JAMBURA LAW REVIEW

Volume 6 Issue 01
JALREV 6 (1) 2024

January 2024
ISSN Print: 2654-9266
ISSN Online: 2656-0461

Enabling Circular Economy: Towards Sustainable Electronic Waste Management Regulation

Fenty U. Puluhulawa[1]✉
Amanda Adelina Harun[2]

[1,2]Faculty of Law, Universitas Negeri Gorontalo, Indonesia.

✉ *fentypuluhulawa@ung.ac.id*

Article Info

Submitted: Aug 7, 2023
Revised: Dec 9, 2023
Accepted: Jan 9, 2024

Keywords:
Circular Economy; Electronic Waste Management; Regulation.

How to cite *[Chicago Manual of Style 17th edition (full note)]:*
Puluhulawa, Fenty U., and Amanda Adelina Harun. "Enabling Circular Economy: Towards Sustainable Electronic Waste Management Regulation." *Jambura Law Review* 6, no. 1 (2024): 33–65.

Abstract

Electronic waste contains hazardous and toxic materials which could pollute the environment and endanger humans, therefore it requires special management. In Indonesia, Law No. 18 of 2008 concerning Waste Management has not specifically regulated the management of electronic waste. This article explores how circular economy concept are applied in Indonesia's waste management laws, specifically addressing electronic waste. The results of the study found that the waste management model in Indonesia, which generally accumulates waste in Final Disposal Sites, could not be a long-term solution for electronic waste. Based on circular economy principles, every product must be utilized optimally both as a product and as an ingredient by recycling. Recycle in an economy circular also known in Law No. 18 of 2008. The recycling method needs to be applied to electronic waste, purposed to reduce pollution caused by electronic waste, as well as reduce hazardous content due to the production process. Indonesia is still lacking in terms of electronic waste regulation.

1. Introduction

Technology plays a significant role in human life, aiding in the facilitation of human activities. Currently, Indonesia is in the era of the fourth industrial revolution, characterized by rapid developments in internet-based human activities.[1] Various innovations in electronics are created to keep up with technological advancements, leading to an increase in the sales of electronic goods that can be challenging to restrict.[2] The dynamic and rapid movement of the electronic market results in a buildup of unused electronic goods that eventually turn into waste. This waste in the form of electronic items is then known as electronic waste or e-waste, which can include items such as rice cookers, laptops, refrigerators, televisions, tape recorders, radios, mobile phones, air conditioners, washing machines, water dispensers, and so on.[3] Typically, electronic waste today originates mainly from household appliances and needs to go through a separate management process from domestic waste.[4] Electronic waste generally falls under the category of Hazardous and Toxic Waste (Bahan Berbahaya dan Beracun or B3) because electronic devices contain components or parts that contain hazardous substances (such as lead, mercury, cadmium, and others).[5] Electronic waste also contains various materials such as precious metals and rare earth elements, making it necessary to make efforts for recovery.[6]

Such content can pollute the environment and pose health risks to humans by damaging human tissue and potentially causing various diseases.[7] Hence, electronic waste requires specialized management distinct from the management of other types of waste. Electronic waste poses a challenge for developing countries, especially those

[1] Kementerian Pendidikan dan Kebudayaan Republik Indonesia, "Majalah JendelaSekilas Pandang Revolusi Industri 4.0" (2022).
[2] I Putu and Udiyana Wasista, "Isu Keusangan Terencana Dan Sampah Elektronik Pada Revolusi Industri 4.0," *Prosiding Seminar Nasional Desain Dan Arsitektur (SENADA)* 3 (2020): 2655–4313.
[3] Josua Jonny Hardianto Banjar Nahor, "Implikasi Dan Pengelolaan Limbah Elektronik," *Buletin Utama Teknik* 14, no. 2 (2019): 1410–4520.
[4] Irwan Ridwan Rahim, Rasdiana Zakaria, and Anisa Ramadhani Sahlan, "Studi Kemauan Membayar (Willingness To Pay) Masyarakat Dalam Pengelolaan Sampah Elektronik Di Kota Makassar," *Jurnal Penelitian Enjiniring* 19, no. 03 (2017).
[5] Hilda Fentika and Mohamad Mirwan, "Peran Serta Masyarakat Dalam Pengelolaan Sampah Elektronik Di Wilayah Surabaya Utara," *Ilmiah Teknik Lingkungan* 8, no. 2 (2021): 112–17.
[6] Nahor, "Implikasi Dan Pengelolaan Limbah Elektronik."
[7] Nahor.

with large populations like Indonesia.[8] The issue of electronic waste is not only related to its rapid growth but also concerns the availability of facilities for storage and processing, as well as finding concepts that are suitable for local conditions, taking into consideration social-economic and cultural dimensions as important factors for policy considerations.[9]

The concept of a circular economy aims to encourage that a product can be processed again with the steps of Reduce, Reuse, Recycle, Replace, and Repair.[10] The concept of a circular economy aims to enhance the economy and the quality of the environment, as well as benefit future generations, based on the business model and consumption patterns of society.[11] The circular economy has the potential to be a reliable concept for addressing the issue of electronic waste and can serve as a fundamental concept in policies regarding electronic waste management.

The Circular Economy is currently a concept promoted by the European Union, as well as several countries including France, Canada, the Netherlands, Sweden, China, Japan, the United Kingdom, and Finland, along with various business sectors worldwide.[12] In some scientific literature, it is stated that the concept of a circular economy creates management by reducing the production and consumption of a product.[13] The circular economy has gained global attention, but in the development of its concept and

[8] Widi Astuti, "Dampak Kandungan Logam Berat Dalam Sampah Elektronik (E-Waste) Terhadap Kesehatan Dan Lingkungan," *Majalah Ilmiah Universitas Pandanaran* 11, no. 25 (2013): 1–8.
[9] Trina Ayuni, Dodik Ridho Nurrochmat, and Nastiti Siswi Indrasti, "Strategi Pengelolaan Limbah Elektronik Melalui Pengembangan Infrastruktur Ramah Lingkungan," *Risalah Kebijakan Pertanian Dan Lingkungan: Rumusan Kajian Strategis Bidang Pertanian Dan Lingkungan* 3, no. 1 (February 22, 2017): 8, https://doi.org/10.20957/jkebijakan.v3i1.15238.
[10] Indah Purwanti, "Konsep Implementasi Ekonomi Sirkular Dalam Program Bank Sampah (Studi Kasus: Keberlanjutan Bank Sampah Tanjung)," *AmaNu: Jurnal Manajemen Dan Ekonomi* 4, no. 1 (2021): 89–98; Angga Wijaya Holman Fasa, "Aspek Hukum Dan Kebijakan Pemerintah Indonesia Mengenai Ekonomi Sirkular Dalam Rangka Mencapai Tujuan Pembangunan Berkelanjutan," *Jurnal Rechts Vinding: Media Pembinaan Hukum Nasional* 10, no. 3 (2021): 339, https://doi.org/10.33331/rechtsvinding.v10i3.774.
[11] Holman Fasa, "Aspek Hukum Dan Kebijakan Pemerintah Indonesia Mengenai Ekonomi Sirkular Dalam Rangka Mencapai Tujuan Pembangunan Berkelanjutan."
[12] Jouni Korhonen, Antero Honkasalo, and Jyri Seppälä, "Circular Economy: The Concept and Its Limitations," *Ecological Economics* 143 (2018): 37–46, https://doi.org/10.1016/j.ecolecon.2017.06.041.
[13] Adelia Tesalonika and Haddy Sutjipto, "Human Capital Dan Masyarakat Ekonomi Sirkular: Teologis Keberlanjutan Global Di Indonesia," *EMAGRAP Economic Military and Geography Business Review* 1, no. 1 (2023): 1–18; Tonni Agustiono Kurniawan et al., "Reforming MSWM in Sukunan (Yogjakarta, Indonesia): A Case-Study of Applying a Zero-Waste Approach Based on Circular Economy Paradigm," *Journal of Cleaner Production* 284 (2021), https://doi.org/10.1016/j.jclepro.2020.124775.

practices, there are still challenges and research gaps that need to be addressed.[14] Several recent scientific studies have stated that circular economy practices, waste management, accountability, and management accounting practices contribute to achieving the goals of ecosystem protection and sustainable development.[15] Other research results indicate that digital technologies such as the Internet of Things, value-added manufacturing and 3D printing, blockchain technology, and online platforms play a role in achieving sustainable electronic products within the circular economy,[16] However, other research results suggest that this idea is more developed in scientific studies than in practice.[17] The concept of a circular economy has been widely studied recently, but it has not been explicitly discussed, particularly concerning business management models as the primary actors.[18] The concept of a circular economy is essential in achieving environmentally friendly development, making it crucial for the development of circular economy sectors in education, health, and infrastructure.[19] In Indonesia's waste management laws, the concept of a circular economy is only subtly reflected. Moreover, in the realm of electronic waste management, there exists a legal vacuum, and it is necessary to regulate and govern electronic waste management in accordance with the principles of the circular economy.

2. Problem Statement

This article concentrates on analyzing the circular economy within the legal framework of waste management in Indonesia, specifically concerning the management of electronic waste laws.

---

[14] Joana Fernandes and Paulo Ferrão, "A New Framework for Circular Refurbishment of Buildings to Operationalize Circular Economy Policies," *Environments - MDPI* 10, no. 3 (2023), https://doi.org/10.3390/environments10030051.

[15] Assunta Di Vaio et al., "The Transition towards Circular Economy and Waste within Accounting and Accountability Models: A Systematic Literature Review and Conceptual Framework," *Environment, Development and Sustainability* 25, no. 1 (2023): 734–810, https://doi.org/10.1007/s10668-021-02078-5.

[16] Laura Piscicelli, "The Sustainability Impact of a Digital Circular Economy," *Current Opinion in Environmental Sustainability* 61 (2023): 101251, https://doi.org/10.1016/j.cosust.2022.101251.

[17] Magdalena Rusch, Josef Peter Schöggl, and Rupert J. Baumgartner, "Application of Digital Technologies for Sustainable Product Management in a Circular Economy: A Review," *Business Strategy and the Environment* 32, no. 3 (2023): 1159–74, https://doi.org/10.1002/bse.3099.

[18] Tulin Dzhengiz et al., "Unpacking the Circular Economy: A Problematizing Review," *International Journal of Management Reviews* 25, no. 2 (2023): 270–96, https://doi.org/10.1111/ijmr.12329.

[19] Tesalonika and Sutjipto, "Human Capital Dan Masyarakat Ekonomi Sirkular: Teologis Keberlanjutan Global Di Indonesia."

3. Methods

This article is a normative legal research study and aims to analyze the concept of a circular economy in the context of electronic waste management. The research approach was the conceptual approach, which analyzes the concept of circular economy and waste management. Besides the conceptual approach, this article also uses the statute approach, especially Law No. 18 of 2008 on Waste Management and other laws related to waste management.

4. Result and Discussion

The circular economy concept is rooted in a 'win-win' perspective, aiming to achieve economic prosperity and environmental conservation simultaneously.[20] The concept of the circular economy offers a production and usage process for a product that can be illustrated as a circle, demanding fewer and more economical resources and energy usage.[21] The proposed cycle model can serve as a solution for the regulation of electronic waste management.

4.1. Circular Economy, Respond for Linear Economy

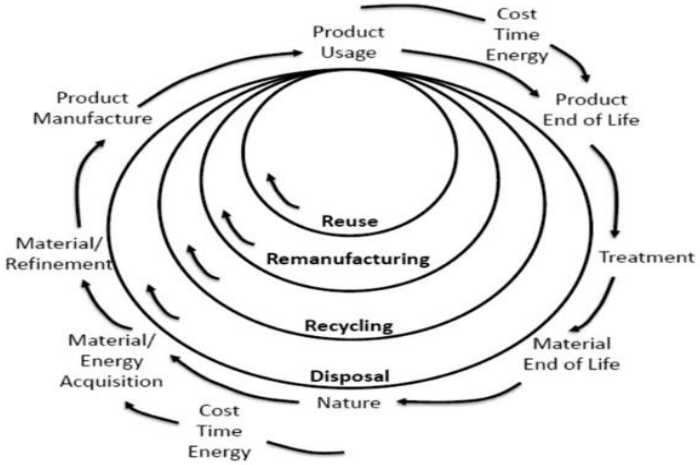
The concept of the circular economy began to gain popularity in the 1990s as a response to economic development challenges and the need to reduce excessive exploitation of natural resources.[22] This concept gained popularity in China, emerging as a response to the high rate of economic growth, environmental degradation as a consequence, the impact on human health due to pollution, and issues of social justice.[23] The awareness that the linear and "unlimited" increase in production and societal well-being is impossible in a world with "limited" resources has become evident.[24] Several experts contributed to the concept of the circular economy can be identified, such as John Lyle, William McDonough, Michael Braungart, and Walter

[20] Baljinder Kaur, Kirandeep Kaur, and Harreet Kaur, "E-Waste Management: A Transition towards a Circular Economy," *The Impact of Climate Change and Sustainability Standards on the Insurance Market*, no. May (2023): 403–16, https://doi.org/10.1007/978-981-15-7525-9.
[21] Korhonen, Honkasalo, and Seppälä, "Circular Economy: The Concept and Its Limitations."
[22] Purwanti, "Konsep Implementasi Ekonomi Sirkular Dalam Program Bank Sampah (Studi Kasus: Keberlanjutan Bank Sampah Tanjung)."
[23] K. Winans, A. Kendall, and H. Deng, "The History and Current Applications of the Circular Economy Concept," *Renewable and Sustainable Energy Reviews* 68, no. October 2015 (2017): 825–33, https://doi.org/10.1016/j.rser.2016.09.123.
[24] Florin Bonciu, "The European Economy: From a Linear to a Circular Economy," *Romanian Journal of European Affairs* 14, no. 4 (2014): 78–91.

Stahel.[25] Recently, the concept of the circular economy has started to receive attention from a regulatory and political perspective as a concept that focuses on the synergy between economic growth and environmental protection.[26]

The concept of the circular economy replaces the 'end-of-life' concept with reduction, alternative reuse, recycling actions, and material recovery in the production/distribution and consumption processes, thus creating new business models and responsible consumers.[27] From a business perspective, the implementation of the circular economy not only provides environmental benefits but also has the potential to generate economic advantages.[28] The processes offered by the concept of the circular economy need to be implemented at the micro level (products, companies, consumers), the meso level (eco-industrial parks), and the macro level (cities, regions, countries, and so on), to achieve sustainable development to create environmental quality, economic well-being, and social justice for both the present and future generations.[29]

Figure 1. Circular Economy Concept



[25] Winans, Kendall, and Deng, "The History and Current Applications of the Circular Economy Concept."
[26] Allen Alexander and Stefano Pascucci, *Handbook of the Circular Economy: Transitions and Transformation*, ed. Fiona Charnley (Germany: Walter de Gruyter GmbH & Co KG, 2023); A. Kasztelan, "Green Growth, Green Economy and Sustainable Development: Terminological and Relational Discourse," *Prague Economic Papers* 26, no. 4 (2017): 487–99, https://doi.org/10.18267/j.pep.626.
[27] Julian Kirchherr, Denise Reike, and Marko Hekkert, "Conceptualizing the Circular Economy: An Analysis of 114 Definitions," *Resources, Conservation and Recycling* 127, no. April (2017): 221–32, https://doi.org/10.1016/j.resconrec.2017.09.005.
[28] Andreas Budihardjo et al., *Fenomena Bisnis Ekonomi Terkini: Seri 2 2022-2023* (Jakarta: Prasetiya Mulya Publishing, 2023).
[29] Kirchherr, Reike, and Hekkert, "Conceptualizing the Circular Economy: An Analysis of 114 Definitions."

The concept of the circular economy offers a process where, after raw materials are extracted, refined, and produced at normal costs, economically and business-wise, it is expected that these costs will result in products that can be used for as long as possible,[30] as shown in Figure 1.[31] The circular economy addresses the weaknesses of the linear economy[32] which is based on production, consumption, and disposal.[33] The linear pattern has a negative impact on the environment because it becomes problematic when resources are limited, tends to generate pollution, emissions, and produces a significant amount of waste. Maintaining a product for as long as possible means value chains without waste, supported by regenerative (renewable) energy.[34] This places the production process of goods towards sustainability by reducing resource consumption and minimizing the resource usage, emissions, and energy wastage by slowing down, narrowing, or even closing the product's lifecycle.[35] This is achieved by reducing the use of new products, restoration, recycling, sustainable economy, and eco-efficiency.[36] The circular economy approach is the competitive advantage gained by organizations that adopt circular economy principles as a core element of their growth strategies.[37] Some view of the circular economy as a marketing gimmick that exploits ecological issues to attract consumer attention.[38] Utilizing

[30] Korhonen, Honkasalo, and Seppälä, "Circular Economy: The Concept and Its Limitations"; Sylvie Geisendorf and Felicitas Pietrulla, "The Circular Economy and Circular Economic Concepts—a Literature Analysis and Redefinition," *Thunderbird International Business Review* 60, no. 5 (2018): 771–82, https://doi.org/10.1002/tie.21924; Nurhidayati Dwiningsih and Ludwina Harahap, "Pengenalan Ekonomi Sirkular (Circular Economy) Bagi Masyarakat Umum Empowerment : Jurnal Pengabdian Masyarakat," *Empowerment: Jurnal Pengabdian Masyarakat* 1, no. 2 (2022): 135–41.

[31] James R. Mihelcic et al., "Sustainability Science and Engineering: The Emergence of a New Metadiscipline," *Environmental Science and Technology* 37, no. 23 (2003): 5314–24, https://doi.org/10.1021/es034605h.

[32] Richard Jatimulya Alam Wibowo et al., "Studi Komparatif Ekonomi Sirkular Dalam Arah Kebijakan Hukum Pengelolaan Sampah Kemasan Plastik Di Indonesia Dan Jerman," *Nusantara: Jurnal Ilmu Pengetahuan Sosial* 10, no. 5 (July 28, 2023): 2467–80, https://doi.org/10.31604/jips.v10i5.2023.2467-2480.

[33] Sri Kurnia et al., "Circular Solutions for Decent Work and Economic Growth: Lessons from Sustainable Development Goals (SDG) 8," *Academia Open* 8, no. 1 (July 5, 2023), https://doi.org/10.21070/ACOPEN.8.2023.6657.

[34] Peter Lacy and Jakob Rutqvist, *Waste to Wealth* (United States of America: Palgrave Macmillan, 2015).

[35] Muhammad Rafiqi Sitompul, "Ekonomi Sirkular Dalam Pengembangan Bisnis Penerbangan Di Indonesia," *Warta Penelitian Perhubungan* 35, no. 1 (2023): 49–58.

[36] Wibowo et al., "Studi Komparatif Ekonomi Sirkular Dalam Arah Kebijakan Hukum Pengelolaan Sampah Kemasan Plastik Di Indonesia Dan Jerman."

[37] Lacy and Rutqvist, *Waste to Wealth*.

[38] Husna Ni'matul Ulya, Wening Purbarin, and Palupi Soenjoto, "Ekonomi Sirkular: Praktik Strategi Pemasaran Berkedok Isu Ekologi," in *Prosiding Konferensi Integrasi Interkoneksi Islam Dan Sains*, vol. 5, 2023, 253–59.

ecological issues in product promotion provides satisfaction to customers as they feel they have contributed to 'saving the environment,' creating a psychological bond between consumers and the product.[39]

4.2. Economy Circular on Indonesia Waste Management Law

The circular economy is an effort to conceptualize the integration of economic activities and environmental well-being in a sustainable manner.[40] Economic activities have an impact on environmental degradation, so the condition of the environment needs to be preserved to ensure the survival of future generations.[41] Indonesia does indeed have abundant natural resources, but with high levels of exploitation, these natural resources have limitations in regenerating themselves. Due to the limited nature of these natural resources, it is necessary to shift the economic activities from a linear economy to a circular economy.[42] The linear economic system is considered to deplete resources, generate high levels of waste and emissions, and have adverse impacts on the environment.[43]

The economic activities referred to encompass the entire process from production, distribution, usage, and post-usage. The circular economy is closely related to waste management,[44] because one of the propositions it offers is to reduce waste accumulation by maximizing the economic value of waste,[45] As a result, waste management is also a part of the process that needs to be based on the circular economy concept. The majority of developing countries, including Indonesia, face issues related to waste.[46] The waste generated from garbage in Indonesia has reached

[39] Ni'matul Ulya, Purbarin, and Soenjoto.
[40] Alan Murray, Keith Skene, and Kathryn Haynes, "The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context," *Journal of Business Ethics* 140, no. 3 (2017): 369–80, https://doi.org/10.1007/s10551-015-2693-2.
[41] José Luís Cardoso, "The Circular Economy: Historical Grounds," *Changing Societies: Legacies and Challenges* III (2018): 115–27.
[42] Fadhila Abidah, Syarifa Hanoum, and Faiz Sugihartanto, "Perkembangan Rantai Pasok Sirkular: Kajian Literatur," *Jurnal Sains Dan Seni ITS* 11, no. 5 (2022): 169–71.
[43] Abidah, Hanoum, and Sugihartanto.
[44] Sitompul, "Ekonomi Sirkular Dalam Pengembangan Bisnis Penerbangan Di Indonesia."
[45] Amy Zahrawaan, "Tetra Pak Printing: Sebuah Model Pengolahan Sampah Berbasis Seni," *Urban: Jurnal Seni Urban* 6, no. 1 (2022): 41–56, https://doi.org/10.52969/jsu.v6i1.55.
[46] Hernawati W. Retno Wiratih et al., "Upaya Mengolah Limbah Sampah Menjadi Peluang Social Enterprise Ekonomi Kreatif Bagi Generasi-Z," in *Prosiding Konferensi Nasional Pengabdian Kepada Masyarakat Dan Corporate Social Responsibility (PKM-CSR)*, vol. 4, 2021, 1049–55, https://doi.org/10.37695/pkmcsr.v4i0.1319.

175,000 tons per day, which is equivalent to 64 million tons per year.[47] Waste management in Indonesia is carried out with 69% of the waste being collected and dumped in landfills, 10% buried, 7% composted and recycled, 5% incinerated, and 7% left unmanaged.[48] Based on the presented data, the waste management model in Indonesia is still concentrated in the Final Processing Sites (Tempat Pembuangan Akhir or TPA), with very little going through the 3R process (reduce, recycle, reuse).[49] Waste management is a significant challenge that needs to be addressed by authorities in developing countries.[50] This is where it is important to consider the crucial role of law in regulating matters such as environmental protection enshrined in the constitution,[51] especially in countries with large populations like Indonesia. Indonesia follows a Civil Law System, where legislation under the constitution plays a primary role in the legal framework.[52]

The legal basis for waste management in Indonesia is the Law No. 18 of 2008 on Waste Management. While some other regulations touch on waste-related issues, they do not specifically address waste management. For example, these references can be found in laws such as Law No. 17 of 2008 on Shipping, Law No. 3 of 2022 on the National Capital City, Law No. 28 of 2002 on Building Construction, and others. Currently, Indonesia does not have specific regulations that govern the implementation of a circular economy, [53] Except for Law No. 3 of 2022, which explicitly states that waste management is based on the concept of the circular economy.[54] Other regulations

[47] Wiratih et al.
[48] Wiratih et al.
[49] Wiratih et al.
[50] Anggun Pesona et al., "Perancangan Sistem Manajemen Berbasis Ekonomi Sirkular Pada Kegiatan Usaha Pengelolaan Sampah Terintegrasi," *Dedikasi Jurnal Pengabdian Kepada Masyarakat* 2, no. 2 (2023): 313–23.
[51] Novendri M Nggilu et al., "The Indonesian State Policy: History and the Future," *American Journal of Multidisciplinary Research & Development (AJMRD)* 04, no. 05 (2022): 7–11.
[52] Fenty Puluhulawa, Mohammad Rusdiyanto Puluhulawa, and Amanda Adelina Harun, "Legal Culture of Local Community in Plastic Waste Management," in *3rd International Conference on Law Reform (3rd INCLAR)*, vol. 2022 (KnE Social Sciences, 2022), 183–91, https://doi.org/10.18502/kss.v7i15.12089.
[53] A. D. Sartono, "Potensi Implementasi Ekonomi Sirkular Dalam Mengelola Sampah Plastik Di Kabupaten Bogor," *Syntax Literate: J. Ilmiah Indonesia* 7, no. 3 (2022): 1184–94.
[54] "Management of urban functional areas that are environmentally oriented; and d. implementation of waste and waste processing using circular economy principles". See, Article 18, paragraph (3) point (c), Republic of Indonesia, "Law Number 3 of 2022 Concerning National Capital" (2022).

indirectly govern programs and policies related to waste management.[55] The regulation on circular economy in Law No. 3 of 2022 mainly addresses circular economy principles at the management level and lacks a comprehensive approach.[56]

Waste management is considered one of the components of the circular economy. According to the Law No. 18 of 2008 on Waste Management, waste management is defined as a systematic, comprehensive, and continuous activity that includes waste reduction and handling.[57] Law No. 18 of 2008 on Waste Management does not explicitly state that waste management methods should be based on the circular economy concept. However, some policies within the law align with the principles of the circular economy. Law No. 18 of 2008 on Waste Management is essentially oriented towards waste reduction, aiming to reduce waste accumulation by promoting recycling and reuse of waste, both with the same and different functions.[58] This can be seen, among other things, in the Waste Management Law in Article 6 concerning waste reduction and limitation and Article 20 concerning recycling and reuse. The 3R (Reduce-Reuse-Recycle) or even 5R (Reduce-Reused-Recycle-Recovery-Repair) methods[59] are in line with three main principles of circular economy: (1) eliminating waste and pollution; (2) circulating materials in products; and (3) regenerating nature.[60]

[55] Sartono, "Potensi Implementasi Ekonomi Sirkular Dalam Mengelola Sampah Plastik Di Kabupaten Bogor."
[56] Sofwan Rizko Ramadoni, Kalen Sanata, and Reza Pramasta Gegana, "Ekonomi Sirkular: Tantangan Dan Peluang Pengaturan Pengelolaan Sampah Dan Limbah Di IKN Nusantara," *Prosiding Seminar Nasional Unars* 2, no. 1 (August 22, 2023): 416–28.
[57] Article 1, number 5, Republic of Indonesia, "Law Number 18 of 2008 Concerning Waste Management" (2008).
[58] Sartono, "Potensi Implementasi Ekonomi Sirkular Dalam Mengelola Sampah Plastik Di Kabupaten Bogor."
[59] Aloysius Hari Kristianto and Jones Parlindungan Nadapdap, "Dinamika Sistem Ekonomi Sirkular Berbasis Masyarakat Metode Causal Loop Diagram Kota Bengkayang," *Sebatik* 25, no. 1 (2021): 59–67, https://doi.org/10.46984/sebatik.v25i1.1279; Ola Persson and Jennifer B. Hinton, "Second-Hand Clothing Markets and a Just Circular Economy? Exploring the Role of Business Forms and Profit," *Journal of Cleaner Production* 390, no. June 2022 (2023): 136139, https://doi.org/10.1016/j.jclepro.2023.136139; Andrean W Finaka, "Prinsip 5R Untuk Ciptakan Indonesia Bersih," 2019, https://indonesiabaik.id/infografis/prinsip-5r-untuk-ciptakan-indonesia-bersih#:~:text=Prinsip 5R dapat dilakukan melalui,dengan melakukan perbaikan (repair).
[60] Pesona et al., "Perancangan Sistem Manajemen Berbasis Ekonomi Sirkular Pada Kegiatan Usaha Pengelolaan Sampah Terintegrasi."

Waste management services in Indonesia are not yet optimal due to limited land availability, limited resources, and restricted budgets in the waste management sector.[61] At the implementation level, waste management in Indonesia generally follows the old concept of collecting-transporting-disposing or end-of-pipe, where waste is collected, transported, and then disposed of in final disposal sites (TPAs).[62] Waste that ends up in TPAs is generally mixed and not sorted based on specific categories.[63] As a result, it is difficult to implement the 3R or 5R models in TPAs. These models place a burden on TPAs because the end-of-pipe model tends to require extensive land and expensive environmental protection facilities.[64] In addition to land, waste management models like this require operational facilities to transport waste from residential areas to TPAs. The budget used to manage TPAs will increase over time as the amount of waste accumulates. Without proper waste management mechanisms, various problems can arise, such as operational issues like uncollected waste, inadequate facilities, and improper facility operation in terms of technical requirements.[65] The scarcity of facilities related to waste operations and limited temporary waste storage areas minimally encourage the community to dispose of waste in inappropriate places, such as rivers and roadsides.[66]

The adoption of the circular economy in Indonesian laws tends to be relatively recent, primarily focusing on implementing the 3R or 5R methods. As far as is known, there are no regulations mandating businesses to use durable materials that can be recycled, even though such practices are part of the circular economy. The 3R or 5R methods are recognized within several waste management laws in Indonesia. These include not

[61] Pesona et al.
[62] Dyah Ernawati, Sri Budiastuti, and M Masykuri, "Analisis Komposisi, Jumlah Dan Pengembangan Strategi Pengelolaan Sampah Di Wilayah Pemerintah Kota Semarang Berbasis Analisis SWOT," *Jurnal Ekosains* IV, no. 2 (2012): 13–22.
[63] Danang Aji Kurniawan and Ahmad Zaenal Santoso, "Pengelolaan Sampah Di Daerah Sepatan Kabupaten Tangerang," *ADI Pengabdian Kepada Masyarakat* 1, no. 1 (2021): 31–36, https://doi.org/10.34306/adimas.v1i1.247.
[64] Tri Yudianto, Prabang Setyono, and I Gusti Ayu Ketut Rachmi Handayani, "Implementasi Kebijakan Dan Strategi Dalam Pengelolaan Sampah Di Kabupaten Blora," *Jurnal Kesehatan Lingkungan Indonesia* 20, no. 1 (2021): 21–26, https://doi.org/10.14710/jkli.20.1.21-26.
[65] Reni Masrida, "Kajian Timbulan Dan Komposisi Sampah Sebagai Dasar Pengelolaan Sampah Di Kampus Ii Universitas Bhayangkara Jakarta Raya," *Journal of Env. Engineering & Waste Management* 2, no. 2 (2017): 69–78.
[66] Kurniawan and Santoso, "Pengelolaan Sampah Di Daerah Sepatan Kabupaten Tangerang."

only the Law Number 18 of 2008 on Waste Management, but are also acknowledged in the Government Regulation Number 81 of 2012 on the Management of Hazardous and Toxic Waste, Government Regulation Number 97 of 2017 concerning the Control of Pollution and/or Destruction of the Environment Due to Plastic Waste, and the Regulation of the Minister of Environment and Forestry Number P.75/MENLHK/SETJEN/KUM.1/11/2016 concerning the Guidelines for the Implementation of 3R in the Environment of the Ministry of Environment and Forestry. Waste management through adopting a circular economy includes harnessing the economic potential of waste,[67] however, this proves challenging due to the low recycling rates. The recycling rate of waste in Indonesia remains notably low. Specifically, for plastic waste in 2023, the recycling rate is reported at 7%,[68] while concurrently, the total waste accumulation in 2023 reaches 35.83 million tons.[69] Low recycling rate potential for waste accumulation to pollute the environment is thereby reduced.[70] The recycling or utilization stages of waste for economic purposes within a circular economy are not explicitly regulated in waste management laws in Indonesia. It needs to be ensured that national laws regulate up to the recycling stage,[71] otherwise, it will consequently lead to a tendency for waste accumulation.

4.3. Economy Circular Towards Indonesian Electronic Waste Problem

The increase in population, economic growth rate, and development in a region have both positive and negative impacts. On one hand, it contributes to the well-being of society, but on the other hand, it leads to environmental degradation.[72] Environmental

[67] Kementerian Koordinator Bidang Pembangunan Manusia dan Kebudayaan, "7,2 Juta Ton Sampah Di Indonesia Belum Terkelola Dengan Baik," 2023, https://www.kemenkopmk.go.id/72-juta-ton-sampah-di-indonesia-belum-terkelola-dengan-baik.

[68] Djacinta Rasya Andini, Deasy Olivia, and Anisza Ratnasari, "Penerapan Konsep Arsitektur Berbasis Komunitas Pada Pusat Edukasi Daur Ulang Sampah," *IKRA-ITH Teknologi Jurnal Sains Dan Teknologi* 7, no. 3 (2023): 1–12, https://doi.org/10.37817/ikraith-teknologi.v7i3.3228.

[69] Cindy Mutia Annur, "Sampah Indonesia Bertambah Pada 2022, Terbanyak Dalam Empat Tahun," Volume Timbulan Sampah Nasional (2019-2022), 2023, https://databoks.katadata.co.id/datapublish/2023/10/16/sampah-indonesia-bertambah-pada-2022-terbanyak-dalam-empat-tahun.

[70] Tri Yuniarti and Titik Anggraeni, "Dampak Tempat Pembuangan Akhir Sampah Putri Cempo Surakarta Terhadap Penyakit Kulit Pada Masyarakat Mojosongo," *Jurnal Ilmiah Rekam Medis Dan Informatika Kesehatan, ISSN 2086-2628* 8, no. 1 (2018): 26–29.

[71] Shamila Dawood and Ajra Azhar, "Trash Trade and Environmental Regulations: An Assessment," *Lentera Hukum* 8, no. 3 (2021): 347, https://doi.org/10.19184/ejlh.v8i3.27138.

[72] S N Qodriyatun, "Meningkatkan Kesejahteraan Masyarakat Melalui Pengelolaan Sampah Berdasarkan UU No. 18 Tahun 2008," *Aspirasi: Jurnal Masalah-Masalah Sosial*, no. 18 (2014): 21–34.

issues, such as the extinction of certain parts of biodiversity, water, air, and soil pollution, diminishing resources, and excessive land use, are increasingly endangering the Earth's life support systems,[73] because the environment is the source of human needs.[74] One of the environmental problems related to waste is pollution. Indonesia, as the most populous country, faces environmental issues due to the generation of municipal solid waste.[75] The development of urban communities, which tends to become increasingly complex, has an impact on waste-related issues that also tend to become more complex.[76] Waste is the residue of human activities, and without proper management, it tends to have negative impacts on humans and the environment, including decreased aesthetics, environmental pollution, and the spread of diseases.[77] Over time, this can lead to a decline in environmental quality, which can result from pollution caused by industrial waste, household waste, and factories.[78] A preserved environment is a fundamental necessity for human life.[79] Environmental protection is not only aimed at health interests but also economic interests. The deterioration of environmental quality also has the potential to impact the decline in economic income levels.[80]

Information and knowledge have become indispensable resources in supporting modern social progress and economic development.[81] The Fourth Industrial

[73] Martin Geissdoerfer et al., "The Circular Economy – A New Sustainability Paradigm?," *Journal of Cleaner Production* 2, no. 2 (2014): 210–22, https://doi.org/10.1016/j.jclepro.2016.12.048.Abstract.
[74] Fenty Puluhulawa, Mohammad Rusdiyanto Puluhulawa, and Amanda Adelina Harun, "Good Environment as Part of Human Right : A Case Study on Plastic Waste Post Pandemic," in *3rd International Conference on Law Reform (3rd INCLAR)*, vol. 2022, 2022, 10–24, https://doi.org/10.18502/kss.v7i15.12071.
[75] Kurniawan et al., "Reforming MSWM in Sukunan (Yogjakarta, Indonesia): A Case-Study of Applying a Zero-Waste Approach Based on Circular Economy Paradigm."
[76] Kodi Rina Mariani Gobai and Batara Surya, "Kinerja Pengelolaan Sampah Perkotaan (Studi Kasus Kota Nabire Kabupaten Nabire Provinsi Papua) Urban Waste Management Performance (A Case Study of Nabire City, Nabire Regency, Papua Province)," *Urban and Regional Studies Journal* 2, no. 2 (2020): 37–45.
[77] Rina Mariani Gobai and Surya.
[78] Mulyati, "Dampak Sampah Terhadap Kesehatan Lingkungan Dan Manusia," preprint (Open Science Framework, September 16, 2021), 1, https://doi.org/10.31219/osf.io/udesb.
[79] Puluhulawa, Puluhulawa, and Harun, "Good Environment as Part of Human Right : A Case Study on Plastic Waste Post Pandemic."
[80] CNN Indonesia, "BI Prediksi Ekonomi Dunia Susut 14 Persen Jika Acuh Ke Perubahan Iklim," 2023, https://www.cnnindonesia.com/ekonomi/20230330120533-532-931242/bi-prediksi-ekonomi-dunia-susut-14-persen-jika-acuh-ke-perubahan-iklim.
[81] Rusch, Schöggl, and Baumgartner, "Application of Digital Technologies for Sustainable Product Management in a Circular Economy: A Review."

Revolution has led to advancements in digital system technology, which has been developed into forms such as cyber-physical systems, smart factories, the Internet of Things, and the Internet of Services.[82] The development of technology is accompanied by a corresponding need for suitable electronic devices to complement it.[83] A lifestyle that tends to be consumptive, fast-paced, and expects instant results[84] was a challenge addressed by technology. Technological advancements encourage a more consumptive society, with the fulfillment of desires. Competition forces producers to cater more to consumers at relatively low and sometimes irrational costs.[85] In addition to the rapid pace of innovation, some people tend to discard electronic devices even if they still function, to acquire newer technology that aligns with their preferences.[86] The consumerist attitude prevalent in society towards electronic goods is driven by the desire to keep up with the latest technological offerings.[87] This has a positive impact on the rapid development of industrialization.[88] The affordability of electronic goods has made it easier to upgrade them.[89] Several reasons mentioned above have led to a shorter lifespan of electronic products,[90] the rapid development of the electronic market has also contributed to this trend.

The rapid advancement accelerates technological innovation, so an electronic device can quickly become 'suboptimal' and needs to be replaced to function optimally. Therefore, technological progress creates room for the development of electronics.[91]

[82] Putu and Wasista, "Isu Keusangan Terencana Dan Sampah Elektronik Pada Revolusi Industri 4.0."
[83] Anggraini Y. Djafar et al., "Dampak Dari Pencemaran Lingkungan Akibat Sampah Elektronik Dalam Prespektif Hukum Lingkungan," *Journal of Comprehensive Science (JCS)* 2, no. 6 (June 9, 2023): 1637–46, https://doi.org/10.59188/jcs.v2i6.388.
[84] Fenty Puluhulawa and Mohammad Rusdiyanto Puluhulawa, "Plastic Waste in Modern Era: Developing Plastic Waste Management for Sustainability," *E3S Web of Conferences* 259 (2021): 1–5, https://doi.org/10.1051/e3sconf/202125903001.
[85] M Firmansyah and Diah Setyorini Gunawan, "Antara Pembangunan Ekonomi Dan Degradasi Lingkungan," *Eko-Regional* 2, no. 2 (2007): 105–12.
[86] Astuti, "Dampak Kandungan Logam Berat Dalam Sampah Elektronik (E-Waste) Terhadap Kesehatan Dan Lingkungan."
[87] Putu and Wasista, "Isu Keusangan Terencana Dan Sampah Elektronik Pada Revolusi Industri 4.0."
[88] Firmansyah and Gunawan, "Antara Pembangunan Ekonomi Dan Degradasi Lingkungan."
[89] Muhamad Saifudin Sulhi et al., "Pemanfaatan Sampah Elektronik Rumah Tangga Sebagai Pembuatan Powerbank Pintar" (Seminar Nasional Dinamika Informatika 2017 Universitas PGRI Yogyakarta, Yogyakarta: Universitas PGRI Yogyakarta, 2017), 273–77, https://repository.upy.ac.id/1484/.
[90] Rahim, Zakaria, and Sahlan, "Studi Kemauan Membayar (Willingness To Pay) Masyarakat Dalam Pengelolaan Sampah Elektronik Di Kota Makassar."
[91] Putu and Wasista, "Isu Keusangan Terencana Dan Sampah Elektronik Pada Revolusi Industri 4.0."

Electronic waste is a global issue, with the fastest-growing waste stream in the world,[92] electronic waste growth rates are experiencing significance increases between 3% to 5%.[93] On average, each person generates more than 6 kg of electronic waste, with an estimated 50 million metric tons of electronic waste generated globally each year,[94] and 75% to 80% of this electronic waste is shipped to Asian and African countries for disposal or recycling.[95] Based on data from the Ministry of Environment and Forestry of the Republic of Indonesia, the amount of electronic waste accumulation was approximately 2 million tons in 2021, with only about 17.4% of it being effectively managed.[96] Indonesia is among the top 10 countries that produce the highest amount of electronic waste,[97] With its large population, Indonesia has an estimated usage of at least 100 million mobile phones.[98] Rapid advancements in information technology, along with the periodic introduction of new designs and technologies, contribute to premature obsolescence in electronic devices.[99] Premature obsolescence of electronic devices leads to faster replacements with the latest technology, while older electronic items are left behind and become electronic waste. For commonly found electronic devices, the average lifespan of their usage is below 8 years.[100]

---

[92] Amelia Agusni, "Merintis Sistem Standardisasi Tata Kelola Sampah Elektronik Pemerintah," *Standar: Better Standard Better Living* 2, no. 1 (2023): 2021–24.

[93] Kripa Shah, "A Circular Economy Approach to Improve E-Waste Recycling in California : Economic Potential and Policy Options," *Master's Projects and Capstones*, 2022, 1–80; Federica Cucchiella et al., "Recycling of WEEEs: An Economic Assessment of Present and Future e-Waste Streams," *Renewable and Sustainable Energy Reviews* 51 (2015): 263–72, https://doi.org/10.1016/j.rser.2015.06.010.

[94] Keshav Parajuly et al., "Future E-Waste Scenarios," *StEP (Bonn), UNU ViE-SCYCLE (Bonn) & UNEP IETC (Osaka)*, 2019, 19.

[95] Fx joko Priyono, "Pengendalian Perdagangan Sampah Elektronik: Kajian Perjanjian Internasional Dan Kebijakan Perdagangan," *Masalah-Masalah Hukum* 47, no. 2 (2018): 175, https://doi.org/10.14710/mmh.47.2.2018.175-183.

[96] Hisyam Usman, "Timbunan Sampah Elektronik Dan Pengelolaanya Di Indonesia," 2022, https://environment-indonesia.com/timbunan-sampah-elektronik-dan-pengelolaanya-di-indonesia/.

[97] H. Soesanto et al., "Current Status of Household E-Waste Management in Jakarta, Indonesia," *IOP Conference Series: Earth and Environmental Science* 1109, no. 1 (2022), https://doi.org/10.1088/1755-1315/1109/1/012042.

[98] Yenita and Lamto Widodo, "Implementation of the Electronic Waste Management to Achieve Environmental Sustainability in Indonesia," *Advances in Social Science, Education and Humanities Research* 478, no. Ticash (2020): 1008–14, https://doi.org/10.2991/assehr.k.201209.160.

[99] Sunil Herat and P. Agamuthu, "E-Waste: A Problem or an Opportunity? Review of Issues, Challenges and Solutions in Asian Countries," *Waste Management and Research* 30, no. 11 (2012): 1113–29, https://doi.org/10.1177/0734242X12453378.

[100] Quantum, "What's the Average Lifespan of Your Electronics?," 2021, https://quantumlifecycle.com/en_CA/blog/whats-the-average-lifespan-of-your-electronics/.

An electronic device typically contains various elements, such as iron, plastic, wood, and others.[101] In addition to the materials mentioned in the figure, electronic waste generally contains hazardous and toxic substances (B3), such as various heavy metals including cadmium, nickel, mercury, and others.[102] The content of hazardous and toxic substances (B3) in electronic waste is defined as "substances, energy, and/or other components which, due to their nature, concentration, and/or quantity, either directly or indirectly, can pollute and/or damage the environment, and/or pose a danger to the environment, health, and the survival of humans and other living organisms."[103] Mercury is one of the common components found in electronic waste, and it has adverse effects on both health and the environment due to its toxic, persistent, bioaccumulative, and long-range atmospheric transport characteristics.[104] Nickel is also considered a hazardous component because it has carcinogenic properties that can lead to cancer.[105]

Indonesia is one of the largest consumers of electronics in the world,[106] Indonesia's high consumption of electronics has made electronic waste a significant problem in the country. The hazardous and toxic content found in electronic waste requires special handling as it has the potential to pollute the surrounding environment. The Law No. 18 of 200 is further regulated in Government Regulation No. 81 of 2012, however it primarily addresses waste management from households and does not specifically

[101] Shunli Zhang and Eric Forssberg, "Mechanical Separation-Oriented Characterization of Electronic Scrap," *Resources, Conservation and Recycling* 21, no. 4 (1997): 247–69, https://doi.org/10.1016/S0921-3449(97)00039-6; Balakrishnan Ramesh Babu, Anand Kuber Parande, and Chiya Ahmed Basha, "Electrical and Electronic Waste: A Global Environmental Problem," *Waste Management and Research* 25, no. 4 (2007): 307–18, https://doi.org/10.1177/0734242X07076941.
[102] Syahrul Azmi, "Pemanfaatan Iptek Melalui Perbaikan Lampu Penerangan LED Untuk Pemuda Desa Alue Lim Sebagai Upaya Pengurangan Sampah Elektronik," in *Proceeding Seminar Nasional Politeknik Negeri Lhokseumawe*, vol. 6, 2022, 191–94.
[103] Presiden Republik Indonesia, "Peraturan Pemerintah Republik Indonesia Nomor 27 Tahun 2020 Tentang Pengelolaan Sampah Spesifik," 4 Peraturan Pemerintah § (2020).
[104] Fenty Puluhulawa and Amanda Adelina Harun, "Policy Formalization of Artisanal and Small-Scale Gold Mining (ASGM) Post-Ratification of Minamata Convention for Sustainability (Case Study of ASGM Gorontalo)," in *E3S Web of Conferences 125 ICENIS*, 2019, 1–7, https://doi.org/10.1051/e3sconf/201.
[105] Pawitania Afifah Sekar Azni, Rangga Sururi, and Djaenudin, "Pengaruh Logam Tembaga Dalam Penyisihan Logam Nikel Dari Larutannya Menggunakan Metode Elektrodeposisi," *Jurnal Rekayasa Lingkungan* 2, no. 2 (2014): 1–11.
[106] Agusni, "Merintis Sistem Standardisasi Tata Kelola Sampah Elektronik Pemerintah."

focus on electronic waste.[107] One key provision that can serve as a basis is the classification of electronic waste as hazardous and toxic waste (B3 waste).

Exactly, the circular economy concept is well-suited for addressing electronic waste issues because it essentially represents an enhancement in waste management models, particularly at the levels of consumption and production.[108]The inherent advantages of the circular economy concept is its ability to minimize waste accumulation through environmentally friendly product design and careful processes across various industries.[109] Furthermore, the optimization of product and material cycles with well-designed products that have good value and utility.[110] Countries like Japan, China, and Germany have their regulations on the circular economy, especially concerning the recovery and recycling of materials.[111] Switzerland is considered the electronic waste most recycling country, with a recycling rate above 90%.[112] Japan, China, South Korea, India, and Taiwan are Asian countries that have electronic waste management regulations.[113] Taiwan is at the forefront in recycling electronic waste, achieving an impressive rate of 82%, and following closely are Japan and South Korea, both with a commendable electronic waste recycling rate of 75%.[114]

Switzerland has embraced the concept of a circular economy in waste management, including electronic waste through a comprehensive and integrated approach, that enshrined in its regulation. Switzerland was a pioneer in electronic waste management

[107] Sutradara Ginting et al., "Potensi Penerapan Urban Mining Dari E-Waste Berbasis Ekonomi Sirkular Dalam Pembangunan Berkelanjutan Di Bukittinggi Potential Application of Urban Mining from E-Waste Based on Circular Economy in Sustainable Development in Bukittinggi," *Jurnal Himasapta* 7, no. 1 (2022): 11–16.
[108] Di Vaio et al., "The Transition towards Circular Economy and Waste within Accounting and Accountability Models: A Systematic Literature Review and Conceptual Framework."
[109] Kristianto and Nadapdap, "Dinamika Sistem Ekonomi Sirkular Berbasis Masyarakat Metode Causal Loop Diagram Kota Bengkayang."
[110] Keshav Parajuly et al., "Behavioral Change for the Circular Economy: A Review with Focus on Electronic Waste Management in the EU," *Resources, Conservation and Recycling: X* 6, no. February (2020): 100035, https://doi.org/10.1016/j.rcrx.2020.100035.
[111] Lúcia Helena Xavier, Marianna Ottoni, and Josh Lepawsky, "Circular Economy and E-Waste Management in the Americas: Brazilian and Canadian Frameworks," *Journal of Cleaner Production* 297 (2021): 126570, https://doi.org/10.1016/j.jclepro.2021.126570.
[112] Giuliano Catalano, "Mind the E-Waste: A Case for Switzerland," Logo of ETH Zurich, to homepage, 2023, https://css.ethz.ch/en/center/CSS-news/2023/08/mind-the-e-waste-a-case-for-switzerland.html.
[113] Kaur, Kaur, and Kaur, "E-Waste Management: A Transition towards a Circular Economy."
[114] Kaur, Kaur, and Kaur.

legislation starting from 1998, through Ordinance on The Return, the Taking Back and the Disposal of Electrical and Electronic Equipment (ORDEE).[115] Switzerland, in managing electronic waste, implements the concept of EPR (Extended Producer Responsibility), this approach legally obliges product manufacturers to oversee the complete life cycle of their creations, encompassing take-back, recycling, and final disposal.[116] According to EPR, retailers, manufacturers, and importers must retrieve, without any cost, the types of appliances they typically carry and are accountable for environmentally friendly disposal, on the other hand, consumers are obligated to return appliances at the end of their life cycle and are prohibited from discarding them through household waste or bulky item collections.[117] Both public and private stakeholders participate in Switzerland's electronic waste management system.[118]

Japan and South Korea had one of the highest electronic waste recycling rate in Asia. Both countries have adopted the circular economy concept in their national regulations. Japan recycle its electronic waste through legislation, the Law for the Promotion of Effective Utilization of Resources (LPUR), which emphasizes the augmentation of strategies for recycling products and mitigating waste production, and the Law for the Recycling of Specified Kinds of Home Appliances (LRHA), places specific obligations on manufacturers and consumers concerning the recycling of used household appliances.[119] LRHA manages four classes of items like television sets, refrigerators, washing machines and air conditioners,[120] LPUR addresses to personal computers and small-sized secondary batteries which are designated as recyclable

[115] Deepali Sinha Khetriwal, Philipp Kraeuchi, and Rolf Widmer, "Producer Responsibility for E-Waste Management: Key Issues for Consideration - Learning from the Swiss Experience," *Journal of Environmental Management* 90, no. 1 (2009): 153–65, https://doi.org/10.1016/j.jenvman.2007.08.019.
[116] Thomas Lindhqvist, "Extended Producer Responsibility in Cleaner Production - Policy Principle to Promote Environmental Improvements of Product Systems" (Lund University, 2000); Khetriwal, Kraeuchi, and Widmer, "Producer Responsibility for E-Waste Management: Key Issues for Consideration - Learning from the Swiss Experience."
[117] Patrick A. Wager, "Waste Management in Switzerland – Achievements and Perspectives," in *International Symposium on EcoTopia Science*, vol. ISETS07, 2007, 799–806.
[118] Presence Switzerland, "Recycling," 2023, https://www.eda.admin.ch/aboutswitzerland/en/home/umwelt/natur/recycling.html.
[119] Sung-woo Chung and Rie Murakami-suzuki, "Perspective : Implications for Developing Countries," 2008.
[120] Satoshi Sugimoto, "E-Waste Management and Recycling Mechanism in Japan," accessed January 8, 2024, https://ewaste.doe.gov.my/wp-content/uploads/2020/12/2.-E-waste-Management-and-Recycling-Mechanism-in-Japan-Sugimoto-san.pdf.

products.[121] South Korea used Producer Recycle (PR), the system works by having the Ministry of Environment annually announce specific rates for each item based on recent recycling performances by manufacturers,[122] and when a new appliance is purchased, manufacturers are obligated to collect used home appliances at the consumer's request, with recycling targets ranging from 55% to 70%.[123] Manufacturers can meet their obligations by constructing their recycling plant, outsourcing to commercial companies, or joining the Producer Responsibility Organization (PRO), both individual and collective responsibilities are allowed and failure to meet mandatory recycling rates incurs fees, which are inversely proportional to the rates, along with an additional financial burden through a recycling charge.[124] The Korea Environment and Resource Corporation oversees system tasks, including record-keeping, performance investigation, and imposing charges.[125]

Circular business models centre on the redesign of product-service systems to augment business capabilities and market competitiveness, embracing circular economy models has the potential to enable firms to tap into unexplored financial and business prospects while simultaneously reducing their overall environmental footprint.[126] Recycling methods are also recognized in the Waste Management Law, although this law is not specific to electronic waste. The law plays a crucial role as a means to change human behaviour,[127] environmental regulation in law aims to protect the sustainability of the environment.[128] The goal is to reduce the amount of electronic waste and utilize the materials efficiently. Electronic devices not only contribute to environmental pollution as waste but also contain various hazardous materials used in

[121] Chung and Murakami-suzuki, "Perspective : Implications for Developing Countries."
[122] Hyein Heo and Mun-hee Jung, "Case Study for OECD Project on Extended Producer Responsibility Republic of Korea," 2014.
[123] Chung and Murakami-suzuki, "Perspective : Implications for Developing Countries."
[124] Chung and Murakami-suzuki.
[125] Chung and Murakami-suzuki.
[126] Mark Weick and Nicole Ray, "How Companies Can Leverage the Circular Economy to Address Global E-Waste," EY, 2023, https://www.ey.com/en_us/climate-change-sustainability-services/how-circular-economy-models-can-address-global-e-waste.
[127] Mohamad Rusdiyanto U. Puluhulawa et al., "The Urgency of Regulation of Electric Bikes in Gorontalo City in a Progressive Legal Perspective," *Jambura Law Review* 4, no. 2 (2022): 270–86, https://doi.org/10.33756/jlr.v4i2.11780.
[128] Dwi Oktafia Ariyanti, Muhammad Ramadhan, and JS Murdomo, "Penegakan Hukum Pidana Terhadap Pelaku Penambangan Pasir Secara Ilegal Di Area Gumuk Pasir," *Jambura Law Review* 2, no. 1 (2020): 30–47, https://doi.org/10.33756/jalrev.v2i1.4376.

their production, including persistent organic compounds used as flame retardants or found in product fluids, lubricants, and coolants.[129] Recycling products, as well as materials or components from electronic devices, can make the production process of electronic devices more efficient.

Waste management is at the core of the circular economy's design, where products that are considered waste are then redesigned, consumed products can be recycled, and become a source of production again.[130] Awareness of recycling processes is relatively low in Indonesia. [131] Indeed, recycling processes that result in usable products have economic value. When properly executed, waste management can make a significant contribution to economic growth. Recycling not only conserves valuable resources but also creates job opportunities in the recycling industry. Additionally, it reduces the need for raw materials, lowers production costs, and minimizes environmental impacts. Therefore, promoting recycling practices can lead to both environmental and economic benefits[132] in order to build people's welfare.[133] The process of transitioning from a linear economy to a circular economy requires support from various stakeholders, ranging from industry players, and government, to education, in order to provide understanding to consumers.[134] Support from various parties is needed, because a circular economy can function with the participation of all stakeholders, including consumers who are expected to adjust their behaviour to the circular economy. Behavioural adjustments, for example, may involve not immediately discarding products that are rarely used or buying new products for only one or two uses. The circular economy also requires the involvement of the waste management

[129] Michelle Heacock et al., "E-Waste and Harm to Vulnerable Populations: A Growing Global Problem," *Environmental Health Perspectives* 124, no. 5 (2016): 550–55, https://doi.org/10.1289/ehp.1509699.
[130] Kery Utami et al., "Analisis Perencanaan Aplikasi Bank Sampah Digital Studi Kasus Pada Bank Sampah Solusi Hijau," *Jurnal Penelitian Manajemen Terapan (PENATARAN)* 7, no. 1 (2021): 34–49.
[131] Hari Widowati, "Rumah Tangga Yang Mendaur Ulang Sampah Hanya 1,2%," Data Boks, 2019, https://databoks.katadata.co.id/datapublish/2019/11/ 01/komposisi-sampah-di-indonesia-didominasi- sampah-organik#%0AYunita; Wiratih et al., "Upaya Mengolah Limbah Sampah Menjadi Peluang Social Enterprise Ekonomi Kreatif Bagi Generasi-Z."
[132] Utami et al., "Analisis Perencanaan Aplikasi Bank Sampah Digital Studi Kasus Pada Bank Sampah Solusi Hijau."
[133] Citra Aditya Kusuma and I A Yafiz, "Integrasi SDGs Pilar Pembangunan Sosial Dan Indikator Kinerja Pemerintah Daerah: Studi Kasus Di Kota Gorontalo," *JAMBURA: Jurnal Ilmiah Manajemen Dan …* 6, no. 1 (2023): 53–60.
[134] Kurnia et al., "Circular Solutions for Decent Work and Economic Growth: Lessons from Sustainable Development Goals (SDG) 8."

sector to recycle certain products or parts of products in order to minimize waste.[135] The concept of a circular economy can be implemented when adopted into national laws that bind all parties involved.

5. Conclusion

From a scholarly perspective, this article contributes in several ways. First, it highlights that Law No. 18 of 2008 on Waste Management does not specifically regulate electronic waste, treating it similarly to other types of waste. Second, it explores the extent to which waste management law accommodates the concept of a circular economy. The circular economy concept aims for products and materials to have a longer lifespan, which aligns with waste management laws governing similar principles. Third, in the context of electronic waste, the article underscores the importance of recycling products and materials, aligning with the circular economy concept. This approach aims to reduce electronic waste accumulation and increase production efficiency through recycling materials, thereby reducing hazardous content from both waste and production processes. The application of the circular economy concept in electronic waste management becomes feasible when it is integrated into national laws that obligate all stakeholders.

References

Abidah, Fadhila, Syarifa Hanoum, and Faiz Sugihartanto. "Perkembangan Rantai Pasok Sirkular: Kajian Literatur." *Jurnal Sains Dan Seni ITS* 11, no. 5 (2022): 169–71.

Afifah Sekar Azni, Pawitania, Rangga Sururi, and Djaenudin. "Pengaruh Logam Tembaga Dalam Penyisihan Logam Nikel Dari Larutannya Menggunakan Metode Elektrodeposisi." *Jurnal Rekayasa Lingkungan* 2, no. 2 (2014): 1–11.

Agusni, Amelia. "Merintis Sistem Standardisasi Tata Kelola Sampah Elektronik Pemerintah." *Standar: Better Standard Better Living* 2, no. 1 (2023): 2021–24.

Alexander, Allen, and Stefano Pascucci. *Handbook of the Circular Economy: Transitions and Transformation*. Edited by Fiona Charnley. Germany: Walter de Gruyter GmbH & Co KG, 2023.

[135] Kurnia et al.

Annur, Cindy Mutia. “Sampah Indonesia Bertambah Pada 2022, Terbanyak Dalam Empat Tahun.” Volume Timbulan Sampah Nasional (2019-2022), 2023. https://databoks.katadata.co.id/datapublish/2023/10/16/sampah-indonesia-bertambah-pada-2022-terbanyak-dalam-empat-tahun.

Ariyanti, Dwi Oktafia, Muhammad Ramadhan, and JS Murdomo. “Penegakan Hukum Pidana Terhadap Pelaku Penambangan Pasir Secara Ilegal Di Area Gumuk Pasir.” *Jambura Law Review* 2, no. 1 (2020): 30–47. https://doi.org/10.33756/jalrev.v2i1.4376.

Astuti, Widi. “Dampak Kandungan Logam Berat Dalam Sampah Elektronik (E-Waste) Terhadap Kesehatan Dan Lingkungan.” *Majalah Ilmiah Universitas Pandanaran* 11, no. 25 (2013): 1–8.

Ayuni, Trina, Dodik Ridho Nurrochmat, and Nastiti Siswi Indrasti. “Strategi Pengelolaan Limbah Elektronik Melalui Pengembangan Infrastruktur Ramah Lingkungan.” *Risalah Kebijakan Pertanian Dan Lingkungan: Rumusan Kajian Strategis Bidang Pertanian Dan Lingkungan* 3, no. 1 (February 22, 2017): 78. https://doi.org/10.20957/jkebijakan.v3i1.15238.

Azmi, Syahrul. “Pemanfaatan Iptek Melalui Perbaikan Lampu Penerangan LED Untuk Pemuda Desa Alue Lim Sebagai Upaya Pengurangan Sampah Elektronik.” In *Proceeding Seminar Nasional Politeknik Negeri Lhokseumawe*, 6:191–94, 2022.

Babu, Balakrishnan Ramesh, Anand Kuber Parande, and Chiya Ahmed Basha. “Electrical and Electronic Waste: A Global Environmental Problem.” *Waste Management and Research* 25, no. 4 (2007): 307–18. https://doi.org/10.1177/0734242X07076941.

Bonciu, Florin. “The European Economy: From a Linear to a Circular Economy.” *Romanian Journal of European Affairs* 14, no. 4 (2014): 78–91.

Budihardjo, Andreas, Aulia Ardista Wiradarmo, Fati Ramadhanti, Saputra, Indra Istijanto, Luki Safriana, M. Setiawan Kusmulyono, et al. *Fenomena Bisnis Ekonomi Terkini: Seri 2 2022-2023*. Jakarta: Prasetiya Mulya Publishing, 2023.

Cardoso, José Luís. “The Circular Economy: Historical Grounds.” *Changing Societies: Legacies and Challenges* III (2018): 115–27.

Catalano, Giuliano. “Mind the E-Waste: A Case for Switzerland.” Logo of ETH Zurich, to homepage, 2023. https://css.ethz.ch/en/center/CSS-news/2023/08/mind-the-e-waste-a-case-for-switzerland.html.

Chung, Sung-woo, and Rie Murakami-suzuki. “Perspective : Implications for Developing Countries,” 2008.

CNN Indonesia. “BI Prediksi Ekonomi Dunia Susut 14 Persen Jika Acuh Ke Perubahan Iklim,” 2023. https://www.cnnindonesia.com/ekonomi/20230330120533-532-931242/bi-prediksi-ekonomi-dunia-susut-14-persen-jika-acuh-ke-perubahan-iklim.

Cucchiella, Federica, Idiano D’Adamo, S. C. Lenny Koh, and Paolo Rosa. “Recycling of WEEEs: An Economic Assessment of Present and Future e-Waste Streams.” *Renewable and Sustainable Energy Reviews* 51 (2015): 263–72. https://doi.org/10.1016/j.rser.2015.06.010.

Dawood, Shamila, and Ajra Azhar. “Trash Trade and Environmental Regulations: An Assessment.” *Lentera Hukum* 8, no. 3 (2021): 347. https://doi.org/10.19184/ejlh.v8i3.27138.

Djacinta Rasya Andini, Deasy Olivia, and Anisza Ratnasari. “Penerapan Konsep Arsitektur Berbasis Komunitas Pada Pusat Edukasi Daur Ulang Sampah.” *IKRA-ITH Teknologi Jurnal Sains Dan Teknologi* 7, no. 3 (2023): 1–12. https://doi.org/10.37817/ikraith-teknologi.v7i3.3228.

Djafar, Anggraini Y., Fenty Puluhulawa, Jufryanto Puluhulawa, and Amanda Adelina Harun. “Dampak Dari Pencemaran Lingkungan Akibat Sampah Elektronik Dalam Prespektif Hukum Lingkungan.” *Journal of Comprehensive Science (JCS)* 2, no. 6 (June 9, 2023): 1637–46. https://doi.org/10.59188/jcs.v2i6.388.

Dwiningsih, Nurhidayati, and Ludwina Harahap. “Pengenalan Ekonomi Sirkular (Circular Economy) Bagi Masyarakat Umum Empowerment : Jurnal Pengabdian Masyarakat.” *Empowerment: Jurnal Pengabdian Masyarakat* 1, no. 2 (2022): 135–41.

Dzhengiz, Tulin, Elizabeth M. Miller, Jukka Pekka Ovaska, and Samuli Patala. “Unpacking the Circular Economy: A Problematizing Review.” *International*

Journal of Management Reviews 25, no. 2 (2023): 270–96. https://doi.org/10.1111/ijmr.12329.

Ernawati, Dyah, Sri Budiastuti, and M Masykuri. "Analisis Komposisi, Jumlah Dan Pengembangan Strategi Pengelolaan Sampah Di Wilayah Pemerintah Kota Semarang Berbasis Analisis SWOT." *Jurnal Ekosains* IV, no. 2 (2012): 13–22.

Fentika, Hilda, and Mohamad Mirwan. "Peran Serta Masyarakat Dalam Pengelolaan Sampah Elektronik Di Wilayah Surabaya Utara." *Ilmiah Teknik Lingkungan* 8, no. 2 (2021): 112–17.

Fernandes, Joana, and Paulo Ferrão. "A New Framework for Circular Refurbishment of Buildings to Operationalize Circular Economy Policies." *Environments - MDPI* 10, no. 3 (2023). https://doi.org/10.3390/environments10030051.

Finaka, Andrean W. "Prinsip 5R Untuk Ciptakan Indonesia Bersih," 2019. https://indonesiabaik.id/infografis/prinsip-5r-untuk-ciptakan-indonesia-bersih#:~:text=Prinsip 5R dapat dilakukan melalui,dengan melakukan perbaikan (repair).

Firmansyah, M, and Diah Setyorini Gunawan. "Antara Pembangunan Ekonomi Dan Degradasi Lingkungan." *Eko-Regional* 2, no. 2 (2007): 105–12.

Geisendorf, Sylvie, and Felicitas Pietrulla. "The Circular Economy and Circular Economic Concepts—a Literature Analysis and Redefinition." *Thunderbird International Business Review* 60, no. 5 (2018): 771–82. https://doi.org/10.1002/tie.21924.

Geissdoerfer, Martin, Paulo Savaget, Nancy M.P. Bocken, and Erik Jan Hultink. "The Circular Economy – A New Sustainability Paradigm?" *Journal of Cleaner Production* 2, no. 2 (2014): 210–22. https://doi.org/10.1016/j.jclepro.2016.12.048.Abstract.

Ginting, Sutradara, Sintiya Hamdina Ritonga, Izzan Nur Aslam, and Kopelma Darussalam Kecamatan Syiah Kuala Kota Banda Aceh. "Potensi Penerapan Urban Mining Dari E-Waste Berbasis Ekonomi Sirkular Dalam Pembangunan Berkelanjutan Di Bukittinggi Potential Application of Urban Mining from E-Waste Based on Circular Economy in Sustainable Development in Bukittinggi." *Jurnal Himasapta* 7, no. 1 (2022): 11–16.

Heacock, Michelle, Carol Bain Kelly, Kwadwo Ansong Asante, Linda S. Birnbaum, Åke Lennart Bergman, Marie Noel Bruné, Irena Buka, et al. "E-Waste and Harm to Vulnerable Populations: A Growing Global Problem." *Environmental Health Perspectives* 124, no. 5 (2016): 550–55. https://doi.org/10.1289/ehp.1509699.

Herat, Sunil, and P. Agamuthu. "E-Waste: A Problem or an Opportunity? Review of Issues, Challenges and Solutions in Asian Countries." *Waste Management and Research* 30, no. 11 (2012): 1113–29. https://doi.org/10.1177/0734242X12453378.

Holman Fasa, Angga Wijaya. "Aspek Hukum Dan Kebijakan Pemerintah Indonesia Mengenai Ekonomi Sirkular Dalam Rangka Mencapai Tujuan Pembangunan Berkelanjutan." *Jurnal Rechts Vinding: Media Pembinaan Hukum Nasional* 10, no. 3 (2021): 339. https://doi.org/10.33331/rechtsvinding.v10i3.774.

Hyein Heo, and Mun-hee Jung. "Case Study for OECD Project on Extended Producer Responsibility Republic of Korea," 2014.

Kasztelan, A. "Green Growth, Green Economy and Sustainable Development: Terminological and Relational Discourse." *Prague Economic Papers* 26, no. 4 (2017): 487–99. https://doi.org/10.18267/j.pep.626.

Kaur, Baljinder, Kirandeep Kaur, and Harreet Kaur. "E-Waste Management: A Transition towards a Circular Economy." *The Impact of Climate Change and Sustainability Standards on the Insurance Market*, no. May (2023): 403–16. https://doi.org/10.1007/978-981-15-7525-9.

Kementerian Koordinator Bidang Pembangunan Manusia dan Kebudayaan. "7,2 Juta Ton Sampah Di Indonesia Belum Terkelola Dengan Baik," 2023. https://www.kemenkopmk.go.id/72-juta-ton-sampah-di-indonesia-belum-terkelola-dengan-baik.

Kementerian Pendidikan dan Kebudayaan Republik Indonesia. "Majalah JendelaSekilas Pandang Revolusi Industri 4.0," 2022.

Khetriwal, Deepali Sinha, Philipp Kraeuchi, and Rolf Widmer. "Producer Responsibility for E-Waste Management: Key Issues for Consideration - Learning from the Swiss Experience." *Journal of Environmental Management* 90, no. 1 (2009): 153–65. https://doi.org/10.1016/j.jenvman.2007.08.019.

Kirchherr, Julian, Denise Reike, and Marko Hekkert. “Conceptualizing the Circular Economy: An Analysis of 114 Definitions.” *Resources, Conservation and Recycling* 127, no. April (2017): 221–32. https://doi.org/10.1016/j.resconrec.2017.09.005.

Korhonen, Jouni, Antero Honkasalo, and Jyri Seppälä. “Circular Economy: The Concept and Its Limitations.” *Ecological Economics* 143 (2018): 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041.

Kristianto, Aloysius Hari, and Jones Parlindungan Nadapdap. “Dinamika Sistem Ekonomi Sirkular Berbasis Masyarakat Metode Causal Loop Diagram Kota Bengkayang.” *Sebatik* 25, no. 1 (2021): 59–67. https://doi.org/10.46984/sebatik.v25i1.1279.

Kurnia, Sri, Muhammad Isa Alamsyahbana, Rachmad Chartady, Surya Violita Arifin, and Mohammad Iqbal Sesaria. “Circular Solutions for Decent Work and Economic Growth: Lessons from Sustainable Development Goals (SDG) 8.” *Academia Open* 8, no. 1 (July 5, 2023). https://doi.org/10.21070/ACOPEN.8.2023.6657.

Kurniawan, Danang Aji, and Ahmad Zaenal Santoso. “Pengelolaan Sampah Di Daerah Sepatan Kabupaten Tangerang.” *ADI Pengabdian Kepada Masyarakat* 1, no. 1 (2021): 31–36. https://doi.org/10.34306/adimas.v1i1.247.

Kurniawan, Tonni Agustiono, Ram Avtar, Deepak Singh, Wenchao Xue, Mohd Hafiz Dzarfan Othman, Goh Hui Hwang, Iswanto Iswanto, Ahmad B. Albadarin, and Axel Olaf Kern. “Reforming MSWM in Sukunan (Yogjakarta, Indonesia): A Case-Study of Applying a Zero-Waste Approach Based on Circular Economy Paradigm.” *Journal of Cleaner Production* 284 (2021). https://doi.org/10.1016/j.jclepro.2020.124775.

Kusuma, Citra Aditya, and I A Yafiz. “Integrasi SDGs Pilar Pembangunan Sosial Dan Indikator Kinerja Pemerintah Daerah: Studi Kasus Di Kota Gorontalo.” *JAMBURA: Jurnal Ilmiah Manajemen Dan …* 6, no. 1 (2023): 53–60.

Lacy, Peter, and Jakob Rutqvist. *Waste to Wealth*. United States of America: Palgrave Macmillan, 2015.

Lindhqvist, Thomas. “Extended Producer Responsibility in Cleaner Production - Policy Principle to Promote Environmental Improvements of Product Systems.” Lund University, 2000.

Masrida, Reni. “Kajian Timbulan Dan Komposisi Sampah Sebagai Dasar Pengelolaan Sampah Di Kampus Ii Universitas Bhayangkara Jakarta Raya.” *Journal of Env. Engineering & Waste Management* 2, no. 2 (2017): 69–78.

Mihelcic, James R., John C. Crittenden, Mitchell J. Small, David R. Shonnard, David R. Hokanson, Qiong Zhang, Hui Chen, et al. “Sustainability Science and Engineering: The Emergence of a New Metadiscipline.” *Environmental Science and Technology* 37, no. 23 (2003): 5314–24. https://doi.org/10.1021/es034605h.

Mulyati. “Dampak Sampah Terhadap Kesehatan Lingkungan Dan Manusia.” Preprint. Open Science Framework, September 16, 2021. https://doi.org/10.31219/osf.io/udesb.

Murray, Alan, Keith Skene, and Kathryn Haynes. “The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context.” *Journal of Business Ethics* 140, no. 3 (2017): 369–80. https://doi.org/10.1007/s10551-015-2693-2.

Nahor, Josua Jonny Hardianto Banjar. “Implikasi Dan Pengelolaan Limbah Elektronik.” *Buletin Utama Teknik* 14, no. 2 (2019): 1410–4520.

Nggilu, Novendri M, Dian Ekawaty Ismail, Suwitno Y Imran, and Lisnawaty W Badu. “The Indonesian State Policy: History and the Future.” *American Journal of Multidisciplinary Research & Development (AJMRD)* 04, no. 05 (2022): 7–11.

Ni’matul Ulya, Husna, Wening Purbarin, and Palupi Soenjoto. “Ekonomi Sirkular: Praktik Strategi Pemasaran Berkedok Isu Ekologi.” In *Prosiding Konferensi Integrasi Interkoneksi Islam Dan Sains*, 5:253–59, 2023.

Parajuly, Keshav, Colin Fitzpatrick, Orla Muldoon, and Ruediger Kuehr. “Behavioral Change for the Circular Economy: A Review with Focus on Electronic Waste Management in the EU.” *Resources, Conservation and Recycling: X* 6, no. February (2020): 100035. https://doi.org/10.1016/j.rcrx.2020.100035.

Parajuly, Keshav, Ruediger Kuehr, Abhishek Kumar Awasthi, Colin Fitzpatrick, Josh Lepawsky, Elisabeth Smith, Rolf Widmer, and Xianlai Zeng. "Future E-Waste Scenarios." *StEP (Bonn), UNU ViE-SCYCLE (Bonn) & UNEP IETC (Osaka)*, 2019, 19.

Persson, Ola, and Jennifer B. Hinton. "Second-Hand Clothing Markets and a Just Circular Economy? Exploring the Role of Business Forms and Profit." *Journal of Cleaner Production* 390, no. June 2022 (2023): 136139. https://doi.org/10.1016/j.jclepro.2023.136139.

Pesona, Anggun, Intan Puspita, Rike Penta Sitio, and Rosita Fitriyani. "Perancangan Sistem Manajemen Berbasis Ekonomi Sirkular Pada Kegiatan Usaha Pengelolaan Sampah Terintegrasi." *Dedikasi Jurnal Pengabdian Kepada Masyarakat* 2, no. 2 (2023): 313–23.

Piscicelli, Laura. "The Sustainability Impact of a Digital Circular Economy." *Current Opinion in Environmental Sustainability* 61 (2023): 101251. https://doi.org/10.1016/j.cosust.2022.101251.

Presiden Republik Indonesia. Peraturan Pemerintah Republik Indonesia Nomor 27 Tahun 2020 Tentang Pengelolaan Sampah Spesifik, 4 Peraturan Pemerintah § (2020).

Priyono, Fx joko. "Pengendalian Perdagangan Sampah Elektronik: Kajian Perjanjian Internasional Dan Kebijakan Perdagangan." *Masalah-Masalah Hukum* 47, no. 2 (2018): 175. https://doi.org/10.14710/mmh.47.2.2018.175-183.

Puluhulawa, Fenty, and Amanda Adelina Harun. "Policy Formalization of Artisanal and Small-Scale Gold Mining (ASGM) Post-Ratification of Minamata Convention for Sustainability (Case Study of ASGM Gorontalo)." In *E3S Web of Conferences 125 ICENIS*, 1–7, 2019. https://doi.org/10.1051/e3sconf/201.

Puluhulawa, Fenty, and Mohammad Rusdiyanto Puluhulawa. "Plastic Waste in Modern Era: Developing Plastic Waste Management for Sustainability." *E3S Web of Conferences* 259 (2021): 1–5. https://doi.org/10.1051/e3sconf/202125903001.

Puluhulawa, Fenty, Mohammad Rusdiyanto Puluhulawa, and Amanda Adelina Harun. "Good Environment as Part of Human Right : A Case Study on Plastic Waste Post

Pandemic." In *3rd International Conference on Law Reform (3rd INCLAR)*, 2022:10–24, 2022. https://doi.org/10.18502/kss.v7i15.12071.

———. "Legal Culture of Local Community in Plastic Waste Management." In *3rd International Conference on Law Reform (3rd INCLAR)*, 2022:183–91. KnE Social Sciences, 2022. https://doi.org/10.18502/kss.v7i15.12089.

Puluhulawa, Mohamad Rusdiyanto U., Jufryanto Puluhulawa, Vifi Swarianata, and Fitriana Nur Biya. "The Urgency of Regulation of Electric Bikes in Gorontalo City in a Progressive Legal Perspective." *Jambura Law Review* 4, no. 2 (2022): 270–86. https://doi.org/10.33756/jlr.v4i2.11780.

Purwanti, Indah. "Konsep Implementasi Ekonomi Sirkular Dalam Program Bank Sampah (Studi Kasus: Keberlanjutan Bank Sampah Tanjung)." *AmaNu: Jurnal Manajemen Dan Ekonomi* 4, no. 1 (2021): 89–98.

Putu, I, and Udiyana Wasista. "Isu Keusangan Terencana Dan Sampah Elektronik Pada Revolusi Industri 4.0." *Prosiding Seminar Nasional Desain Dan Arsitektur (SENADA)* 3 (2020): 2655–4313.

Qodriyatun, S N. "Meningkatkan Kesejahteraan Masyarakat Melalui Pengelolaan Sampah Berdasarkan UU No. 18 Tahun 2008." *Aspirasi: Jurnal Masalah-Masalah Sosial*, no. 18 (2014): 21–34.

Quantum. "What's the Average Lifespan of Your Electronics?," 2021. https://quantumlifecycle.com/en_CA/blog/whats-the-average-lifespan-of-your-electronics/.

Rahim, Irwan Ridwan, Rasdiana Zakaria, and Anisa Ramadhani Sahlan. "Studi Kemauan Membayar (Willingness To Pay) Masyarakat Dalam Pengelolaan Sampah Elektronik Di Kota Makassar." *Jurnal Penelitian Enjiniring* 19, no. 03 (2017).

Ramadoni, Sofwan Rizko, Kalen Sanata, and Reza Pramasta Gegana. "Ekonomi Sirkular: Tantangan Dan Peluang Pengaturan Pengelolaan Sampah Dan Limbah Di IKN Nusantara." *Prosiding Seminar Nasional Unars* 2, no. 1 (August 22, 2023): 416–28.

Republic of Indonesia. Law Number 3 of 2022 concerning National Capital (2022).

———. Law Number 18 of 2008 concerning Waste Management (2008).

Rina Mariani Gobai, Kodi, and Batara Surya. "Kinerja Pengelolaan Sampah Perkotaan (Studi Kasus Kota Nabire Kabupaten Nabire Provinsi Papua) Urban Waste Management Performance (A Case Study of Nabire City, Nabire Regency, Papua Province)." *Urban and Regional Studies Journal* 2, no. 2 (2020): 37–45.

Rusch, Magdalena, Josef Peter Schöggl, and Rupert J. Baumgartner. "Application of Digital Technologies for Sustainable Product Management in a Circular Economy: A Review." *Business Strategy and the Environment* 32, no. 3 (2023): 1159–74. https://doi.org/10.1002/bse.3099.

Sartono, A. D. "Potensi Implementasi Ekonomi Sirkular Dalam Mengelola Sampah Plastik Di Kabupaten Bogor." *Syntax Literate: J. Ilmiah Indonesia* 7, no. 3 (2022): 1184–94.

Shah, Kripa. "A Circular Economy Approach to Improve E-Waste Recycling in California : Economic Potential and Policy Options." *Master's Projects and Capstones*, 2022, 1–80.

Sitompul, Muhammad Rafiqi. "Ekonomi Sirkular Dalam Pengembangan Bisnis Penerbangan Di Indonesia." *Warta Penelitian Perhubungan* 35, no. 1 (2023): 49–58.

Soesanto, H., M. S. Maarif, S. Anwar, and Y. Yurianto. "Current Status of Household E-Waste Management in Jakarta, Indonesia." *IOP Conference Series: Earth and Environmental Science* 1109, no. 1 (2022). https://doi.org/10.1088/1755-1315/1109/1/012042.

Sugimoto, Satoshi. "E-Waste Management and Recycling Mechanism in Japan." Accessed January 8, 2024. https://ewaste.doe.gov.my/wp-content/uploads/2020/12/2.-E-waste-Management-and-Recycling-Mechanism-in-Japan-Sugimoto-san.pdf.

Sulhi, Muhamad Saifudin, Triana Cahya Ningrum, Suci Perwita Sari, and Dini Retnowati. "Pemanfaatan Sampah Elektronik Rumah Tangga Sebagai Pembuatan Powerbank Pintar," 273–77. Yogyakarta: Universitas PGRI Yogyakarta, 2017. https://repository.upy.ac.id/1484/.

Switzerland, Presence. "Recycling," 2023. https://www.eda.admin.ch/aboutswitzerland/en/home/umwelt/natur/recycling.html.

Tesalonika, Adelia, and Haddy Sutjipto. "Human Capital Dan Masyarakat Ekonomi Sirkular: Teologis Keberlanjutan Global Di Indonesia." *EMAGRAP Economic Military and Geography Business Review* 1, no. 1 (2023): 1–18.

Usman, Hisyam. "Timbunan Sampah Elektronik Dan Pengelolaanya Di Indonesia," 2022. https://environment-indonesia.com/timbunan-sampah-elektronik-dan-pengelolaanya-di-indonesia/.

Utami, Kery, Zackharia Rialmi, Ranti Nugraheni, and Fakultas Ekonomi. "Analisis Perencanaan Aplikasi Bank Sampah Digital Studi Kasus Pada Bank Sampah Solusi Hijau." *Jurnal Penelitian Manajemen Terapan (PENATARAN)* 7, no. 1 (2021): 34–49.

Vaio, Assunta Di, Sohail Hasan, Rosa Palladino, and Rohail Hassan. "The Transition towards Circular Economy and Waste within Accounting and Accountability Models: A Systematic Literature Review and Conceptual Framework." *Environment, Development and Sustainability* 25, no. 1 (2023): 734–810. https://doi.org/10.1007/s10668-021-02078-5.

Wager, Patrick A. "Waste Management in Switzerland – Achievements and Perspectives." In *International Symposium on EcoTopia Science*, ISETS07:799–806, 2007.

Weick, Mark, and Nicole Ray. "How Companies Can Leverage the Circular Economy to Address Global E-Waste." EY, 2023. https://www.ey.com/en_us/climate-change-sustainability-services/how-circular-economy-models-can-address-global-e-waste.

Wibowo, Richard Jatimulya Alam, Caroline Tresnoputri, Fico Acchedya Wijaya, Ali Bastanta, Austin Junior, and Jennifer Claudia. "Studi Komparatif Ekonomi Sirkular Dalam Arah Kebijakan Hukum Pengelolaan Sampah Kemasan Plastik Di Indonesia Dan Jerman." *Nusantara: Jurnal Ilmu Pengetahuan Sosial* 10, no. 5 (July 28, 2023): 2467–80. https://doi.org/10.31604/jips.v10i5.2023.2467-2480.

Widowati, Hari. “Rumah Tangga Yang Mendaur Ulang Sampah Hanya 1,2%.” Data Boks, 2019. https://databoks.katadata.co.id/datapublish/2019/11/ 01/komposisi-sampah-di-indonesia-didominasi- sampah-organik#%0AYunita.

Winans, K., A. Kendall, and H. Deng. “The History and Current Applications of the Circular Economy Concept.” *Renewable and Sustainable Energy Reviews* 68, no. October 2015 (2017): 825–33. https://doi.org/10.1016/j.rser.2016.09.123.

Wiratih, Hernawati W. Retno, Ilmi Dwiastuti, Ikramina Larasati Hazrati Havidz, M Havidz Aima, Shinta Amalina Hazrati Havidz, and Maya Puspita Dewi. “Upaya Mengolah Limbah Sampah Menjadi Peluang Social Enterprise Ekonomi Kreatif Bagi Generasi-Z.” In *Prosiding Konferensi Nasional Pengabdian Kepada Masyarakat Dan Corporate Social Responsibility (PKM-CSR)*, 4:1049–55, 2021. https://doi.org/10.37695/pkmcsr.v4i0.1319.

Xavier, Lúcia Helena, Marianna Ottoni, and Josh Lepawsky. “Circular Economy and E-Waste Management in the Americas: Brazilian and Canadian Frameworks.” *Journal of Cleaner Production* 297 (2021): 126570. https://doi.org/10.1016/j.jclepro.2021.126570.

Yenita, and Lamto Widodo. “Implementation of the Electronic Waste Management to Achieve Environmental Sustainability in Indonesia.” *Advances in Social Science, Education and Humanities Research* 478, no. Ticash (2020): 1008–14. https://doi.org/10.2991/assehr.k.201209.160.

Yudianto, Tri, Prabang Setyono, and I Gusti Ayu Ketut Rachmi Handayani. “Implementasi Kebijakan Dan Strategi Dalam Pengelolaan Sampah Di Kabupaten Blora.” *Jurnal Kesehatan Lingkungan Indonesia* 20, no. 1 (2021): 21–26. https://doi.org/10.14710/jkli.20.1.21-26.

Yuniarti, Tri, and Titik Anggraeni. “Dampak Tempat Pembuangan Akhir Sampah Putri Cempo Surakarta Terhadap Penyakit Kulit Pada Masyarakat Mojosongo.” *Jurnal Ilmiah Rekam Medis Dan Informatika Kesehatan, ISSN 2086-2628* 8, no. 1 (2018): 26–29.

Zahrawaan, Amy. “Tetra Pak Printing: Sebuah Model Pengolahan Sampah Berbasis Seni.” *Urban: Jurnal Seni Urban* 6, no. 1 (2022): 41–56. https://doi.org/10.52969/jsu.v6i1.55.

Zhang, Shunli, and Eric Forssberg. “Mechanical Separation-Oriented Characterization of Electronic Scrap.” *Resources, Conservation and Recycling* 21, no. 4 (1997): 247–69. https://doi.org/10.1016/S0921-3449(97)00039-6.