for the right to repair, proactively supporting environmentally-friendly laws and practices, and establishing recycling initiatives.¹²² By implementing these measures, firms may minimise their ecological footprint and maintain a competitive advantage in the international market.¹²³

The Ministry of Information, Communications and the Digital Economy is establishing centres around the country to oversee the handling of substantial quantities of electronic waste (e-waste) and assure its appropriate disposal and rehabilitation in both government and private organisations.¹²⁴

Addressing the issue of e-waste necessitates the use of both tangible and intangible strategies. Promoting ethical tech consumption is crucial for reducing e-waste and promoting sustainable industrial practices.¹²⁵ Developing ethical digital consumerism is a dual strategy - firstly, adopting a slower pace and secondly, becoming conscious of our tech usage.¹²⁶ Deliberate choices about technology use are essential for promoting ethical practices among tech consumers, especially in relation to the influence on electronic waste generation.¹²⁷ As part of ethical tech consumption, customers may reduce the

¹²¹ *The world's e-waste is a huge problem. It's also a golden opportunity* (2019) *World Economic Forum*. Available at: <https://www.weforum.org/agenda/2019/01/how-a-circular-approach-can-turn-e-waste-into-a-golden-opportunity/> (Accessed: 17 June 2024).

¹²² 'E-waste management in Kenya: Regulatory landscape and what companies can do to safeguard the environment – Vellum Kenya' (no date). Available at: <https://vellum.co.ke/e-waste-management-in-kenya-regulatory-landscape-and-what-companies-can-do-to-safeguard-the-environment/> (Accessed: 17 June 2024).

¹²³ Ibid.

¹²⁴ 'eWaste Kenya – eWaste Kenya' (no date). Available at: <https://www.ewaste.go.ke/> (Accessed: 17 June 2024).

¹²⁵ *Tackling the E-Waste Problem by Encouraging Ethical Tech Consumerism* (2022) *Global Research and Consulting Group Insights*. Available at: <https://insights.grcglobalgroup.com/tackling-the-e-waste-problem-by-encouraging-ethical-tech-consumerism/> (Accessed: 18 June 2024).

¹²⁶ Ibid.

¹²⁷ Ibid.

generation of electronic waste by being conscious of the principles and practices of tech firms.¹²⁸ They can also actively boycott or switch from companies that are renowned for accumulating excessive and unnecessary amounts of e-waste.¹²⁹

Global circular value chains may be facilitated by the emergence of service business models and improved product tracking and take-back systems.¹³⁰ Material efficiency, the development of recycling infrastructure, and the expansion of the quantity and quality of recycled materials are all crucial factors in meeting the demands of electronic supply chains.¹³¹ With the implementation of an appropriate policy combination and effective management, the industry has the potential to generate a substantial number of high-quality employment on a global scale.¹³²

5. Conclusion

There is an urgent need for a fresh perspective on the manufacturing and use of electronic and electrical products.¹³³ Designers, manufacturers, investors, traders, miners, raw material producers, consumers, policy-makers, and other stakeholders have a pivotal responsibility in minimising waste, preserving value within the system, prolonging the economic and physical lifespan of a product, and enhancing its capacity for repair, recycling, and reuse.¹³⁴

¹²⁸ Ibid.

¹²⁹ Ibid.

¹³⁰ United Nations E-waste Coalition, 2019. A new circular vision for electronics: time for a global reboot. World Economic Forum. Available at https://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf

¹³¹ Ibid.

¹³² Ibid.

¹³³ United Nations E-waste Coalition, 2019. A new circular vision for electronics: time for a global reboot. World Economic Forum. Available at https://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf

¹³⁴ Ibid.

Enhancing E-waste Management in Kenya for a Cleaner Environment

It is necessary to implement a functional system upgrade that replaces the linear economy with the circular economy.¹³⁵ It is vital to reassess e-waste, re-evaluate the electronics business, and restart the system to benefit the industry, consumers, workers, human health, and the environment.¹³⁶

Enhancing E-waste management in Kenya for a cleaner environment is an imperative whose time is now.

References

'eWaste Kenya – eWaste Kenya' (no date). Available at: <https://www.ewaste.go.ke/> (Accessed: 17 June 2024).

'E-waste management in Kenya: Regulatory landscape and what companies can do to safeguard the environment – Vellum Kenya' (no date). Available at: <https://vellum.co.ke/e-waste-management-in-kenya-regulatory-landscape-and-what-companies-can-do-to-safeguard-the-environment/> (Accessed: 17 June 2024).

'Kenya enhances e-waste management strategy to mitigate climate change – Kenya News Agency' (2022), 4 March. Available at: <https://www.kenyanews.go.ke/kenya-enhances-e-waste-management-strategy-to-mitigate-climate-change/> (Accessed: 20 June 2024).

Abalansa, S., El Mahrad, B., Icely, J. and Newton, A., 2021. Electronic waste, an environmental problem exported to developing countries: The GOOD, the BAD and the UGLY. *Sustainability*, 13(9), p.5302; *Electronic waste (e-waste)* (no date). Available at: [https://www.who.int/news-room/fact-sheets/detail/electronic-waste-\(e-waste\)](https://www.who.int/news-room/fact-sheets/detail/electronic-waste-(e-waste)) (Accessed: 22 June 2024).

Africa's rising information economy (2011) *Africa Renewal*. Available at: <https://www.un.org/africarenewal/magazine/april-2011/africas-rising-information-economy> (Accessed: 21 June 2024).

AfricaNews (2023) *Entrepreneurs in Nairobi find a way to tackle electronic waste*, *Africanews*. Available at: <https://www.africanews.com/2023/03/07/entrepreneurs-in-nairobi-find-a-way-to-tackle-electronic-waste/> (Accessed: 17 June 2024).

¹³⁵ Ibid.

¹³⁶ Ibid.

Enhancing E-waste Management in Kenya for a Cleaner Environment

Andeobu, L., Wibowo, S. and Grandhi, S., 2023. Informal E-waste recycling practices and environmental pollution in Africa: What is the way forward? *International journal of hygiene and environmental health*, 252, p.114192.

Aniyie, I. (2009) 'The Influx of Used Electronics into Africa: A Perilous Trend', *Law, Environment and Development Journal*, 5.

Aramendia, E. *et al.* (2023) 'Global energy consumption of the mineral mining industry: Exploring the historical perspective and future pathways to 2060', *Global Environmental Change*, 83, p. 102745. Available at: <https://doi.org/10.1016/j.gloenvcha.2023.102745>.

Asante, K.A., Amoyaw-Osei, Y. and Agusa, T., 2019. E-waste recycling in Africa: risks and opportunities. *Current Opinion in Green and Sustainable Chemistry*, 18, pp.109-117.

Asimwe, E.N. and Åke, G., 2012. E-waste management in East African community. In *Handbook of research on E-Government in emerging economies: adoption, e-participation, and legal frameworks* (pp. 307-327). IGI Global.

Bargavi, N., Irfana, S., Ramana, A.V., Shankar, G., Nagpal, P. and Dhote, S., 2024. Circular Economy Towards Sustainable Businesses: Exploring Factors Shaping Adoption and Implementation Barriers. *Educational Administration: Theory and Practice*, 30(3), pp.813-819.

Bimir, M. (2020) 'Revisiting E-Waste Management Practices in Africa: Selected Countries' Cases', *Journal of the Air & Waste Management Association*, 70. Available at: <https://doi.org/10.1080/10962247.2020.1769769>.

bpreston (2024) 'Does the extraction of minerals contribute to carbon emissions?', *MAJR Resources*, 7 June. Available at: <https://majrresources.com/does-the-extraction-of-minerals-contribute-to-carbon-emissions-4/> (Accessed: 21 June 2024).

Chalana, A., Singh, K., Sharma, S., Bhardwaj, V. and Rai, R.K., 2023. E-waste management: prospects and strategies. In *Microbial technology for sustainable e-waste management* (pp. 303-318). Cham: Springer International Publishing.

Chen, D.M.-C. *et al.* (2020) 'The world's growing municipal solid waste: trends and impacts', *Environmental Research Letters*, 15(7), p. 074021. Available at: <https://doi.org/10.1088/1748-9326/ab8659>.

Chynoweth, A.G. (1976) 'Electronic Materials: Functional Substitutions', *Science*, 191(4228), pp. 725-732.

Circular Electronics Initiative (no date). Available at: <https://tcocertified.com/circular-electronics-initiative/> (Accessed: 21 June 2024).

Enhancing E-waste Management in Kenya for a Cleaner Environment

Closing the Loop on the World's Fastest-growing Waste Stream: Electronics (no date) Baker Institute. Available at: <https://www.bakerinstitute.org/research/closing-loop-worlds-fastest-growing-waste-stream-electronics> (Accessed: 17 June 2024).

EAC bans dumping of electronic waste, calls for recycling (2021) *The East African*. Available at: <https://www.theeastafrican.co.ke/tea/news/east-africa/eac-bans-dumping-of-electronic-waste-calls-for-recycling-3633632> (Accessed: 21 June 2024).

Environmental Management and Co-ordination (Waste Management) Regulations, Legal Notice No. 121 of 2006, Kenya Gazette supplement No 69, 29th September, 2006.

Environmental Management and Coordination Act No. 8 of 1999, Draft E-waste Regulations, 2013. Available at <https://www.nema.go.ke/images/Docs/Regulations/Draft%20E-waste%20Regulations-1.pdf>

Environmental Management and Coordination Act, No. 8 of 1999, Laws of Kenya.

E-waste it wisely: lessons from Africa | *Discover Applied Sciences* (no date). Available at: <https://link.springer.com/article/10.1007/s42452-022-04962-9> (Accessed: 22 June 2024).

Ferronato, N. and Torretta, V. (2019) 'Waste Mismanagement in Developing Countries: A Review of Global Issues', *International Journal of Environmental Research and Public Health*, 16(6), p. 1060. Available at: <https://doi.org/10.3390/ijerph16061060>.

Hossain, Md.S., Al-Hamadani, S.M.Z.F. and Rahman, Md.T. (2015) 'E-waste: A Challenge for Sustainable Development', *Journal of Health & Pollution*, 5(9), pp. 3–11. Available at: <https://doi.org/10.5696/2156-9614-5-9.3>.

Information Technology in Sub-Saharan Africa (no date). Available at: https://www.africa.upenn.edu/Comp_Articles/Information_Technology_117.html (Accessed: 21 June 2024).

Joshi, A. (2022) *Advancing E-Waste Recycling*, CIL. Available at: <https://www.circularinnovationlab.com/post/advancing-e-waste-recycling> (Accessed: 21 June 2024).

Kaddoura, M., Kambanou, M.L., Tillman, A.M. and Sakao, T., 2019. Is prolonging the lifetime of passive durable products a low-hanging fruit of a circular economy? A multiple case study. *Sustainability*, 11(18), p.4819. Available at: <https://doi.org/10.3390/su11184819>.

Kala, E.S.M. (2023) 'Challenges of Technology in African Countries: A Case Study of Zambia', *Open Journal of Safety Science and Technology*, 13(4), pp. 202–230. Available at: <https://doi.org/10.4236/ojsst.2023.134011>.

Enhancing E-waste Management in Kenya for a Cleaner Environment

- Kirchherr, J., Yang, N.H.N., Schulze-Spüntrup, F., Heerink, M.J. and Hartley, K., 2023. Conceptualizing the circular economy (revisited): an analysis of 221 definitions. *Resources, Conservation and Recycling*, 194, p.107001.
- Lab, I. (2024) 'The Electronics Value Chain and Its Raw Materials: An Overview', *Medium*, 11 May. Available at: <https://infinitalab.medium.com/the-electronics-value-chain-and-its-raw-materials-an-overview-01fd4c6b7b5c> (Accessed: 21 June 2024).
- Lebbie, T.S., Moyebi, O.D., Asante, K.A., Fobil, J., Brune-Drisse, M.N., Suk, W.A., Sly, P.D., Gorman, J. and Carpenter, D.O., 2021. E-Waste in Africa: A Serious Threat to The Health of Children. *International Journal of Environmental Research and Public Health*, 18(16), p.8488.
- Lundgren, K., 2012. The global impact of e-waste: Addressing the challenge. International Labour Office. *Programme on Safety and Health at Work and the Environment (SafeWork)*.
- Maes, T. and Preston-Whyte, F. (2022) 'E-waste it wisely: lessons from Africa', *Sn Applied Sciences*, 4(3), p. 72. Available at: <https://doi.org/10.1007/s42452-022-04962-9>.
- Maphosa, V. and Maphosa, M., 2020. E-waste management in Sub-Saharan Africa: A systematic literature review. *Cogent Business & Management*, 7(1), p.1814503.
- Massonini Ngoma, R.G.T., Abraham Mahanga Tsoni, C.G., Meng, X. and Bashiru Danwana, S., 2023. The impact of the mining equipment, technological trends, and natural resource demand on climate change in Congo. *Sustainability*, 15(2), p.1691.
- Modekwe, H.U., Ayeleru, O.O., Adeniran, J.A., Fafowora, B.L., Onu, M.A., Nyam, T.T. and Olubambi, P.A., 2023. Electronic Waste Management in Developing Countries—The Sub-Saharan Africa Experience. *Electronic Waste Management: Policies, Processes, Technologies, and Impact*, pp.1-12.
- Montalvo, C., Peck, D. and Rietveld, E., 2016. A longer lifetime for products: benefits for consumers and companies.
- Moyen Massa, G. and Archodoulaki, V.-M. (2023) 'Electrical and Electronic Waste Management Problems in Africa: Deficits and Solution Approach', *Environments*, 10(3), p. 44. Available at: <https://doi.org/10.3390/environments10030044>.
- National Environment Management Authority's Environmental Sustainability Guidelines for Ministries, Departments and Agencies (MDAs). Available at https://www.nema.go.ke/images/featured/Environmental_sustainability_guidelines_for_MDA.pdf
- Ngethe, D., 2021. Influence of Electronic Waste Management Systems in Kenya. A Critical Literature Review. *Journal of Environment*, 1(1), pp.45-60.

Enhancing E-waste Management in Kenya for a Cleaner Environment

Njoku, A., Agbalenyo, M., Laude, J., Ajibola, T.F., Attah, M.A. and Sarko, S.B., 2023. Environmental Injustice and Electronic Waste in Ghana: Challenges and Recommendations. *International Journal of Environmental Research and Public Health*, 21(1), p.25.

Onyeneke, R.U., Chidiebere-Mark, N.M. and Ayerakwa, H.M. (2024) 'Impact of Information and Communication Technologies and Renewable Energy Consumption on Carbon Emissions in Africa', *Carbon Research*, 3(1), p. 53. Available at: <https://doi.org/10.1007/s44246-024-00130-3>.

Owolabi, O.A. *et al.* (2023) 'Do Information and Communications Technology (ICT) and financial development contribute to economic diversification? Evidence from sub-Saharan Africa', *Journal of Economic Structures*, 12(1), p. 5. Available at: <https://doi.org/10.1186/s40008-023-00299-7>.

Palanivel, T.M. and Sulaiman, H., 2014. Generation and composition of municipal solid waste (MSW) in Muscat, Sultanate of Oman. *APCBEE procedia*, 10, pp.96-102.

Park, J.K., Hoerning, L., Watry, S., Burgett, T. and Matthias, S., 2017. Effects of electronic waste on developing countries. *Advances in Recycling & Waste Management*, 2(2), pp.1-6.

Ponelis, S.R. and Holmner, M.A. (2015) 'ICT in Africa: Enabling a Better Life for All', *Information Technology for Development*, 21(1), pp. 1–11. Available at: <https://doi.org/10.1080/02681102.2014.985521>.

Rauf, A.U., 2024. Electronic Waste Problem in Developing Nations: Mismanagement, Health Implications, And Circular Economy Opportunities. *Journal of Environmental Health*, 16(1).

Sánchez-García, E. *et al.* (2024) 'Revolutionizing the circular economy through new technologies: A new era of sustainable progress', *Environmental Technology & Innovation*, 33, p. 103509. Available at: <https://doi.org/10.1016/j.eti.2023.103509>.

Seif, R., Salem, F.Z. and Allam, N.K. (2024) 'E-waste recycled materials as efficient catalysts for renewable energy technologies and better environmental sustainability', *Environment, Development and Sustainability*, 26(3), pp. 5473–5508. Available at: <https://doi.org/10.1007/s10668-023-02925-7>.

Shahabuddin, M. *et al.* (2023) 'A review of the recent development, challenges, and opportunities of electronic waste (e-waste)', *International Journal of Environmental Science and Technology*, 20(4), pp. 4513–4520. Available at: <https://doi.org/10.1007/s13762-022-04274-w>.

storbyuniversitetet, O.- (no date) *Extending product life yields a greater environmental impact than any other measure*. Available at: <https://www.oslomet.no/en/research/featured-research/the-most-effective-environmental-measure-is-rarely-ever-used> (Accessed: 21 June 2024).

Sustainable Waste Management Act, No. 31 of 2022, Laws of Kenya.

Enhancing E-waste Management in Kenya for a Cleaner Environment

Tackling the E-Waste Problem by Encouraging Ethical Tech Consumerism (2022) *Global Research and Consulting Group Insights*. Available at: <https://insights.grcglobalgroup.com/tackling-the-e-waste-problem-by-encouraging-ethical-tech-consumerism/> (Accessed: 18 June 2024).

The art of recycling used electronics to make the planet greener (2023) *Nation*. Available at: <https://nation.africa/kenya/health/the-art-of-recycling-used-electronics-to-make-the-planet-greener-4347064> (Accessed: 21 June 2024).

The circular economy in detail (no date). Available at: <https://www.ellenmacarthurfoundation.org/the-circular-economy-in-detail-deep-dive> (Accessed: 21 June 2024).

The world's e-waste is a huge problem. It's also a golden opportunity (2019) *World Economic Forum*. Available at: <https://www.weforum.org/agenda/2019/01/how-a-circular-approach-can-turn-e-waste-into-a-golden-opportunity/> (Accessed: 17 June 2024).

Tofail, S.A.M. *et al.* (2018) 'Additive manufacturing: scientific and technological challenges, market uptake and opportunities', *Materials Today*, 21(1), pp. 22–37. Available at: <https://doi.org/10.1016/j.mattod.2017.07.001>.

Toxic trash dumps Africa in the danger zone (no date) *ENACT Africa*. Available at: <https://enactafrica.org/enact-observer/toxic-trash-dumps-africa-in-the-danger-zone> (Accessed: 21 June 2024).

UN report: Time to seize opportunity, tackle challenge of e-waste (2019) *UN Environment*. Available at: <http://www.unep.org/news-and-stories/press-release/un-report-time-seize-opportunity-tackle-challenge-e-waste> (Accessed: 17 June 2024).

United Nations E-waste Coalition, 2019. A new circular vision for electronics: time for a global reboot. World Economic Forum. Available at https://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf

United Nations, *Turning e-waste into gold: the untapped potential of African landfills* (2018) *UNEP*. Available at: <http://www.unep.org/news-and-stories/story/turning-e-waste-gold-untapped-potential-african-landfills> (Accessed: 22 June 2024).

Valavanidis, A. (2018) 'Concept and Practice of the Circular Economy'.

What Is the Digital Divide and How Is It Being Bridged? (no date) *WhatIs*. Available at: <https://www.techtarget.com/whatis/definition/digital-divide> (Accessed: 17 June 2024).

Yee, A. (2019) 'Electronic Marvels Turn into Dangerous Trash in East Africa', *The New York Times*, 12 May. Available at: <https://www.nytimes.com/2019/05/12/climate/electronic-marvels-turn-into-dangerous-trash-in-east-africa.html> (Accessed: 21 June 2024).

Enhancing E-waste Management in Kenya for a Cleaner Environment

Zeng, X., Mathews, J.A. and Li, J. (2018) 'Urban Mining of E-Waste is Becoming More Cost-Effective Than Virgin Mining', *Environmental Science & Technology*, 52(8), pp. 4835–4841. Available at: <https://doi.org/10.1021/acs.est.7b04909>.