Comparative Analysis of E-Waste Policies in New Zealand and Leading Global Markets: A Path Toward Sustainable E-Waste Management

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Abstract.

The purpose of this thesis is to investigate the reasons underlying New Zealand's inadequate e-waste recycling performance in comparison to high-performing jurisdictions (the European Union (EU) and Australia) and to identify policy lessons that can facilitate the shift to more effective e-waste management. The study uses comparative policy analysis and thematic analysis of legislation, policy reports, and scheme evaluations from these jurisdictions to identify key features of effective extended producer responsibility and product stewardship systems. These include enforceable producer responsibility, clear collection targets, circular product design requirements, and accessible, well-governed collection systems. These stand in contrast to New Zealand's mostly voluntary, fragmented arrangements, which are influenced by a broader tradition of light-handed regulation, insufficient national goals, unequal access to services, and poor coordination. The study concludes that implementing international "best practices" requires adapting policies to New Zealand's institutional and political environment. The study identifies several key priorities: enacting mandatory e-waste extended producer responsibility (EPR) with reuse and refurbishment goals; establishing national infrastructure for collection and reporting, incorporating circular design and right-to-repair obligations; and establishing a specialised stewardship governance body to provide high-participation, equitable e-waste services.

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Attestation of Authorship

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (unless it is clearly stated, and referenced, along with the purpose of use), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning."

Signature

Keshav Ashish Biyani

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Chapter 1: Introduction

The growth of electronic appliances has transformed contemporary society and, at the same time, posed a challenge never before encountered in waste management. Electronic waste (e-waste) is currently the fastest-growing waste stream worldwide, with about 62 million tonnes produced in 2022, and it is estimated to grow to 82 million tonnes in 2030 (Balde et al., 2024). Technological innovation, shorter product life cycles, and expanded global markets for electronic products contribute to this exponential growth (Kumar et al., 2017). The threat to environmental and human health from improper e-waste management is substantial, including the leaching of toxic materials, the waste of resources, and the loss of opportunities for material recovery and reuse (Awasthi et al., 2019).

E-waste is a complex paradox of a waste stream. Although it contains toxic elements that have a significant impact on the environment and human health, it also contains valuable materials and rare earth elements, offering significant economic prospects once extracted efficiently (Islam and Huda, 2019). The United Nations University has estimated that the worldwide monetary value of e-waste generated in 2022 amounted to 91 billion USD in metals. However, only 22.3% was reported to have been properly collected and recycled (Baldé et al., 2024).

E-waste management has evolved beyond waste-disposal concerns and has become an essential part of the circular economy and the overall environmental sustainability agenda. In a bid to move away from linear, “take-make-dispose” systems towards circular systems, in which resources are used most productively, and their value is preserved for as long as possible, e-waste policy frameworks serve as essential tools for facilitating the transition (Ghisellini et al., 2016). The advanced economies have established more detailed regulatory structures, frequently based on the Extended Producer Responsibility (EPR) principle, under which manufacturers are financially and physically liable for end-of-life products (Khetriwal et al., 2009). At the same time, technological advances have enhanced recycling by increasing the recovery of valuable materials, making it more economically attractive to recycle e-waste (Awasthi et al., 2019).

Despite these dynamics, the world is still witnessing significant inequities in e-waste, with developed countries continuing to export large volumes of toxic e-waste to developing countries that lack the infrastructure and regulations to handle it safely. These “digital dumping grounds” not only expose vulnerable populations to poisonous substances but also allow developed countries to externalise the real environmental costs of their consumption habits (Perkins et al., 2014). New Zealand presents an interesting case study in e-waste management. Despite the country's good reputation for environmental stewardship and a clean, green image, it has not developed effective e-waste collection and processing systems. With only an estimated 2% of its e-waste formally collected and recycled (Blake et al., 2019), New Zealand is among the highest per capita e-waste generators: 20kg per capita, substantially exceeding the global average of 7.8kg per capita (Baldé et al., 2024) and 18.3kg per capita (*Unmanaged E-waste per Capita*, 2025) for the OECD countries, placing it among the top quartile. This disparity raises fundamental questions about the factors that determine the effectiveness of e-waste management systems and the feasibility of transferring policies across national contexts.

This thesis synthesises existing research on regulatory frameworks, implementation challenges, and outcome assessments across different jurisdictions. By exploring the intersection of policy design, circular economy principles, and sustainable development imperatives, this research aims to answer the following questions:

1. ***RQ1:*** *What are the key characteristics of the regulatory systems governing e-waste management in jurisdictions that have achieved comparatively high e-waste recovery and recycling rates?*
2. ***RQ2:*** *What is the existing nature of the regulatory system governing e-waste management in New Zealand, and what can New Zealand learn from other jurisdictions that have achieved much higher recovery and recycling rates?*

This thesis has been organised into five chapters to systematically answer the research questions and offer actionable insights for e-waste policy development in New Zealand. Chapter 2 (Literature Review) begins to answer these questions by defining and examining key aspects of efficient e-waste management systems worldwide and by setting the stage for further empirical research on the New Zealand system. Chapter 3 (Methodology) outlines the qualitative comparative policy analysis approach, thematic analysis of policy documents in the chosen jurisdictions, and extensive data selection criteria to ensure credibility. The presentation of the thematic analysis findings in Chapter 4 (Findings) first characterises the regulatory systems of high-recovery jurisdictions (to answer RQ1). Then it assesses the current voluntary stewardship arrangements in New Zealand in light of these best practices (to answer RQ2). Chapter 5 (Discussion and Conclusion) discusses these findings in relation to the existing literature. It also concludes the thesis by considering lessons for New Zealand, the study's limitations, and possible future directions for related research.

Chapter 2: Literature Review

E-Waste- Definition and Composition

Electronic waste (hereafter, e-waste) refers to a broad and complex category of waste comprising discarded electrical and electronic devices (EEE) that have reached the end of their useful life or become obsolete due to physical damage, shifts in consumer preferences, or technological progress. The formal definition provided by the European Union's Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU characterises e-waste as "*electrical or electronic equipment which is waste... including all components, sub-assemblies, and consumables which are part of the product at the time of discarding*" (European Parliament, 2012, p.43). This waste stream consists of a broad category of goods such as screens and monitors, temperature exchange devices (e.g. refrigerators, air conditioners freezers and lamps), large and small equipment (e.g. dishwashers, washing machines, printers, e-cigarettes, microwave ovens and electrical tools), and small information technology and telecommunication equipment (e.g. computers, cell phones and routers) (Balde et al., 2024).

The complexity of e-waste arises due to its varied material composition, which often contains a mixture of compounds that can be categorised as either non-hazardous or hazardous. The hazardous substances usually include heavy metals such as lead, zinc, mercury, cadmium, and chromium; flame retardants, including polybrominated diphenyl ethers (PBDEs), used in circuit boards; and chlorofluorocarbons (CFCs) or hydrochlorofluorocarbons (HCFCs) found in refrigeration equipment. At the same time, precious metals such as copper, aluminium, ruthenium, indium, silver, platinum, and gold are also found in e-waste (Ilankoon et al., 2018).

Global rise of e-waste

E-waste is one of the world's fastest-growing waste streams, posing substantial environmental challenges while offering significant potential for resource recovery. An unprecedented 62 billion kg of e-waste was produced globally in 2022, according to the Global E-waste Monitor 2024, an average of 7.8 kg per person (Baldé et al., 2024). This is nearly an 80 per cent increase from the 34 billion kg generated in 2010, indicating a rising volume of waste. This volume is expected to increase to 82 billion kilograms by 2030, more than 2.5 times in just 20 years (Balde et al., 2024).

Several interconnected processes cause this exponential growth. First, due to persistent technological progress, product life cycles have declined dramatically, thus predisposing people to a habit of quick replacement rather than maintenance or prolonged use (Kumar et al., 2017). The average smartphone replacement cycle was approximately 21 months in 2016, and the mobile phone replacement cycle in the pre-smartphone era in 2000 was 4.8 years (Bakker et al., 2014; Cordella et al., 2020). This is further worsened by the "planned obsolescence" business model used by many electronics manufacturers, which intentionally designs devices with short lifespans to promote frequent replacements (Makov & Fitzpatrick, 2021; Satyro et al., 2018). For example, Apple slowed down iPhones' performance with ageing batteries in January 2017 by introducing a performance management feature in iOS 10.2.1 (Panzarino, 2017). However, Apple failed to notify customers of this modification or its effects, which confused consumers when the devices began underperforming. The "Batterygate" controversy started when the public became aware of it in December 2017. The result was that, in 2020, Apple reached a $500 million USD settlement in the United States, along with similar fines in other nations (Stempel, 2020). The complexity of e-waste components has also increased due to technological convergence, which combines multiple functions into a single device, making recycling more difficult.

Second, access to electronic products has increased due to rising global economic growth, especially in developing economies. By 2024, the internet user base reached more than 5.5 billion people worldwide, representing 68% of the total world population, up from 53% in 2019, a 15% increase in five years (International Telecommunication Union, 2024). This consumption of electronic products and the use of the internet have been observed to be growing significantly in emerging economies such as China, Malaysia, and Brazil (Poushter, 2016; Tsetsi & Rains, 2017). India experienced a 252 per cent increase in demand for feature-rich phones with the introduction of JioPhone. Reliance Industries (the company that produces the JioPhone) increased its rural subscriber base from 4.25% in 2016 to 32% in 2018 by offering free 4G and affordable smart feature phones (James, 2020).

Current Destination of E-Waste

Flows of e-waste around the world exhibit massive disparities between production and disposal areas, leading to what scholars refer to as "digital dumping grounds" in developing nations. Despite international regulatory frameworks such as the Basel Convention, which aims to prohibit the cross-border movement of hazardous waste, a considerable quantity of e-waste is exported from developed to underdeveloped nations via a variety of legal loopholes and unlawful networks (Lepawsky, 2014; Perkins et al., 2014). Exporting e-waste to underdeveloped countries has become commonplace for several reasons. Such exports are encouraged by high labour costs and strict environmental regulations on the disposal of hazardous waste in developed nations (Perkins et al., 2014).

Informal recycling hubs have developed in these recipient developing nations. Specific areas in Ghana, Guiyu, China, Mandoli, India, and Karachi, Pakistan represent significant concentrations of informal e-waste processing (Awasthi et al., 2016a; Daum et al., 2017; Ilankoon et al., 2018; Imran et al., 2017; Wang et al., 2016). The Agbogbloshie market in Accra, Ghana, which primarily receives e-waste from North America and Europe, has come to represent worldwide e-waste flows (Amoyaw-Osei et al., 2011; Daum et al., 2017). In Asia, despite China's 2018 ban on the import of waste, significant amounts of e-waste continue to flow through neighbouring nations, with e-waste processing sites in Guiyu (a town in China) attracting special scholarly interest (Wang et al., 2019). Karachi, Pakistan, and Delhi-NCR, India, are among the primary processing centres for e-waste in South Asia (Awasthi et al., 2016; Imran et al., 2017). These areas, referred to as digital dumping grounds, often use crude processing methods, including acid leaching, open burning, and manual disassembly, which seriously contaminate the environment and pose health risks to workers (Kumar et al., 2017; Orlins & Guan, 2015; Perkins et al., 2014).

Environmental problems associated with e-waste.

E-waste presents a wide range of environmental problems, from local pollution to global ecological impacts. The leading causes of environmental degradation are hazardous components in electronic devices and, generally, poor disposal and recycling technologies.

Modern electrical equipment contains an alarming number of hazardous components, causing significant environmental and human health issues. Solder often contains lead, chip resistors contain cadmium, connectors contain beryllium, and circuit board plastic shells contain brominated flame retardants (Herat & Agamuthu, 2012; Perkins et al., 2014). Flat-screen displays include mercury, while the glass of older cathode ray tubes has high concentrations of lead oxide; one monitor may have as much as 3 kg of lead (Tsydenova & Bengtsson, 2010). The presence of heavy metals in rechargeable batteries, such as nickel, cadmium, and lithium, may pose environmental hazards if improperly disposed of (Herat & Agamuthu, 2012). These substances are present in considerable amounts. The 62 billion kg of e-waste generated globally in 2022 contained more than 58 tonnes of mercury, 45 million kilograms of polymers containing brominated flame retardants, and 145 billion kg of carbon dioxide equivalents from refrigerants (Baldé et al., 2024). In 2022 alone, 12 billion kilograms of metals, including gold, silver, palladium, lead, zinc, and cobalt, were lost to non-compliant e-waste management practices (Baldé et al., 2024).

E-waste recycling has caused massive environmental contamination affecting soil, water, and air globally, especially in regions where informal recycling operations predominate (Awasthi et al., 2016; Pradhan & Kumar, 2014). Improper processing techniques like open burning of cables, acid leaching of circuit boards, and uncontrolled dumping have resulted in dangerously high concentrations of heavy metals, including lead, cadmium, mercury, chromium, and copper, in surface soils, frequently exceeding regulatory standards by several orders of magnitude (Li et al., 2011; Olafisoye et al., 2013; Wu et al., 2014). This contamination persists long after processing activities cease, as demonstrated in locations like Mandoli (Delhi), Guiyu (China), and Bangalore (India) (Pradhan & Kumar, 2014; Guo et al., 2009; Ha et al., 2009). Contamination of water occurs through leaching, runoff, and wastewater discharge, leading to high concentrations of arsenic, lead, and mercury that threaten drinking water resources and aquatic life (Wong et al., 2006; Asante et al., 2012; Zhang et al., 2012). Open burning causes air pollution by releasing dioxins, heavy metals, and polycyclic aromatic hydrocarbons, exposing workers and nearby communities to harmful airborne contaminants (Caravanos et al., 2011; Zheng et al., 2013). The absence of protective infrastructure in informal recycling sectors amplifies these exposure risks across affected regions (Herat & Agamuthu, 2012; Chatterjee & Kumar, 2009).

Apart from polluting the environment, e-waste contributes significantly to resource depletion by losing valuable materials embedded in discarded electronics, such as gold, silver, copper, and rare earth elements (Friege, 2012; Rene et al., 2021). For example, 3 million kg of mineral ore (rock) have to be mined to produce 1 kg of gold (Baldé et al., 2024). These limited resources are not recovered when mishandled or disposed of in landfills, which raises the need for primary resource extraction that harms the environment (Zhang et al., 2012). This extraction procedure increases energy consumption and ecological degradation, while hastening the depletion of natural resources. Furthermore, the development of a sustainable circular economy is hampered by informal e-waste processing and insufficient recycling infrastructure, which worsens material loss (Ghulam & Abushammala, 2023). Therefore, it is essential to address resource depletion through effective recovery methods, both to support environmental sustainability and to shield vulnerable communities from the harmful effects of improper e-waste handling (Heacock et al., 2015; Grant et al., 2013).

Approaches to address E-Waste problems.

Having established the scale and environmental impact of the e-waste problem, attention now turns to examining the various approaches being developed and implemented to address these challenges. These approaches range from business innovations and circular economy principles to government regulations and extended producer responsibility schemes.

Circular economy and e-waste management.

The circular economy paradigm has emerged as a useful theoretical framework for addressing e-waste. In contrast to the linear take-make-waste model, the essence of the circular economy is the reuse of materials and products through recycling, remaking, repairing, and refurbishing (Ellen MacArthur Foundation, 2013). Geissdoerfer et al. (2016, p. 759) define the circular economy as a "*regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops*".

Circular economy principles in the electronics sector involve designing products with long lifespans, durable repairability, and reusability, and promoting reuse, refurbishment, and material recovery to minimise waste and resource extraction (Bocken et al., 2016; Ellen MacArthur Foundation, 2018). This strategy supports sustainable development by maximising value throughout a product's lifecycle. A clear hierarchy guides interventions: reuse offers the greatest environmental benefit, followed by refurbishment, remanufacturing, recycling, and, finally, disposal (Cole et al., 2019).

Business models such as leasing (where customers pay for temporary use rather than ownership), take-back schemes (where manufacturers/municipalities collect products at end-of-life for refurbishment or recycling), and product-as-a-service (where companies retain ownership and responsibility for products throughout their lifecycle, such as Philips' “light as a service” model) support circular economy principles (Philips Lighting, 2017). These approaches encourage manufacturers to design for longevity and retain control of materials (Bocken et al., 2016; Tukker, 2013; Xavier et al., 2023). Moreover, initiatives such as second-hand markets, repair cafés (community workshops where volunteers help repair broken items), and refurbishment programs extend the use of products. At the same time, advanced recycling technologies recover critical materials when reuse is no longer feasible (Esmaeilian et al., 2020).

Applying the concepts of a circular economy to e-waste governance has gained popularity in policymaking. The European Union's Circular Economy Action Plan explicitly names electronics as a priority product category. It suggests policies such as the “right to repair”, common charging standards, and incentive programs for the return of outdated electronic devices (European Commission, 2024; European Union, 2020).

Extended Producer Responsibility (EPR) as a Circular Economy Mechanism

A crucial piece of the legislative framework of the circular economy concept, Extended Producer Responsibility (EPR) transfers the costs and accountability for managing end-of-life products from consumers and municipalities to manufacturers. EPR establishes economic incentives for businesses to build more robust, repairable, and recyclable items by holding manufacturers physically and financially liable for their goods after consumers use them (Organisation for Economic Co-operation and Development (OECD), 2016).

Several nations have developed regulations to manage electronic waste through EPR policies and recycling schemes. In the United States, state-level regulations make EPR mandatory, requiring producers to bear the costs of collecting and recycling electronic products (“5 Global E-Waste Regulations Every Consumer Should Know,” 2024). India adopted the E-Waste (Management) Rules 2022, which went into force on April 1, 2023. These rules require manufacturers, producers, refurbishers, and recyclers to register through a portal established by the Central Pollution Control Board to ensure adequate tracking and accountability throughout the e-waste lifecycle (E-Waste Management System, n.d.). Another EPR-based strategy is the National Television and Computer

Recycling Scheme (NTCRS), implemented in Australia. The NTCRS provides free household and small business recycling collections, funded by importers and manufacturers. It aims to increase recycling rates by making collection events and drop-off points easily accessible, thereby encouraging the circular flow of materials ("5 Global E-Waste Regulations Every Consumer Should Know," 2024).

The potential benefits of e-waste recycling.

Electronic waste is one of the rapidly expanding waste categories worldwide, and the efficient management of e-waste requires appropriate collection, recycling, and resource recovery systems that offer significant environmental, social, and economic benefits.

Environmental Benefits.

The avoidance of hazardous material emissions is arguably the most obvious example of how appropriate e-waste processing benefits the environment. The numerous hazardous compounds present in electronic devices can pose significant environmental risks when not handled appropriately (Forti et al., 2020). These materials contaminate air, soil, and water systems when e-waste is processed informally or inappropriately, causing long-term environmental harm (Awasthi et al., 2016; Baldé et al., 2024). Effective processing systems use controlled environments with adequate containment and treatment technologies to prevent hazardous substances from leaching out. Whereas informal processing methods release up to 80% of heavy metals into the atmosphere, formal e-waste recycling facilities can achieve containment rates above 95% (Asante et al., 2019; Kumar et al., 2017; Robinson, 2009). For instance, recycling 10 kilograms of aluminium not only saves 90% of the energy but also avoids producing 20 kg of CO2 gas and 13 kg of bauxite waste (Kumar et al., 2017; Zhang et al., 2012). This controlled processing reduces soil contamination, groundwater pollution, and air emissions that would otherwise last for decades (Pradhan & Kumar, 2014; Guo et al., 2009).

E-waste is also rich in valuable elements that can be extracted and used in production processes. According to Cucchiella et al. (2015), more than 60 different materials, including rare earth elements, valuable metals such as gold, silver, and platinum, and basic metals such as copper and aluminium, may be recovered through effective e-waste processing. The recovery of these minerals results in a reduced requirement of primary extraction activities or virgin mining, which comes with significant environmental effects, including loss of habitat, use of energy, and emission of greenhouse gases (Ahirwar &

Tripathi, 2020; Ghulam & Abushammala, 2023; Kumar et al., 2017; Menikpura et al., 2014; Shahabuddin et al., 2022; Zeng et al., 2018; Zhang et al., 2012). The possibility for material recovery is significant. The 62 billion kilogrammes of e-waste generated worldwide in 2022 contained an estimated 1.6 million kilogrammes of precious metals, such as gold, silver, palladium, and platinum (Baldé et al., 2024). Effective recovery of these materials eases the strain on the extraction of natural resources. For example, 24kg of gold may be extracted from one million cell phones, but the same would require roughly 24000 tonnes of mine ore (Kumar et al., 2017). This underlines the importance of e-waste recycling in enhancing resource efficiency, reducing environmental degradation, and facilitating the transition to a more sustainable, circular economy.

Economic Benefits.

In addition to generating environmental benefits, the recovery of valuable materials from electronic equipment also creates significant economic benefits. According to the Global E-waste Monitor 2024, the total value of the materials found in e-waste worldwide in 2022 is estimated at $91 billion; however, only 22% of this amount is recycled through official channels (Baldé et al., 2024). Computer motherboards and mobile phone handsets are examples of mass-produced consumer components that include 200-250 grams of gold and 80 grams of palladium per tonne (grams/ton). Cell phones can contain up to 350 grams of gold and 130 grams of palladium per tonne. This is significantly higher than the average of less than 10 grams per tonne of gold or platinum group metals (platinum, palladium, rhodium, iridium, ruthenium) found in basic ores (Hagelüken, 2012; Shahabuddin et al., 2022; Xavier et al., 2019; Zhang et al., 2012). The idea of recycling e-waste, or, to scholars, "urban mining" (Xavier et al., 2019; Zeng et al., 2018), is attractive from an economic perspective due to the high inherent metal values, which could generate more than $20 billion annually (Kumar et al., 2017) and also because of the much higher concentration than in ore mining.

The issues of e-waste management have prompted technological advancements with broader economic implications. With a compound annual growth rate of 13.4%, the e-waste management recycling industry is expected to reach $94.2 billion by 2032 from its 2023 assessment of $30.4 billion (Gupta, 2022). This expansion presents substantial business prospects in process design and equipment production. Unlike many automated sectors, recycling e-waste still requires significant labour at several stages, especially for pre-processing tasks such as physical sorting and disassembly. The International Labour

Organisation (2019) states that formal recycling procedures can generate between 30 and 200 jobs for every 1,000 tonnes of e-waste processed, and that effective management of electronic waste can create millions of jobs globally (International Labour Organisation, 2019). For instance, over 100,000 people work as e-waste recyclers in Guiyu, China, which is considered one of the world's most extensive e-waste recycling facilities (Heacock et al., 2015). These trends illustrate how efficient e-waste management not only addresses environmental issues but also catalyses industry innovation, economic growth, and the creation of numerous jobs.

Social Benefits.

Properly regulated e-waste processing significantly improves public health outcomes by reducing exposure to hazardous materials generated by unofficial recycling activities. Communities with formalised e-waste management had significantly lower levels of carcinogenic compounds than those that relied on informal processing, according to Heacock et al. (2015). This is especially important for more susceptible groups, such as children. For example, the average blood lead level in children in communities without informal e-waste recycling was 3.2 µg/dL (microgrammes per decilitre). In contrast, those in communities that did so had a mean of 15.3 µg/dL. This increase has significant consequences on long-term health and cognitive development (Grant et al., 2013; Zhang et al., 2012; Zheng et al., 2012).

In addition to health, reuse and refurbishment programs are vital to developing social justice and digital inclusivity. These initiatives help bridge the digital divide by expanding access to technology for low-income households, organisations, and educational institutions (Alhassan & Adam, 2021). The Global E-waste Statistics Partnership has further supported this inclusive approach by providing training in sustainable e-waste practices to over 360 professionals from 60 countries. This has facilitated equitable access to technology and international capacity building (Forti et al., 2020). When taken as a whole, these advancements highlight the revolutionary social effects of formal e-waste management through enhanced digital equity, education, and health.

Global Disparities in E-Waste Processing Effectiveness

The differences in infrastructure development, economic incentives, sociocultural factors, and legislative frameworks worldwide have led to significant variations in the effectiveness of e-waste processing. The effects of these differences include a disjointed international outlook on e-waste management activities and enormous environmental and resource recovery implications.

The European Union (EU) is at the forefront of providing holistic e-waste management worldwide through the Waste Electrical and Electronic Equipment (WEEE) Directive, first enacted in 2003 and reinforced in 2012 (European Parliament, 2012). The WEEE Directive has led to a visible increase in formal collection and recycling levels in the region. However, the vast majority of Member States have not yet reached the 65% mark. In 2021, EU-27 (27 Member States of the EU), Norway, the United Kingdom, Switzerland, and Iceland produced around 10.4 million metric tonnes of e-waste, of which 5.6 million metric tonnes (54%) were documented as collected, the highest rate of any world region and approximately three times the global average of 17.4% (Baldé et al., 2022). The EU-wide collection rate of WEEE, measured against equipment placed on the market, rose from 38.6% in 2014 to 48.6% in 2019, before stabilising around 40-45% through 2022 (European Environment Agency, 2025). Notably, only a handful of the EU-27 (Bulgaria, Latvia, Croatia, and Slovakia) have achieved the 65% threshold, with Poland standing alone in meeting the more ambitious 85% target in recent years (Eurostat, 2025). Implementation success varies significantly across the EU, with Nordic states exceeding 50% because of accessible customer drop-off locations and practical public awareness efforts (Huisman et al., 2017), while Eastern and Southern states hover around 25-30%, due to inadequate infrastructure and difficulties with enforcement (Baldé et al., 2024).

A regulated producer responsibility model, Australia's National Television and Computer Recycling Scheme (NTCRS), shows even greater improvement in specific categories. The pre-scheme showed that less than 17 per cent of televisions and computers at the end of life were recycled (Dollinson et al., 2017). The NTCRS set a first-year target of 30% (41,327 tonnes in 2012-13), achieving 98.8% of the target, 40,813 tonnes recycled, nearly double prior levels. By 2013-14, the scheme recycled 52,700 tonnes against a 33% target (43,400 tonnes), and by 2015-16 it approached 50% recycling (49,892 tonnes achieved versus 51,870 targeted) (Commonwealth of Australia, 2014; Dollisson et al., 2017). A 2017 review of the NTCRS by Australia and New Zealand Recycling Platform Limited (ANZRP) confirmed the scheme had a 99% compliance rate (Dollisson et al., 2017). According to the Global E-waste Monitor 2024, a total of 130,000 tonnes of television and computer waste have been collected to date through a network of 1800 collection services (Baldé et al., 2024).

Elsewhere, Japan has adopted a unique strategy through the Act on Promotion of Recycling of Small Waste Electrical and Electronic Equipment and the Home Appliance Recycling Law. To provide financial incentives for appropriate disposal, this approach requires users to pay end-of-life costs when disposing of appliances. Retailers serve as the main collection points, creating a closed-loop system with a 50% recycling rate (Aizawa et al., 2008; F. Yoshida & Yoshida, 2014; Shimada & Van Wassenhove, 2016; Yoshida et al., 2015).

Even in developed nations, recycling performance varies. Despite its superior technological capabilities, the United States struggles to achieve universal e-waste management due to the lack of federal legislation and reliance on state-level restrictions, leading to a patchwork of policies with varying degrees of effectiveness (Schumacher & Agbemabiese, 2020; Schumacher, 2016). Economic development alone cannot be seen as a guarantee of good e-waste management, as evidenced by the fact that, due to fragmentation, overall recycling rates have been lower than in countries with centralised regulatory systems.

Conversely, many developing nations have enacted e-waste legislation based on international best practices. China's 2011 Regulations on Recovery Processing of Waste Electrical and Electronic Products and India's E-Waste (Management) Rules of 2016 established the principles of extended producer responsibility. Still, their implementation remains challenging due to policy implementation, resource constraints and the persistence of informal recycling networks, which handle 95% of e-waste (Awasthi et al., 2016; Ilankoon et al., 2018).

Factors driving effective e-waste recycling.

Policy and Regulatory Framework

The successful recycling of e-waste requires a robust policy and regulatory framework that establishes clear rules, roles, and enforcement measures among the various stakeholders involved in the lifecycle of electronic devices. The Waste Electrical and Electronic Equipment (WEEE) Directive of the European Union can be used as a good example of comprehensive regulations, as it develops the concept of Extended Producer

Responsibility (EPR) according to which manufacturers and distributors need to deal directly with the lifecycle of their electronic products, including recycling and end-of-life disposal (European Parliament, 2012). By shifting the operational and financial cost of managing e-waste from governments to producers, this paradigm encourages recyclable design. It establishes long-term funding sources for infrastructure related to collection and processing (Parajuly et al., 2020).

Other key elements in achieving successful recycling include international policy coordination and harmonisation. Improved transboundary movement controls and capacity building initiatives have been made possible by the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal amendments, the Bamako Convention, the Restriction of Hazardous Substances Directive (RoHS), and regional initiatives such as the Association of Southeast Asian Nations (ASEAN) (Sthiannopkao & Wong, 2012). Formal recycling initiatives are nevertheless hampered by the illegal e-waste trade, underscoring the need for stronger enforcement measures and global collaboration (Grant et al., 2013; Perkins et al., 2014).

Recycling effectiveness has been observed to increase, especially when regulatory frameworks align with the principles of a circular economy. Systemic conditions created by policies that encourage disassembly-friendly design, material standardisation, and the requirement of recycling content favour higher recycling rates (Awasthi et al., 2019). Product lifespans are further increased, and waste generation is decreased through the incorporation of mandated repairability score systems and right-to-repair laws (European Commission, 2023; Hernandez et al., 2020).

Economic Incentives

One of the key factors influencing efficient e-waste recycling is still economic viability. Cucchiella et al. (2015) postulate that recycling programs can be considered sustainable when the monetary value of the collected material exceeds the costs of collection, processing, and administration. With the recovery of gold, silver, and platinum serving as the primary economic rationale for official recycling activities, the volatility of precious metal prices has a substantial impact on recycling economics (Hagelüken, 2012).

Market-based tools that have effectively increased collection include tax incentives and deposit-refund schemes. Customers are encouraged to return electronic devices for appropriate recycling through deposit-refund schemes, such as those in Finland (Ylä-

Mella et al., 2015). Recycling fees in Japan are integrated into product costs and provide long-term finance for the management of e-waste (Liu et al., 2023; Sthiannopkao & Wong, 2012). Similarly, tax incentives for recycling companies and consumers have enhanced the economic attractiveness of formal recycling channels over informal disposal methods (Ghisellini et al., 2015; F. Wang et al., 2012).

Consumer Behaviour and Awareness

Consumer participation is a fundamental prerequisite for effective e-waste recycling systems. Most studies conducted in both advanced and developing countries show that customers often keep end-of-life devices at home rather than properly dispose of them (Tanskanen, 2013; Yla-Mella et al., 2015; Borthakur & Govind, 2016; Yin et al., 2013). Consumer involvement rates are mainly determined by environmental awareness, the ease of disposal options, and trust in recycling programs, as studied by Saphores et al. (2012). Individual recycling practices are amplified by social impact and community-based initiatives through social learning mechanisms and peer effects (Sidique et al., 2009).

Technological Innovation and Infrastructure

Technological innovation and adequate infrastructure are essential factors in enhancing global e-waste management. Sustainable waste management systems must evolve in line with the rapid increase in electronic use to manage growing volumes and complexity. Advancements in recycling technology, including AI-based disassembly, automated sorting, and advanced material recovery facilities (MRFs), have greatly enhanced the extraction and separation of valuable materials such as precious metals and rare earth elements (Fang et al., 2023; Sun et al., 2016). Moreover, scalable e-waste recovery methods, e.g., extracting metals through hydro metallurgy, pyrometallurgy, or bioleaching, allow higher recovery rates with minimised environmental and human health impacts (Ahirwar & Tripathi, 2020; Arya & Kumar, 2020; Ilankoon et al., 2018). The integration of digital platforms, blockchain technology, and IoT (Internet of Things) for tracking and managing e-waste flows, making informal-to-formal transition feasible in developing economies, leads to effective e-waste management (Aggarwal et al., 2019; Arya & Kumar, 2020; Ilankoon et al., 2018; Sahoo et al., 2021).

The ability to collect and process e-waste is higher in nations that invest in such infrastructure. For instance, e-waste movements in Europe are significantly streamlined by Extended Producer Responsibility (EPR) systems supported by centralised databases and sophisticated logistics (Arya & Kumar, 2020; Kumar et al., 2017). Even well-thought-out policies are ineffective in practice without such infrastructure and technology frameworks. Thus, infrastructure and innovation are essential prerequisites for creating sustainable and efficient e-waste systems, not merely facilitators.

Transferability of Successful Initiatives.

The transferability of e-waste management technologies to other environments is a complex issue. Even though some of the concepts sound broadly applicable, local circumstances must be taken into account to be effectively applied.

Extended Producer Responsibility (EPR) systems have proven successful across a wide range of environments. Following the EU's success, nations such as China, India, and Brazil have adopted comparable frameworks (Arya & Kumar, 2020; Baldé et al., 2024; Patil & Ramakrishna, 2020). The success of implementation, however, varies by market formality, stakeholder participation, and enforcement capability. The effectiveness is strongly related to the enforcement capabilities at the institutional level, and the effectiveness of EPR systems transfer required significant adaptation to local institutions of governance (Arya & Kumar, 2020; Corsini et al., 2016; Herat, 2021; Portugaise et al., 2023). For example, the social, environmental, and economic boundaries should be considered when transferring formal technologies to developing countries. Direct technology transfer without regard for interrelated non-technical components of waste management may result in inadequate systems (Herat, 2021; Schluep et al., 2009). Similarly, a study by Borthakur and Govind (2016) documented how India's adaptation of the Swiss e-waste model required significant modifications to account for socioeconomic differences and the prominent role of the informal sector. Similarly, China's WEEE fund model, which was initially plagued by a significant funding shortfall, was remodelled to include consumer contributions, fund montages, and incentives for the production of environmentally friendly products (Gu et al., 2017). This demonstrates how e-waste management systems can be more ecologically and financially effective when they are customised to a nation's unique institutional and economic circumstances.

Regional partnership initiatives can resolve transboundary e-waste issues by fostering global refurbishment and product recovery/recycling between developed and developing countries. The Basel Convention's Partnership for Action on Computing Equipment (PACE), established in 2008, is a multi-stakeholder partnership that has facilitated knowledge transfer on the current management of used and end-of-life computing equipment (Basel Convention, 2011). In a similar vein, the StEP (Solving the E-waste Problem) program has encouraged international information exchange while honouring regional variations in implementation (Schluep et al., 2009). Bilateral cooperation projects have shown promise in promoting system transfers. Japan's collaboration with Asian nations, including Malaysia, India, Thailand, China, the Philippines, and others, through the Japan International Cooperation Agency (JICA), has dramatically accelerated the development of these nations by offering technical assistance, training programs, and funding for pilot projects about environmental sustainability, waste management, and the circular economy (Japan International Cooperation Agency (JICA), 2009, 2018, 2020).

Changes in economic settings require changes in technology and infrastructure. Advanced recycling facilities from developed nations may be economically unviable in low-income countries. Labour-intensive versus capital-intensive approaches require context-appropriate balancing. Instead, “medium-tech” solutions that balance formal and informal sector integration have shown greater transferability to developing contexts (Schluep et al., 2009). In developing nations where informal recyclers dominate the e-waste market (Awasthi et al., 2016a), Wang et al. (2012) found that it is more feasible to start small and work gradually up to profitable fractions rather than implementing ambitious plans with all-inclusive solutions for all e-waste categories, especially if there is little to no government or financial support.

Effective transfer of e-waste management systems/technologies requires meticulous adaptation rather than replication, as solutions must fit the diverse institutional, socioeconomic, and environmental contexts of the respective regions to be sustainable and effective over the long term.

Building on the insights gained from the literature review, the next chapter outlines the methodological approach adopted for this study. While existing research highlights the diversity and evolution of e-waste policy frameworks across jurisdictions, few provide detailed comparisons of how these policies operate in practice. To address this, the following chapter explains how this research systematically examines e-waste policies in New Zealand and selected international contexts. It details the research design, data collection, and analytical procedures used to identify and compare key policy themes and practices relevant to advancing sustainable e-waste management.

Chapter 3: Methodology

Introduction

This chapter describes the methodology used to answer the research questions posed in this study. The technique aims to provide a systematic framework for assessing New Zealand's current e-waste management procedures and for identifying lessons from overseas examples to enhance the country's electronic recycling and refurbishment rates.

Research Questions

This study addresses two key research questions:

***RQ1:** What are the key characteristics of the regulatory systems governing e-waste management in jurisdictions that have achieved comparatively high e-waste recovery and recycling rates?*

***RQ2:** What is the existing nature of the regulatory system governing e-waste management in New Zealand, and what can New Zealand learn from other jurisdictions that have achieved much higher recovery and recycling rates?*

The research questions clearly focus on New Zealand as the key case, with overseas instances providing insights and lessons that could help enhance New Zealand's e-waste management framework. Through a methodical examination of policy documents, academic studies and industry reports from New Zealand and relevant jurisdictions overseas, the research approach outlined below is designed to address these concerns.

Research Design

The qualitative research method used in the current study is particularly appropriate for studying policy phenomena and the environments in which e-waste management processes and regulations operate. This analytical approach allows for a thorough examination of the factors that influence e-waste recycling and refurbishment procedures, revealing the complexity and contextual nuances that quantitative methods may overlook (Creswell & Poth, 2018).

Qualitative approaches are uniquely positioned to uncover the underlying mechanisms, contextual influences, and stakeholder experiences that shape policy outcomes, which makes them especially relevant to the investigation of complicated policy phenomena that cannot be sufficiently described using quantitative measures alone (Mason, 2017; Denzin & Lincoln, 2011; Creswell & Poth, 2018; Patton, 2015). These approaches are excellent at providing answers to the “how” and “why” questions, investigating the procedures used in the creation and application of policies (Mason, 2017; Tisdell et al., 2025), and exposing the frequently overlooked elements that contribute to the success or failure of policies (Tisdell et al., 2025). Numerous studies have documented the use of qualitative approaches in policy analysis, with scholars highlighting their unique significance for comprehending the efficacy and implementation of policies across a variety of contexts (Yanow, 2000, 2007). The essence of policy analysis is to understand why and how governments enact legislation, and the impacts of that legislation. This calls for techniques that can effectively capture the complexities of political processes and stakeholder relationships (Dunn, 2015; Yanow, 2007).

Qualitative methods are useful in implementation research, as they focus on challenging questions, such as how and why best practices are applied successfully or unsuccessfully, and how various actors perceive and interpret implementation initiatives (Hamilton & Finley, 2019). These methods enable systematic examination of recurrent themes and patterns in legislative texts, regulatory documents, and implementation reports. Document analysis, a well-established qualitative research method, is particularly well-suited to policy research (Bowen, 2009). The credibility of this method is supported by a broad base of peer-reviewed literature focusing on qualitative comparative policy analysis (Ritchie et al., 2013; Yin, 2009).

Data Collection

The data collection method involves a systematic approach to acquiring and analysing major documents that shed light not only on the successful practices at the global scale but also on the current approach to e-waste management in New Zealand. In addition to learning from nations that have achieved better recycling and refurbishment outcomes, the study also aims to identify the current state of e-waste management in New Zealand.

To answer the first research question on lessons from best practices, the study examines policy documents and programme assessments from two jurisdictions that have demonstrated leadership in e-waste management: the European Union and Australia. These jurisdictions were selected for their comprehensive, publicly available documentation of their policies and performance, their operation under different constitutional contexts, their range of country sizes, and their diverse e-waste disposal strategies that have shown remarkable success.

The European Union is a key point of reference due to its WEEE Directive, which has established international standards for e-waste laws and has been widely adopted as a template by other nations. Further insights into creative policy mechanisms that go beyond conventional recycling procedures can be gained from the EU's right-to-repair laws and circular economy efforts. Since Australia resembles New Zealand in terms of geographic isolation and political culture, the paper will discuss the National Television and Computer Recycling Scheme (NTCRS) and other product stewardship programs in Australia. From voluntary sector initiatives to mandated producer responsibility programs, these global examples offer a wide range of legislative options that could help New Zealand identify avenues to follow.

To answer the second research question, the research begins with an extensive review of the existing policy framework for e-waste in New Zealand. The key documents that will be analysed in this paper include Waste Minimisation Act (2008) (Ministry for the Environment, 2008), which establishes the legal framework for product stewardship programmes, the E-waste Product Stewardship Framework (Ministry for the Environment & SLR Consulting NZ Limited, 2015; Tech Collect NZ, 2021), which proposes the government strategies for handling electronic waste, and the Declaration of Priority Products Notice 2020 (Ministry for the Environment, 2020), which names e-waste as a priority product category. Implementation reports, consultation documents, and evaluation studies that provide light on the difficulties encountered during implementation and the operationalisation of these policies are also included for analysis.

Selection of data sources

The selection of documents adheres to methodical standards to guarantee that the analysis uses relevant and credible sources. The research will focus on government policy reports (such as those of the European Parliament, New Zealand Legislation, and the Australian EPA), official legislative documents, programme evaluations, and implementation studies published by reputable academic institutions, international organisations (such as the OECD, United Nations, and Global E-waste Monitor), and environmental ministries. For documents to be current and pertinent to current policy issues, they must be made publicly accessible and published within the last 15 to 20 years. This timeline covers the development of diverse regulatory approaches across countries and the emergence of e-waste as an acknowledged policy issue.

The document-gathering procedure includes a systematic search of official government websites, policy databases, and academic literature repositories, like Google Scholar, Scopus, and JSTOR. The first step in identifying key policies and legislation papers is to consult the main environmental and waste management organisations in each jurisdiction. International organisation databases, particularly those maintained by the OECD and UN agencies, provide comparative research and evaluation reports that assess policy performance across countries. Peer-reviewed evaluations of the execution and results of policies are added to these official sources by academic databases.

The study draws on government policy reports, official legislative documents, and high-quality peer-reviewed research to ensure the evidence base is both authoritative and directly linked to current policy and practice. The study also includes credible media pieces and advocacy publications that support e-waste management. Furthermore, documents of unclear provenance or authority or those that deviate from the e-waste policy or refurbishment are not included. The chosen jurisdictions, all of which have credible, easily accessible policy documentation, and the data sources outlined above, will ensure that the study is both analytically rich and feasible given the time and resource limitations of a Master’s thesis. Since the data used in this study is publicly available, specific ethics approval is not necessary. All sources are properly credited, and copyright is considered when using and reproducing content. The study complies with accepted academic integrity norms, which include truthful portrayal and open disclosure of source materials.

Data Analysis

Thematic analysis, as described by Braun and Clarke (2006), is a qualitative method that helps identify, analyse, and understand patterned meanings or “themes” in qualitative data. Their six-phase approach - discussed below - enables researchers to make sense of complex data systematically and transparently. Due to its ability to identify patterns and themes across a variety of document types and its adaptability to the various regulatory and political contexts represented in the data, this analytical approach is especially well-suited for policy research (Ahmed et al., 2025; Braun & Clarke, 2006, 2021; Terry et al., 2017).

Following Braun and Clarke's six-phase process, the analysis begins with familiarisation, which involves reading all selected documents in depth to understand their context and content. This first stage ensures a comprehensive grasp of each jurisdiction's policy approach and the unique issues it faces, laying the groundwork for later analytical processes.

The second stage is methodically coding each document's pertinent material. Specific policy mechanisms, implementation tactics, reported results, obstacles found, and stakeholder reactions are all highlighted through the coding process. Since these characteristics directly relate to the study's research concerns about the learning that can be implemented for efficient e-waste management, special attention is devoted to factors that appear to enhance or undermine policy effectiveness.

After this initial coding, related codes are grouped into potential themes to identify broader patterns in the data. This process entails determining broad policy measures, including right-to-repair programs, extended producer responsibility, collection and recycling goals, and stakeholder engagement tactics. Implementation difficulties, enforcement strategies, and contextual elements that affect policy success are also addressed during the theme development process.

In the fourth phase, the identified themes are then reviewed and refined to ensure they accurately represent the data and provide relevant insights into answering the research questions. This stage could entail combining related themes, breaking down intricate themes into more focused groups, or eliminating themes that do not significantly advance our understanding of the efficacy of e-waste policies.

In the fifth phase, each theme is precisely defined and supported by particular instances from the examined papers. This procedure ensures that the themes are supported by robust findings on the key policies of e-waste management in jurisdictions that have achieved greater success, as well as the lessons New Zealand could learn from other countries' experiences.

Synthesising the themes into a cohesive story that directly responds to the research questions is the sixth and last stage of analysis. This synthesis uses a study of New Zealand policy documents to pinpoint the current state of e-waste management. At the same time, it draws lessons from global experiences that could guide New Zealand's strategy, ensuring they are applied in a practical setting and are appropriate to the location.

Generative AI tools (primarily ChatGPT) were used in a limited support capacity to conduct a preliminary analysis of this study's large qualitative dataset of policy documents, as permitted by the AUT Postgraduate Handbook. The use of these tools was restricted to assisting with document organisation, identifying sections of each document that were relevant to the design of regulatory systems, and producing a high-level summarisation of source materials. This assisted the author in focussing on the parts of each document most relevant to the research questions. All AI-generated outputs were critically reviewed by the author and used only as a starting point for independent analysis. Generative AI was not used to assign codes, generate themes, make interpretive decisions, or determine the final findings. Thematic analysis relies heavily on researcher interpretation, and so all coding, theme development, comparison across jurisdictions was conducted independently by the author. The final interpretation, analysis, and validation of all content remain the sole responsibility of the author.

Chapter 4: Findings

The previous chapter showcased the research design and methodology which is being used to answer the research questions, and the following chapter presents findings from a thematic analysis of policy documents from two high-performing jurisdictions, the European Union and Australia, to identify key features of their systems of electronic waste (e-waste) product stewardship. These findings address the following research question:

RQ1: *What are the key characteristics of the regulatory systems governing e-waste management in jurisdictions that have achieved comparatively high e-waste recovery and recycling rates?*

The analysis identifies four key themes that characterise the governance frameworks of these high-performing jurisdictions: legally enforceable producer responsibility; circular product design and the right to repair; quantitative targets for collection, recycling, and recovery rates; and public awareness and access. Each theme is developed through sub-sections based on analytical codes, with supporting evidence from the documents presented to show how the themes and codes are evident in the source material.

The chapter also presents findings from an analysis of New Zealand's current approach to e-waste and related product stewardship, including the existing Waste Minimisation Act 2008, priority product declarations, and early examples of regulated stewardship such as Tyrewise for end-of-life tyres. These findings address the following research question:

RQ2: *What is the existing nature of e-waste management in New Zealand, and what can New Zealand learn from jurisdictions that have achieved much higher recovery and recycling rates?*

In this second part of the analysis, the same four themes serve as an organising framework to assess New Zealand's current e-waste management settings, thereby highlighting specific gaps, strengths, and opportunities for regulatory development.

The following table summarises the key themes and evidence that emerged from the thematic analysis of European Union and Australian policy documents. For each theme, the table lists the analytical code and supporting quotations showing how the theme is expressed in the source material.

Table 1. Summary of themes and codes

THEMES	CODE	KEY DESCRIPTIVE QUOTES
Legally Enforceable Producer Responsibility	The Polluter Pays Principle and Financial Liability	Each producer provides a guarantee when placing a product on the market showing that the management of all WEEE will be financed.” (European Parliament, 2012, p.48) Member States shall encourage the shift payment for the collection of this waste from general taxpayers to the consumers of EEE, in line with the ‘polluter pays’ principle. (European Parliament, 2012, p.41)
	Fee Modulation Linked to Product Design Performance	Extended producer responsibility obligations are modulated, where possible, for individual products or groups of similar products, notably by taking into account their durability, reparability, re-usability and recyclability. (European Parliament, 2008, p.13)
	Mandatory Participation and Compliance Mechanisms	“A person is a liable party for a financial year if, in the previous financial year... the person imported or manufactured in Australia more than 5,000 computers or printers” (Department of Climate Change, Energy, the Environment and Water, 2021, p.6); This Act provides for 3 regimes relating to product stewardship, each of which is designed to encourage or require manufacturers, importers, distributors and other persons to take responsibility for products.” (Department of Climate Change, Energy, the Environment and Water, 2020, p.4)
Circular Product Design and Right-to-Repair	Ecodesign for Durability and Anti-Obsolescence	[Member States shall establish ... waste prevention programmes...] The promotion of eco-design (the systematic integration of environmental aspects into product design with the aim to improve the environmental performance of the product throughout its whole life cycle).” (European Parliament, 2008, p.52) Member states shall encourage the design, manufacturing and use of products that are resource-efficient, durable (including in terms of life span and absence of planned

		obsolescence), reparable, re usable and upgradable" (European Parliament, 2008, p.15)
	Digital Product Passports and Information Transparency	"Digital product passports must include information on substances of concern, component identification, and disassembly instructions." (European Parliament, 2024b, p.33)
	Right to Repair and Re-use	"Manufacturers shall not use any contractual clauses, hardware or software techniques that impede the repair of goods covered by Union legal acts listed in Annex II." (European Parliament, 2024a, p.13)
	Support for Repair Infrastructure	"Member States should take at least one measure promoting repair. Such measures could be of financial or of non-financial nature. (European Parliament, 2024a, p.10)
Quantitative Targets for Collection, Recycling and Recovery Rates	Binding Collection and Recycling Targets	"From 2019, the minimum collection rate to be achieved annually shall be 65 % of the average weight of EEE placed on the market in the three preceding years in the Member State concerned, or alternatively 85 % of WEEE generated on the territory of that Member State." (European Parliament, 2008, p.45) "The Policy and Action Plan align with the priorities set out in the National Circular Economy Framework and contribute specifically to the framework's 80% resource recovery target [by 2030]." (Commonwealth of Australia, 2024, p.3)
	Recovery and Recycling Standards	Television or computer products that are recycled must be recycled... by a person certified to AS/NZS 5377" (Department of Climate Change, Energy, the Environment and Water, 2021, p.8)
Robust Governance and	Producer Registration and Harmonised	"Member States shall collect information..., on the quantities and categories of EEE placed on their markets, collected through all routes, prepared for re-use, recycled and recovered within the Member State, and on separately

Compliance Monitoring	Data Collection	collected WEEE exported.” (European Parliament, 2012, p.49)
	Inspection, Monitoring and Enforcement	“The rules may make provision... requiring a person who is a liable party in relation to a product, or the administrator of an approved co-regulatory arrangement in relation to a product, to give specified reports to the Minister.” (Department of Climate Change, Energy, the Environment and Water, 2020, p.86)
Public Awareness and Engagement	Public Awareness	The use of awareness campaigns and information provision directed at the general public or a specific set of consumers.” (European Parliament, 2012, p.52)

Effective e-waste product stewardship: Key principles from Australia and the European Union

A thematic analysis of policy papers from the European Union and Australia reveals that these two jurisdictions share many standard governance features. Since these jurisdictions experience high rates of electronic recycling and refurbishment, these practices can be considered provisional examples of international best practice.

Theme 1: Legally Enforceable Producer Responsibility

The architectural foundation of high-performing e-waste stewardship systems is a binding form of extended producer responsibility (EPR) that places financial and organisational liability for e-waste management on producers and importers rather than on taxpayers or local councils. Rather than relying on voluntary initiatives or subsidies, both the EU and Australian frameworks internalise the costs of collection, treatment and recovery into producer fees, and explicitly link those costs to product design, durability and recyclability (Department of Climate Change, Energy, the Environment and Water, 2020, 2021; European Parliament, 2008, 2012).

Code 1.1: The Polluter Pays Principle and Financial Liability

The EU's Waste Framework Directive (European Parliament, 2008) establishes the “polluter pays” principle, forcing the original waste producer or current holder to fund waste management expenses. The Waste Electrical and Electronic Equipment (WEEE) Directive

(European Parliament, 2012) operationalises this general rule for electronics by requiring manufacturers to pay for the collection, treatment, and recovery of WEEE from specified collection points. Producers are required to accept individual financial responsibility for waste management resulting from their own products placed on the market after the Directive entered into force.

> *Each producer provides a guarantee when placing a product on the market showing that the management of all WEEE will be financed." (European Parliament, 2012, p.48)*

> *Member States shall encourage the shift payment for the collection of this waste from general taxpayers to the consumers of EEE, in line with the 'polluter pays' principle. (European Parliament, 2012, .41)*

At the same time, historic WEEE is addressed through a shared obligation among all current producers. To ensure that this obligation is fulfilled, producers must provide financial guarantees demonstrating that future waste management costs will be funded, thereby preventing taxpayers from bearing the expenses of "orphan" items when companies leave.

> *The responsibility for the financing of the management of historical waste should be shared by all existing producers through collective financing schemes to which all producers that exist on the market when the costs occur contribute proportionately. (European Parliament, 2012, p.41)*

Code 1.2: Fee Modulation Linked to Product Design Performance

A distinctive feature of the EU's approach is that the producer fees are not uniform across all products. The EU framework makes it explicit that producer responsibility is a means of transforming product systems rather than just a funding tool. The WEEE Directive and the Waste Framework Directive (European Parliament, 2008, 2012) stipulate that financial contributions for EPR be modulated by product design, making poorly designed products more costly than those designed for circularity. In other words, EPR is viewed under EU law as an incentive structure throughout the product life cycle rather than merely as a back-end levy or tax.

> *Extended producer responsibility obligations are modulated, where possible, for individual products or groups of similar products, notably by taking into account their*

durability, reparability, re-usability and recyclability. (European Parliament, 2008, p.13)

On the other hand, a review of the Australian Product Stewardship Act 2011 (Commonwealth of Australia, 2020) suggests expanding its goals to include promoting product design. It has recommended the possibility of "eco-modulated" fees, similar to those of the EU, which compensate manufacturers whose goods adhere to stricter design guidelines.

introduction of modulated fees to reward producers or importers of products by taking into account the durability, reparability, re-usability, recyclability and the presence of hazardous substances of products. (Commonwealth of Australia, 2020, p.17)

Code 1.3: Mandatory Participation and Compliance Mechanisms

Although Australian practice originates from a different institutional setting to the EU, specifically a federal system where states share waste management responsibilities with the Commonwealth government, the methodology used is very similar. The National Television and Computer Recycling Scheme (NTCRS) explains "liable parties" as manufacturers and importers of television sets, computers, and computer peripherals, who are responsible for the recycling of products they sell in Australia that exceed predefined thresholds (Department of Climate Change, Energy, the Environment and Water, 2021). Although the current scheme design has a limited scope, proposals have been put forward to expand it to include small electrical products (mobile phones, audio and video devices, radios, speakers, etc.) and photovoltaic system waste (Commonwealth of Australia, 2023).

A person is a liable party for a financial year if, in the previous financial year ... the person imported or manufactured in Australia more than 5,000 computers or printers. (Recycling and Waste Reduction (Department of Climate Change, Energy, the Environment and Water, 2021, p.6)

Scheme recycling is paid for by companies who import television and computer products or manufacture them in Australia. This is a form of product stewardship where producers take responsibility for the whole lifecycle of their products. (Commonwealth of Australia, 2015, p.1)

Payments by these responsible parties under co-regulatory agreements ensure sufficient funds for collection and recycling operations. An operational evaluation of the NTCRS reports that *"the majority of stakeholders, including those from liable parties, agreed that a scheme* *which requires industry to bear the lion's share of the responsibility and cost is both fair and reasonable, and also in line with public expectations.*" (Australian Continuous Improvement Group (ACIG), 2017). This suggests that regulated, producer-funded stewardship is viewed as both equitable and aligned with community expectations, not just a regulatory imposition that industry reluctantly accepts.

> *This Act provides for 3 regimes relating to product stewardship, each of which is designed to encourage or require manufacturers, importers, distributors and other persons to take responsibility for products." (Commonwealth of Australia, 2020, p.4)*

Theme Two: Circular Product Design and Right-to-Repair

A second distinguishing element of international best practice, as expressed in the regulatory approaches of the EU and Australia, is that it extends stewardship beyond waste management to include product design, durability, and repairability. Products must be designed to increase durability, dependability, repairability, upgradability, reusability, and recyclability in accordance with the EU's Ecodesign framework (European Parliament, 2024b). In the section above, we saw that financial liability for e-waste treatment is intended to incentivise circular design. Beyond those incentives, certain product laws establish measurable performance requirements for specific types of equipment.

Code 2.1: Ecodesign for Durability and Anti-Obsolescence

The EU's Ecodesign Regulation (2024/1781) requires that electronic products be designed to improve durability, reliability, repairability, upgradability, reusability and recyclability (European Parliament, 2024b). Importantly, these are not voluntary guidelines or recommendations; they are measurable, legally binding performance requirements embedded in mandatory product regulations (European Parliament, 2024b).

> *It [Eco Design Regulation] shall provide for the setting of new ecodesign requirements to improve product durability, reliability, repairability, upgradability, reusability and recyclability (European Parliament, 2024b, p.2)*

The regulation explicitly targets a practice known as "planned" or "premature" obsolescence, a strategy that deliberately shortens product lifespans through design choices, thereby encouraging the purchase of replacements. These ecodesign requirements establish a legislative environment in which durable, readily repairable items are the rule rather than the exception.

> *Ecodesign requirements shall, where relevant, ensure ... that products do not become prematurely obsolete, for reasons that include design choices by manufacturers, the use of components which are significantly less robust than other components, the impeded disassembly of key components, unavailable repair information or spare parts, software that no longer works once an operating system is updated or software updates that are not provided (European Parliament, 2024b, p.33)*

Similarly, Australia's evolving product stewardship and waste management framework demonstrates a growing policy emphasis on circular product design and lifecycle responsibility. Under the Recycling and Waste Reduction (RAWR) Act 2020, the government is tasked with *"encouraging and regulating manufacturers, importers, distributors, designers and other persons to take responsibility for products"* (Department of Climate Change, Energy, the Environment and Water, 2020, p.2) by reducing waste through improved design, enhancing durability, reparability and reusability, and ensuring products are managed responsibly throughout their life cycle. This legislative intent is reinforced by the National Waste Policy Action Plan 2024, which identifies key areas for change that *"include facilitation or promotion of reuse schemes, product stewardship, use of recycled materials, regulating the use of chemicals of concern, and prioritisation of circular economy practices."* (Commonwealth of Australia, 2024, p.6). Together, these policies establish a clear directional shift toward design-based stewardship where producers are expected not only to manage end-of-life waste but also to prevent it upstream through better product design and accountability across the entire production cycle.

Code 2.2: Digital Product Passports and Information Transparency

To support repairability, refurbishment and recycling, the EU has introduced digital product passports. For these design obligations to be effective in practice, transparency of information is essential. The new EU requirement for digital product passports mandates that complex products carry a digital record, including *"information on substances of concern, component identification, and disassembly instructions"* (European Parliament, 2024b, p. 33). By making product information digitally accessible from the design stage, the EU establishes a standardised information architecture for circular activity across the product life cycle. This transparency requirement enables higher-quality recycling by removing significant information asymmetries. Consequently, stakeholders, including customers, repairers, recyclers, and authorities, can access vital data without the need to reverse-engineer products or request information directly from manufacturers.

> *The Commission shall set up and manage a publicly accessible web portal allowing stakeholders to search for and compare data included in digital product passports (European Parliament, 2024b, p.43)*

Code 2.3: Right to Repair and Re-use

The EU's Repair Directive (2024/1799) establishes a statutory right to repair that extends beyond the manufacturer's warranty period (European Parliament, 2024a). Manufacturers are prohibited under a specific Repair Directive from using *"any contractual clauses, hardware or software techniques that impede the repair of goods covered by Union legal acts listed in Annex II."* (European Parliament, 2024a, p.13)

Under EU legislation, manufacturers are required to provide reasonably priced spare parts, repair tools, and repair and maintenance instructions for a period of seven years after the product is discontinued from the market.

> *Manufacturers that make spare parts and tools available for goods covered by Union legal acts listed in Annex II shall offer these spare parts and tools at a reasonable price that does not deter repair." (European Parliament, 2024a, p.12)*

In addition, the EU increasingly emphasises reuse and the development of second-hand markets (products that undergo repair originating from within the Union), encouraging refurbishment, recommerce, and the sale of used electrical and electronic equipment to keep products in circulation for longer before they enter the waste stream.

> *Member States shall take measures…, to promote the re-use of products and preparing for re-use activites, by encouraging the establishment and support of re-use and repair networks. (European Parliament, 2008, p.13)*

Code 2.4: Support for Repair Infrastructure

The EU framework recognises that legal rights to repair are insufficient without supporting infrastructure and incentives. Member states are also required by law to "*take at least one measure promoting repair"* (European Parliament, 2024a, p.8). These measures can be financial, such as repair vouchers, repair funds, or financing training programs, or non-financial measures, including information campaigns or community-led repair initiatives

(European Parliament, 2024a, p. 10). When taken as a whole, these regulations shift the customer's incentives away from replacement and towards repair and refurbishment.

Theme Three: Quantitative Targets for Collection, Recycling and Recovery Rates

A defining characteristic of the high-performing EU and Australian e-waste regimes is the establishment of legally binding, measurable targets for collection, recycling and recovery rates. Rather than relying on aspirational statements or non-binding guidance, both the EU and Australia specify numerical targets with enforcement mechanisms, regular monitoring and reporting obligations (Department of Climate Change, Energy, the Environment and Water, 2021; European Parliament, 2012). In the previous section, the analysis highlighted how regulatory and financial instruments are used to drive circular product design. Building on this, the following section examines how binding targets and recovery rates translate those principles into measurable performance outcomes, fostering accountability and continuous improvement.

Code 3.1: Binding Collection and Recycling Targets

The WEEE Directive establishes that *“the minimum collection rate to be achieved annually shall be 65 % of the average weight of EEE placed on the market in the three preceding years in the Member State concerned, or alternatively 85 % of WEEE generated on the territory of that Member State”* (European Parliament, 2012, p.45). These targets are legally binding obligations that the EU imposes on its member states to achieve annually. Where member states fail to meet their targets, the European Commission may initiate infringement proceedings, which can result in financial penalties from the Court of Justice of the European Union (European Parliament, 2012). For example, in 2015, the European Commission referred member states (Slovenia, Poland and Germany) to the Court of Justice of the European Union for failing to comply with the EU’s WEEE legislation. It imposed fines and daily penalty payments (EUR 210,078 for Germany, EUR 71,610 for Poland and EUR 8,408 for Slovenia) until full compliance was achieved (European Commission, 2015a, 2015b). The existence of enforcement mechanisms ensures that targets are taken seriously and that persistent underperformance has consequences.

Australia's approach mirrors the EU framework with escalating targets for the collection and recycling of waste televisions and computers. The NTCRS sets year-on-year percentage targets starting with 70% for the year 2021-2022 to 80% by the year 2034-2035, measured as a proportion of the estimated weight of products (printers, computers and their peripherals) placed on the market (Department of Climate Change, Energy, the Environment and Water, 2021). Co-regulatory arrangements must collectively achieve these targets and are subject to compliance monitoring. This approach fosters accountability and enables governments to evaluate whether schemes are achieving their intended outcomes. In addition to collection and recycling percentages, the NTCRS specifies a minimum material recovery target, which "*is the proportion of television or computer products to be sent after recycling for processing into usable materials"* that the co-regulatory schemes are required to achieve (Recycling and Waste Reduction (Department of Climate Change, Energy, the Environment and Water, 2021, p.2).

> *The material recovery target is 90% of television or computer products, based on weight. (Department of Climate Change, Energy, the Environment and Water, 2021, p.20)*

Code 3.2: Recovery and Recycling Standards

Collection targets alone are insufficient to ensure e-waste is managed sustainably. The WEEE Directive therefore establishes minimum recovery and recycling rates for each category of electrical equipment (ranging from 50% to 85% depending on the equipment type), along with the requirement that all collected WEEE undergo proper treatment (European Parliament, 2012). The Directive establishes a two-part approach: firstly, targets for collection rates (as discussed above); and secondly, the requirement that collected material must subsequently be treated to high environmental standards and recovered for reuse or recycling.

> *All separately collected WEEE shall undergo proper treatment. (European Parliament, 2012), p.46)*

Australia adopts a similar approach, under which consistent technical and environmental standards must support quantitative targets to ensure that material recovery is performed to high-quality and environmental specifications. From 1 July 2016, all scheme recycling under the NTCRS has been required to be carried out by service providers certified to the Australian Standard AS 5377 for the collection, storage, transport and treatment of e-waste (Department of Climate Change, Energy, the Environment and Water, 2021). This requirement ensures that quantitative performance targets are matched by nationally consistent technical and environmental process standards.

> *television or computer products that are recycled must be recycled… by a person certified to AS/NZS 5377. (Department of Climate Change, Energy, the Environment and Water, 2021), p.8)*

Theme Four: Robust Governance and Compliance Monitoring

High-performing e-waste stewardship regimes do not rely on voluntary compliance or assume that market forces will automatically deliver desired outcomes. Instead, they establish comprehensive governance arrangements that include enforcement mechanisms, transparency obligations, inspection and monitoring frameworks, and equitable public access to collection services (Department of Agriculture, Water and the Environment, 2021; European Parliament, 2012). Building on the technical standards and recovery targets previously discussed, this section examines the governance and enforcement frameworks that make those goals actionable while also ensuring public awareness.

Code 4.1: Producer Registration and Harmonised Data Collection

The EU frameworks require comprehensive registration and data collection systems to ensure that all manufacturers and importers are identified and contribute fairly to the costs of e-waste management. The WEEE Directive requires member states to maintain national producer registers and to collect and report harmonised data on the quantities and categories of electrical and electronic equipment placed on the market, as well as WEEE collected, reused, recycled and recovered (European Parliament, 2012). These data systems serve multiple purposes, including supporting transparency and accountability, facilitating performance benchmarking across jurisdictions, enabling governments to identify geographic or sectoral gaps in coverage, and providing a factual basis for evidence-based policy refinement.

> *"Member States shall collect information…, on the quantities and categories of EEE placed on their markets, collected through all routes, prepared for re-use, recycled and recovered within the Member State, and on separately collected WEEE exported." (European Parliament, 2012, p.49)*

Code 4.2: Inspection, Monitoring and Enforcement

Governance frameworks in both jurisdictions establish inspection and monitoring capabilities to verify that producers, importers, scheme operators and recyclers comply with their obligations. The WEEE Directive requires member states to undertake inspections and monitoring, as well as checks on suspected illegal e-waste exports (European Parliament, 2012). Infringement of obligations can result in sanctions, signalling that participation and compliance are mandatory rather than optional. This creates a credible deterrent against non-compliance.

> *Member States shall carry out appropriate inspections and monitoring to verify the proper implementation of this Directive. (European Parliament, 2012, p.61)*

The Recycling and Waste Reduction (RAWR) Act 2020 (Department of Climate Change, Energy, the Environment and Water, 2020, 2021) establishes a rigorous enforcement framework designed to ensure that all liable parties are members of an "approved co-regulatory arrangement," failing which they face significant civil penalties, thus contributing to product stewardship. To deter non-compliance, the Act grants the Minister the power to use graduated enforcement tools, including improvement notices, infringement notices, and enforceable undertakings, to secure long-term compliance. Furthermore, Section 89 of the Act explicitly addresses "anti-avoidance," empowering the Minister to make determinations that prevent companies from structuring their operations solely to bypass these regulatory requirements. Monitoring these obligations is supported by strict record-keeping and reporting mandates detailed in both the RAWR Act and the Television and Computers Rules 2021 (Department of Climate Change, Energy, the Environment and Water, 2020, 2021). Administrators of co-regulatory arrangements are required to provide yearly, quarterly, and annual reports to the Minister, detailing membership and progress toward recycling targets.

Theme Five: Public Awareness and Engagement

Building on the previous theme, which showed how regulatory design, funding models, and institutional arrangements shape the architecture of product stewardship schemes. This theme turns to how these systems are communicated to the public. This theme captures how each scheme seeks to inform, motivate, and support the public in participating in more sustainable e-waste management, including information campaigns and clear guidance on returning products and disposing of them in ways that support wider social and environmental benefits.

Code 5.1: Public Awareness

Public participation is essential to achieving high collection rates, but such participation is only possible if the public is aware. Both the EU and Australian frameworks require that households and businesses have convenient, free access to collection services. The WEEE Directive stipulates that member states ensure that users of private EEE are informed of the requirement not to dispose of WEEE as unsorted waste and about the collection systems. Additionally, products must be clearly marked with the crossed-out wheeled bin symbol to indicate that they are meant for separate collection (European Parliament, 2012).

Australian regulations similarly require that collection services funded under the NTCRS are provided free of charge to households and small businesses and are reasonably accessible across metropolitan, regional and remote areas (Department of Climate Change, Energy, the Environment and Water, 2021). This commitment to equitable access reflects recognition that geography and income should not be barriers to participation.

Governance frameworks in both jurisdictions emphasise public awareness and information as essential to behavioural change. Member states in the EU and Scheme administrators in Australia are expected to conduct outreach and education initiatives to inform communities and the general public about their responsibilities and the recycling facilities available to them. Without public awareness and education, even a well-designed collection infrastructure will not achieve high participation rates.

> *The administrator of an approved co-regulatory arrangement in relation to television or computer products must advertise the existence and location of each collection service (Recycling and Waste Reduction (Department of Climate Change, Energy, the Environment and Water, 2021, p.10)*

> *The use of awareness campaigns and information provision directed at the general public or a specific set of consumers." (European Parliament, 2008, p.52)*

Conclusion

The analysis of the EU and Australian frameworks reveals five core themes that together characterise how these jurisdictions approach e-waste and product stewardship, and that can inform the emerging New Zealand system. First, both frameworks embed regulatory design and scope that clearly define covered products, allocate responsibilities to producers, and use mandatory obligations (rather than voluntary initiatives) to secure stable, long-term stewardship arrangements. Second, the EU and Australian schemes are increasingly oriented towards circularity and market development, with measures to support higher-order waste hierarchy outcomes (prevention, reuse, repair) and to foster domestic markets for secondary materials and circular business models. Thirdly, they impose quantitative targets and rely on funding and cost-sharing mechanisms that internalise end-of-life costs, typically through producer-funded levies or scheme fees, which in turn finance collection, treatment, data systems, and oversight.

Fourth, both systems emphasise governance, coordination, and compliance, using accredited or approved organisations, monitoring and enforcement arrangements to align the actions of producers, recyclers, retailers, and governments. Lastly, they educate and encourage the public through awareness campaigns to ensure a smooth implementation of the e-waste policy framework. Taken together, these themes provide a set of organising principles that can guide the design of New Zealand's product stewardship architecture: clarifying scope and responsibilities, ensuring robust and fair funding, building effective governance and compliance systems, and deliberately steering policy settings toward circular, locally beneficial resource use rather than narrow end-of-pipe recycling.

To build on these findings, the chapter now turns to an analysis of how New Zealand currently approaches e-waste management from a regulatory perspective. This next section uses the four themes identified in the EU and Australian frameworks as an analytical lens to assess New Zealand's existing e-waste management initiatives. By applying the same thematic structure, the analysis highlights where New Zealand's regulatory settings align with high-performing jurisdictions, where significant gaps remain, and how these gaps constrain the development of an effective, nationally coherent system of e-waste product stewardship.

The existing shape of New Zealand's e-waste framework

Historical development and limitations

New Zealand's product stewardship framework is established under the Waste Minimisation Act 2008 (hereafter, the WMA) (Ministry for the Environment, 2008), which defines the statutory purpose for waste minimisation and provides the legal architecture for regulated product stewardship schemes. The Act's purpose is "*to encourage waste minimisation and a decrease in waste disposal in order to protect the environment from harm and provide environmental, social, economic, and cultural benefits*" (Waste Minimisation Act 2008, p.6). The Act specifically addresses product stewardship, stating that its purpose is "*to encourage* *and, in certain circumstances, require the people and organisations involved in the life of a product to share responsibility for ensuring there is effective reduction, reuse, recycling, or recovery of the product and managing any environmental harm arising from the product when it becomes waste*" (Waste Minimisation Act 2008, p.11). This dual emphasis on encouragement and compulsion creates a graduated regulatory approach: voluntary schemes remain possible (and in practice, have been preferred), but the Act provides powers to mandate regulated stewardship schemes.

Central to this framework are its 'priority product declaration' powers. Under the WMA, the Minister for the Environment may declare a product a priority product if they are satisfied that it either "*will or may cause significant environmental harm when it becomes waste*," or that there are "*significant benefits from reduction, reuse, recycling, recovery, or treatment of the product and the product can be effectively managed under a product stewardship scheme*" (Waste Minimisation Act 2008, p.11). Once declared a priority product, the expectation shifts from voluntary to regulated stewardship, with schemes required to meet design guidelines that include prioritising the waste hierarchy, covering producer-funded collection costs, ensuring independent non-profit governance, and public performance reporting (Ministry for the Environment, 2019).

For over a decade after the WMA's enactment in 2008, no products were designated as priority products, and stewardship remained largely voluntary. Policy documents from this period note the limited effectiveness of voluntary approaches to e-waste, which achieved approximately 1 per cent diversion from landfill (Blake et al., 2019; Ministry for the Environment, 2019). Despite e-waste being a significant issue, data limitations were cited as a barrier to priority product designation: *"The level of robustness of New Zealand-specific data for e-waste products is currently insufficient to satisfy the requirements of the priority product designation criteria"* (SLR Consulting NZ Limited, 2015).

This changed with the Declaration of Priority Products Notice 2020 (New Zealand Gazette & Sage, 2020), which formally identified six priority product groups: tyres, electrical and electronic products (defined using EU WEEE categories), agrichemicals and their containers, refrigerants and other synthetic greenhouse gases, farm plastics, and packaging. For electrical and electronic products, the declaration specifically includes "*all… categories of waste electrical and electronic equipment (WEEE) defined in Annex II of European Directive*

2012/19/EU" (New Zealand Gazette & Sage, 2020). This was the first use of the WMA's priority product powers, creating a clear legal pathway for regulated e-waste stewardship.

Despite this legislative foundation, the implementation of priority product stewardship schemes have been gradual and uneven. The 2019 consultation on proposed priority products and scheme guidelines outlined detailed design requirements for future regulated schemes, including incentivising product management higher up the waste hierarchy, producers pay principles, independent, non-profit governance which represents producers and wider stakeholders, public awareness and accessible collection nationwide, along with annual public reporting of targets and performance (Ministry for the Environment, 2019)

Reasons for the limitations in e-waste management

New Zealand's prolonged reliance on ineffective voluntary e-waste schemes, despite being one of the few OECD nations without a mandatory national framework, stems from systemic "bureaucratic inertia" and a preference for market-led solutions (Blumhardt, 2018). Even after the e-waste regulation proposal, a significant hurdle remains relating to "Right to Repair" advocacy, while the Consumer Guarantees (Right to Repair) Amendment Bill reached its first reading in early 2025 (New Zealand Parliament, 2025), it faced significant opposition from manufacturer-aligned political interests (National Party, ACT and NZ First) and was recommended not to proceed by a government-majority select committee in August 2025 (The Economic Development, Science and Innovation Committee, 2025). This political impasse leaves consumers trapped in a cycle of "planned obsolescence," where the cost of repair often exceeds the cost of replacement, and manufacturers are not yet legally mandated to provide the spare parts or diagnostic tools needed to extend product lifespans.

As a remote island nation with a small population, New Zealand lacks the domestic industrial scale required for high-tech recovery, such as precious metal smelting, leading to a reliance on costly overseas exports (Brettkelly, 2025; RNZ, 2020). Furthermore, voluntary models have failed primarily due to the free-rider problem, in which ethical recyclers bear the costs while competitors avoid responsibility, resulting in a "tech-tipping" culture in which 98% of e-waste is still diverted to landfills (Blake et al., 2019; North & South, 2024; Product Stewardship Sector Group, n.d).

A potential blueprint: the Tyrewise scheme

New Zealand's response to key waste streams remains limited, with only one fully operational nationwide regulated product stewardship scheme (Tyrewise, 2025). Tyrewise, established under the Waste Minimisation (Tyres) Regulations 2023 (Ministry for the Environment, 2023), governs end-of-life tyres and demonstrates how a compulsory, producer-funded scheme could be applied to e-waste in New Zealand. It aligns closely with Theme 1 (EPR/regulatory design), as the regulations require everyone who imports or sells tyres to participate in an accredited scheme, supported by a stewardship fee of approximately $6.65 + GST per equivalent passenger unit (EPU). An EPU is defined as a standard passenger car tyre (about 9.5 kg when new and 8 kg at end-of-life), with larger tyres converted into EPU multiples so that end-of-life costs are internalised consistently across all tyre types (Tyrewise, 2025).

The Tyrewise scheme also reflects Theme 2 (circularity) by explicitly aligning with the waste hierarchy and prioritising domestic markets for recovered material. Scheme targets include transforming 80% of tyres into products that stay in Aotearoa by 2028, such as playground surfacing, use as tyre-derived fuel in cement manufacture, and other civil engineering applications, and 90% into New Zealand-made goods by 2030. The Puna Taurima fund supports research, development and market growth for recycled tyre materials (for example, crumb rubber in roading), paralleling the types of innovation mechanisms that could be used to grow local repair, refurbishment and recycling capacity for electronic products (Tyrewise, 2025).

Consistent with Themes 3 (collection and recycling) and 4 (governance), the Tyrewise scheme delivers a free, universal take-back network underpinned by a national tracking and payment system. In its first thirteen-month reporting period (1 March 2024- 31 March 2025), the scheme collected 36,801 tonnes of end-of-life tyres, equivalent to 4.6 million passenger car tyres, through 4,624 registered partner locations and 86 public collection sites, reducing landfill disposal and illegal dumping while enabling resource recovery. The tracking system records mass balances and fee flows, with targets such as 99% payment accuracy and quarterly performance reporting to the Ministry for the Environment, providing a concrete example of the data, transparency and institutional oversight that a robust e-waste product stewardship scheme in New Zealand would require.

Chapter 5: Discussion and Conclusion

Introduction

This discussion chapter interprets the findings of the comparative thematic analysis of the e-waste product stewardship frameworks of the European Union and Australia, and the subsequent examination of New Zealand's present e-waste and product stewardship strategy. It unifies the two research questions: first, by synthesising insights from high-performing jurisdictions on effective e-waste regulatory design (RQ1); and second, by critically evaluating how New Zealand's current arrangements accord with or deviate from those principles (RQ2). In doing so, the chapter goes beyond presenting the findings to examine their implications for the future evolution of product stewardship and e-waste regulation in Aotearoa, New Zealand. Importantly, it situates this discussion within New Zealand's broader political-economy context and its longstanding preference for "light-handed" and voluntary forms of regulation. This broader context helps to explain why, despite the availability of international best-practice models and domestic proof-of-concept cases such as Tyrewise (Tyrewise, 2026), New Zealand has so far been cautious about adopting compulsory, comprehensive e-waste regulation.

The discussion focuses on five themes outlined in the findings chapter: legally enforceable producer responsibility (EPR); circular product design and the right to repair; collection, recovery, and reuse (including quantitative targets); governance, coordination; and public access. A systematic comparison between New Zealand and high-performing systems is made possible by using these themes as an analytical framework. It encourages a more accurate description of the areas where New Zealand is already making progress and those where significant gaps still exist.

Interpreting Theme 1: Legally enforceable producer responsibility

The first theme demonstrates that both the Australian and EU frameworks incorporate robust, legally binding forms of producer responsibility, shifting the significant organisational and financial commitment for end-of-life management from taxpayers or consumers to producers. The EU requires producer accountability in all of its member states under the WEEE Directive and associated measures (European Parliament, 2012). Simultaneously, the National Television and Computer Recycling Scheme (NTCRS) and its implementing regulations in Australia mandate that responsible parties contribute to and engage in authorised schemes (Department of Climate Change, Energy, the Environment and Water, 2021). These settings support the international literature's conclusion that strong, legally-mandated EPR is essential for sustainable e-waste management. It ensures long-term funding and accountability for outcomes, unlike voluntary programs.

According to findings from New Zealand, although the Waste Minimisation Act 2008 provides a legal foundation for regulated product stewardship and permits the declaration of priority products (Ministry for the Environment, 2008), e-waste has only recently begun to realise this potential. Product stewardship has been fully implemented only in the tyre industry so far (Ministry for the Environment, 2023). Designating e-waste as a priority product signals the shift toward stewardship required. In reality, though, New Zealand is currently in a transitional stage, with many e-waste streams still being handled via small-scale pilots, council drop-off services, or voluntary programs. In this regard, the results indicate that although New Zealand has embraced the EPR language, it has not yet fully operationalised it across all e-waste categories. This reinforces the argument that a clearer, stronger regulatory move toward mandated producer responsibility is necessary if New Zealand is to match the performance of the EU and Australia.

In this regard, the New Zealand Telecommunications Forum (TCF) oversees voluntary programs that demonstrate the possibilities and constraints of the country's current e-waste product stewardship strategy. TCF collaborates with network operators (2Degrees, One NZ, and Spark), retailers (Noel Leeming and Resene), and recyclers (E-Cycle, Echo Technology, and Swapkit) to coordinate take-back and recycling initiatives for telecom-related products, including mobile phones, tablets, and equipment (NZ Telecommunication Forum Inc., 2025; TCF, 2025). However, compared to fully regulated EPR models, funding is less secure, and participation and product coverage remain partial because these schemes are not regulated. As a result, TCF’s initiatives sit as a voluntary industry programme: they demonstrate willingness among some producers to accept end-of-life responsibility, but they do not deliver the universal participation and comprehensive coverage evident in the EU and Australian systems, or in New Zealand’s own Tyrewise scheme.

Tyrewise is a crucial proof of concept for what regulated product stewardship in New Zealand might entail. In line with the EPR processes in the EU and Australian programs, the Waste Minimisation (Tyres) Regulations 2023 established a system that requires participation from all tyre importers and sellers and is financed by a per-unit stewardship fee. Tyrewise's successful launch and early performance show that, even for scattered, challenging-to-manage waste streams, legally enforceable producer responsibility is politically and administratively achievable in New Zealand. When combined, these results provide confidence that e-waste requires more political and regulatory will than institutional capacity to adopt a similar regulatory framework.

Interpreting Theme 2: Circular product design and the right to repair

The second theme focused on how the EU, in particular, has gradually incorporated circularity concepts into its e-waste regulation through tools such as the Ecodesign and Repair Directives, which aim to improve resource efficiency, durability, reparability, and upstream product design. Although Australia's framework is less comprehensive, it still has several features that promote circularity, such as design requirements, recycling goals, and supplementary programs that encourage reuse and repair. These actions support claims in the literature that EPR should encourage eco-design and material circularity throughout product life cycles in addition to funding end-of-life management.

The results from New Zealand, on the other hand, show that current regulations regarding e-waste incorporate circularity only to a limited extent. Instead of focusing on product design, durability, or reparability at the point of entry into the New Zealand market, the Waste Minimisation Act and the priority product framework are primarily end-of-pipe, focusing on how products are managed once they become waste. The Consumer Guarantees Act of 1993 (CGA) indirectly supports longer product lifetimes by requiring goods to be of acceptable quality, durable for a reasonable period, and fit for purpose, and by giving consumers the right to repair, replacement, or a refund if these guarantees are not met (Ministry of Business, Innovation, and Employment, 1993). The CGA does not constitute a dedicated circularity or right-to-repair regime, though it can encourage manufacturers and retailers to avoid extremely short-lived or obviously defective electronic products. It does not contain any specific obligations on design for disassembly, availability of spare parts, provision of repair information, or minimum repairability standards, all of which are more prominent in emerging EU instruments. This implies that fundamental consumer protection law is presently used in New Zealand to address dependability and durability. On the other hand, when it comes to e-waste, high-performing jurisdictions are increasingly using targeted product and repair regulations to promote circular product design and encourage systematic repair and reuse.

However, the Tyrewise case demonstrates that even in situations where upstream design control is restricted, circularity-oriented goals and market-development methods may be incorporated into New Zealand's stewardship programs, albeit to a limited extent. Tyrewise has set a clear goal to convert 90% of tyres into New Zealand-made products by 2030 and 80% of tyres into items that remain in Aotearoa by 2028. These provisions demonstrate that, by incorporating circularity targets and funding mechanisms from the outset, a New Zealand e-waste plan could be constructed to promote domestic material recovery and higher-order waste hierarchy outcomes rather than just safe disposal. The discussion therefore suggests that, while New Zealand may not be able to drive global product design, it can still embed circular economy objectives into its national stewardship architecture in a way that parallels the intent of EU and Australian reforms.

Interpreting Theme 3: Collection, recovery, reuse and quantitative targets

The third theme demonstrated that quantitative goals for recovery, recycling, and collection are essential tools used by high-performing jurisdictions to ensure that producer responsibility programs deliver tangible results. Australia's NTCRS incorporates tiered collection and recycling targets that have been gradually raised over time, while the EU's WEEE Directive establishes distinct collection and recovery targets for individual equipment categories. These goals, which connect regulatory design (Theme 1) to quantifiable performance in material recovery and collection, are supported by reporting requirements and compliance metrics.

In contrast, the investigation found no comprehensive, nationally mandated, quantifiable targets for recycling or collecting e-waste in New Zealand. Current programs, such as voluntary take-back programs and local council services, frequently lack enforceable national goals or standardised performance indicators, making it difficult to evaluate the system's efficacy and ensure ongoing development. This lack of targets puts New Zealand at odds with practices in the EU and Australia. The relatively low rates of e-waste collection and recycling documented in the broader literature may be partially explained by this.

Tyrewise once again exemplifies how target-setting can be incorporated into New Zealand law. The program operates with clear tonnage expectations and monitors progress through a national data system, even though its main performance indicators centre on collection volumes, landfill diversion, and domestic use of recovered materials. Through a network of thousands of partner locations, Tyrewise collected 36,801 tonnes of end-of-life tyres, or 4.6

million passenger car tyres, in its first thirteen-month reporting period. This shows what can be accomplished when a nationwide, producer-funded, free take-back network is coupled with clear performance goals. The discussion therefore suggests that a key step for New Zealand’s e-waste policy would be to introduce ambitious yet realistic collection and recovery targets, grounded in robust data, and to tie these targets explicitly to producer obligations under regulated stewardship schemes.

Interpreting Themes 4 and 5: Governance, coordination, public access and awareness

The themes underscore the need for governance frameworks that coordinate various actors and ensure public access to reliable services, alongside stringent regulations and goals, to enable efficient e-waste stewardship. Both the Australian and EU systems rely on approved or accredited organisations to manage their programs, which are supported by clear reporting guidelines, government supervision, and enforcement and adjustment procedures. The program's design prioritises public awareness and accessibility, and it develops a user-friendly infrastructure for collection and communication at scale.

The results from New Zealand demonstrate that there is currently no single national organisation responsible for coordinating e-waste stewardship, and that e-waste governance is dispersed across central government, local governments, private recyclers, and non-governmental groups. Public awareness campaigns are typically brief and limited, and public access to e-waste services is unequal and frequently dependent on local council initiatives or one-time events. The comparative research indicates that high participation rates in take-back systems depend on visibility, ease, and confidence, all of which are compromised by this fragmentation.

Tyrewise again provides a counterexample in this regard. Auto Stewardship New Zealand, a committed charity trust, oversees the program, and 3R Group Ltd. manages it (Tyrewise, 2026). It tracks mass balances and fee flows through a nationwide tracking and payment system. Quarterly reporting to the Ministry for the Environment and 99% payment accuracy targets show how accountability, data, and governance can be firmly incorporated into a New Zealand stewardship program. Tyrewise has established a geographically extensive network of partner locations and public collection sites, which is significant because it normalises free take-back and makes it easy for customers to participate. These features suggest that similar governance and access principles could be applied to future e-waste schemes, including the creation of one or more accredited stewardship organisations, standardised national reporting, and coordinated public awareness campaigns to support behaviour change.

New Zealand’s preference for light-handed regulation

The current e-waste structures in New Zealand must also be discussed in the context of a larger political and regulatory economy. Since the mid-1980s, New Zealand has repeatedly implemented what is known as "light-handed" regulation in key infrastructure sectors, depending more on general competition law, commercial negotiation, and information disclosure than on specific sector-specific controls (Bollard & Pickford, 1995; Hill, 1996). Arblaster (2014) and Forsyth (2008) demonstrate how airport policies in Australia and New Zealand were deliberately designed to minimise formal price and quality regulation and to prioritise negotiated-arbitrated mechanisms between airports and airlines. Similar reliance on light-handed methods in electricity networks is documented by Patterson and Cornwell (2000), who also point out the model's shortcomings in terms of consumer protection. Blanchard (1995), Howell (2010), and Tripe (2013) outline a pattern of minimal, competition-focused regulation in financial services and telecommunications, placing New Zealand among the OECD jurisdictions with the least amount of regulation in these areas. When considered collectively, this literature suggests a persistent regulatory approach that prioritises market-based mechanisms and voluntary or self-regulation whenever feasible (Bollard & Pickford, 1995; Hill, 1996; Walker et al., 2000). This history helps to explain why more robust product stewardship and mandatory EPR have been slow to emerge in the e-waste industry.

This preference has both ideological and interest-based rationalisations. A culture of non-regulation has been seen as characteristic of New Zealand's regulatory governance, resulting from policy reformers' and many policy advisers' ideological claims that market incentives and competition are more effective and acceptable means of accomplishing policy goals than specific prescriptive regulations (Bollard & Pickford, 1995; Walker et al., 2000). Walker et al. (2000) demonstrate that industry self-management and voluntary codes of practice were the preferred methods for improving environmental conditions in the forestry sector, with formal regulation introduced only as issues arose. Interest-based explanations highlight New Zealand's open, small economy and reliance on a small number of large companies, including multinational corporations. In industries such as utilities, finance, and telecommunications, where capital is mobile and domestic demand is low, policymakers have been wary of imposing requirements that could be interpreted as compromising competitiveness or deterring investment (Arblaster, 2014; Forsyth, 2008; Howell, 2010; Tripe, 2013). Ambitious, mandatory e-waste EPR appears politically and economically risky due to a strong bias towards light-handed solutions, driven by an ideological commitment to markets and structural concerns about capital mobility.

Political concerns about "nanny-state" interventions also affect New Zealand's choices about rules and regulations. In the late 2000s, the Labour-led government wanted to phase out incandescent light bulbs and make building codes stricter for low-flow shower heads. These ideas became a symbol of an over-intrusive state that tells people what to do in their own homes (Brownlee, 2008; Smith, 2008). Phil Goff, the leader of the Labour Party, later said that the party had "made mistakes" with these policies and that voters saw them as sideshows that distracted from important economic and social issues (Gower, 2009). The current political culture, in which governments remain cautious about regulatory initiatives that could easily be framed as nanny-state overreach, is influenced by these episodes, which are often used as cautionary tales about the electoral risks of visible environmental and energy-efficiency regulations. If significant e-waste regulation is not carefully framed around benefits like resource security, local jobs in recycling and repair, and alignment with international best practices, rather than as an attempt to police individual consumption choices, it runs the risk of being perceived as yet another instance of state interference in this climate (Blake et al., 2019; TechCollect NZ, 2023a, 2023b).

In the history of e-waste policy, the combined impact of these ideological, interest-based, and political factors is clear. Successive governments have been slow to declare e-waste a priority product and to implement mandatory, target-driven stewardship, despite the Ministry for the Environment and commissioned studies making e-waste a priority issue and highlighting the shortcomings of voluntary schemes (Blake et al., 2019; SLR Consulting, 2015; TechCollect NZ, 2023). According to Blake et al.'s (2019) Whangārei case study, municipal services recycle only 2% of locally generated e-waste. The study concluded that without a shift to mandatory programs, voluntary product stewardship is unlikely to yield the required gains in data, access, and design incentives. Similarly, SLR Consulting's 2015 eWasteNZ Final Report concludes that there was insufficient data at the time to support the designation of a priority product. However, it also argues that a well-thought-out regulatory scheme would, in itself, enhance data quality and transparency (SLR Consulting, 2015). This implies that bringing best practices for e-waste regulation from the EU or Australia to New Zealand necessitates not only technical adjustments to local market conditions but also deliberate tactics to overcome and, when necessary, rebalance subconscious preferences for light-handed regulation and opposition to obvious environmental regulations (Arblaster, 2014; Patterson & Cornwell, 2000; Blake et al., 2019).

Synthesising RQ1 and RQ2: What high-performing systems imply for New Zealand?

Together, the thematic analysis of the Australian and EU frameworks (RQ1) and the study of New Zealand's current regulatory settings (RQ2) offer a rational set of design principles for e-waste stewardship in Aotearoa. Clear producer responsibility, circularity objectives (such as eco-design and repair), quantitative targets for collection and recovery performance, robust governance, coordination, and public access are the five main features of high-performing systems. According to this viewpoint, New Zealand has taken the required initial steps, particularly with the Waste Minimisation Act framework and priority product declarations. However, the country has yet to create a thorough, integrated e-waste stewardship architecture.

The analysis shows that the most significant shortcomings in New Zealand are the absence of national quantitative targets for recovery and collection, the fragmented governance structure, the limited incorporation of repair and circularity into regulatory design, and the very limited application of mandatory producer responsibility across e-waste categories. The Tyrewise scheme demonstrates that New Zealand can successfully execute regulated product stewardship, which incorporates many of the traits of high-performing e-waste systems, including stable funding, data-driven oversight, data-driven domestic market development, and national coordination. The discussion therefore supports the conclusion that New Zealand’s challenge is not conceptual; the core principles are well established internationally, but the practical and political challenges of extending and adapting these principles to the e-waste context remain, in ways that reflect New Zealand’s scale, institutional capacity and tikanga-informed environmental values.

Conceptual and practical implications

Conceptually, these findings add to larger discussions about how small, import-dependent states should design their EPR and product stewardship programs. The EU and Australia serve as examples of what can happen when producers are subject to specific obligations and targets set by larger markets. Nevertheless, as demonstrated by New Zealand's experience, smaller jurisdictions may have to rely more on conforming to these external standards while developing their own funding and governance structures to handle products at the end of their useful lives. The Tyrewise case supports the notion that, while these limitations do not preclude ambitious stewardship models, EPR in such situations needs to be carefully adjusted to local market conditions, including the number and size of producers, the existing infrastructure, and regional equity concerns.

In practical terms, the conversation raises several policy and implementation implications. Converting the e-waste priority product declaration into specific regulations requiring producer-funded programs with clear goals, monitoring, and enforcement mechanisms is a top priority for the central government. The findings emphasise that producers and importers must prepare for a shift from voluntary arrangements to regulated schemes that require participation in accredited organisations and the internalisation of end-of-life costs. More national coordination may yield more predictable funding, consistent service levels, and defined roles for recyclers and local governments, but it will also require adaptation to new governance frameworks. Finally, there are implications for public engagement: any future e-waste scheme will need to invest in sustained public awareness and accessible collection options if it is to realise the full benefits of a regulated stewardship model.

Limitations and directions for future research

It is important to recognise the limitations of this study when interpreting the discussion, as is the case with all qualitative policy analyses. Instead of using primary data from surveys or interviews, the analysis primarily relies on official evaluations, legislation, regulations, scheme reports, and documentary sources. This restricts understanding of how stakeholders actually experience and contest policies. The comparative component does not examine other potentially instructive cases, such as particular Asian or North American schemes, and instead focuses on two high-performing jurisdictions: the EU and Australia. The changing regulatory framework in New Zealand, including ongoing reforms and the early implementation of specific stewardship initiatives, also places limitations on the analysis.

These limitations point to several directions for further study. The political and social dynamics that influence stewardship design and implementation in New Zealand would be better understood through empirical studies that collect viewpoints from producers, recyclers, iwi and hapū, local authorities, and community organisations. The set of principles outlined here may be refined through comparative research across a broader range of jurisdictions, including those with diverse legal traditions and varying levels of economic development. Last but not least, quantitative modelling of various e-waste scheme designs that assess costs, environmental effects, and distributional impacts would help policymakers make better decisions about how to operationalise EPR and circularity in New Zealand.

Closing synthesis

Overall, the discussion demonstrates that New Zealand has begun but not yet completed the process of incorporating design principles for efficient e-waste stewardship into its regulatory system, and that the EU and Australian frameworks offer a clear set of design principles for this purpose. The Tyrewise analysis shows that regulated, producer-funded stewardship with robust governance and circularity goals is feasible in New Zealand and can yield observable system-level and environmental benefits. Similar strategies for e-waste would be a big step toward meeting the broader objectives of waste reduction, resource recovery, and a more circular economy, as well as toward aligning New Zealand's practices with those of the world's top-performing jurisdictions.

References

5 Global E-Waste regulations Every consumer should know. (2024, July 29). *Reecollab*. https://reecollabb.com/5-global-e-waste-regulations/

Aggarwal, S., Chaudhary, R., Aujla, G. S., Kumar, N., Choo, K. R., & Zomaya, A. Y. (2019). Blockchain for smart communities: Applications, challenges and opportunities. *Journal of Network and Computer Applications*, *144*, 13–48. https://doi.org/10.1016/j.jnca.2019.06.018

Ahirwar, R., & Tripathi, A. K. (2020). E-waste management: A review of recycling process, environmental and occupational health hazards, and potential solutions. *Environmental Nanotechnology Monitoring & Management*, *15*, 100409. https://doi.org/10.1016/j.enmm.2020.100409

Ahmed, S. K., Mohammed, R. A., Nashwan, A. J., Ibrahim, R. H., Abdalla, A. Q., Ameen, B. M. M., & Khidhir, R. M. (2025). Using thematic analysis in qualitative research. *Journal of Medicine Surgery and Public Health*, 100198. https://doi.org/10.1016/j.glmedi.2025.100198

Aizawa, H., Yoshida, H., & Sakai, S. (2008). Current results and future perspectives for Japanese recycling of home electrical appliances. *Resources Conservation and Recycling*, *52*(12), 1399–1410. https://doi.org/10.1016/j.resconrec.2008.07.013

Alhassan, M. D., & Adam, I. O. (2021). The effects of digital inclusion and ICT access on the quality of life: A global perspective. *Technology in Society*, *64*, 101511. https://doi.org/10.1016/j.techsoc.2020.101511

Amoyaw-Osei, Y., Opoku Agyekum, O., Pwamang, J. A., Mueller, E., Fasko, R., & Schluep, M. (2011). *Ghana e-Waste Country assessment*. https://www.basel.int/portals/4/basel%20convention/docs/ewaste/e-wasteassessmentghana.pdf

Arblaster, M. (2014). The design of light-handed regulation of airports: Lessons from experience in Australia and New Zealand. *Journal of Air Transport Management*, *38*, 27–35. https://doi.org/10.1016/j.jairtraman.2013.12.015

Arya, S., & Kumar, S. (2020). E-waste in India at a glance: Current trends, regulations, challenges and management strategies. *Journal of Cleaner Production*, *271*, 122707. https://doi.org/10.1016/j.jclepro.2020.122707

Asante, K. A., Agusa, T., Biney, C. A., Agyekum, W. A., Bello, M., Otsuka, M., Itai, T., Takahashi, S., & Tanabe, S. (2012). Multi-trace element levels and arsenic speciation in urine of e-waste recycling workers from Agbogbloshie, Accra in Ghana. *The Science of the Total Environment*, *424*, 63–73. https://doi.org/10.1016/j.scitotenv.2012.02.072

Australian Continuous Improvement Group (ACIG). (2017). Evaluation of the National Television and Computer Recycling Scheme (NTCRS). In *NTCRS Valuation Report*. https://www.dcceew.gov.au/environment/protection/waste/publications/ntcrs-evaluation

Awasthi, A. K., Li, J., Koh, L., & Ogunseitan, O. A. (2019). Circular economy and electronic waste. *Nature Electronics*, *2*(3), 86–89. https://doi.org/10.1038/s41928-019-0225-2

Awasthi, A. K., Zeng, X., & Li, J. (2016a). Environmental pollution of electronic waste recycling in India: A critical review. *Environmental Pollution*, *211*, 259–270. https://doi.org/10.1016/j.envpol.2015.11.027

Awasthi, A. K., Zeng, X., & Li, J. (2016b). Integrated bioleaching of copper metal from waste printed circuit board—a comprehensive review of approaches and challenges. *Environmental Science and Pollution Research*, *23*(21), 21141–21156. https://doi.org/10.1007/s11356-016-7529-9

Bakker, C., Wang, F., Huisman, J., & Hollander, M. D. (2014). Products that go round: exploring product life extension through design. *Journal of Cleaner Production*, *69*, 10–16. https://doi.org/10.1016/j.jclepro.2014.01.028

Baldé, C. P., Iattoni, G., Xu, C., & Yamamoto, T. (2022). Update of WEEE Collection Rates, Targets, Flows, and Hoarding – 2021: In the EU-27, United Kingdom, Norway, Switzerland, and Iceland. In *United Nations Institute for Training and Research*. SCYCLE Programme. https://weee-forum.org/wp-content/uploads/2022/12/Update-of-WEEE-Collection_web_final_nov_29.pdf

Baldé, C. P., Kuehr, R., Yamamoto, T., McDonald, R., D'Angelo, E., Althaf, S., Bel, G., Deubzer, O., Fernandez-Cubillo, E., Forti, V., Gray, V., Herat, S., Honda, S., Iattoni, G., Khetriwal, D. S., Luda Di Cortemiglia, V., Lobuntsova, Y., Nnorom, I., Pralat, N., & Wagner, M. (2024). THE GLOBAL E-WASTE MONITOR 2024. In *UNITAR*. UNITAR. https://ewastemonitor.info/wp-content/uploads/2024/12/GEM_2024_EN_11_NOV-web.pdf

Basel Convention. (2011). *The Partnership for Action on Computing Equipment*. https://www.basel.int/Portals/4/Basel%20Convention/docs/pub/leaflets/leafPACE.pdf

Blake, V., Farrelly, T., & Hannon, J. (2019). Is voluntary product stewardship for E-Waste working in New Zealand? a Whangarei case study. *Sustainability*, *11*(11), 3063. https://doi.org/10.3390/su11113063

Blanchard, C. (1995). Telecommunications regulation in New Zealand: Light-handed regulation and the Privy Council's judgment. *Telecommunications Policy*, *19*(6), 465–475. https://doi.org/10.1016/0308-5961(95)00024-z

Bocken, N. M. P., De Pauw, I., Bakker, C., & Van Der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bollard, A., & Pickford, M. (1995). New Zealand's "Light-Handed" approach to utility regulation. *Agenda: A Journal of Policy Analysis and Reform*, *2*(4), 411–422. https://www.jstor.org/stable/43198765

Borthakur, A., & Govind, M. (2016). Emerging trends in consumers' E-waste disposal behaviour and awareness: A worldwide overview with special focus on India. *Resources Conservation and Recycling*, *117*, 102–113. https://doi.org/10.1016/j.resconrec.2016.11.011

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, *9*(2), 27–40. https://doi.org/10.3316/qrj0902027

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport Exercise and Health*, *11*(4), 589–597. https://doi.org/10.1080/2159676x.2019.1628806

Braun, V., & Clarke, V. (2021). *Thematic analysis: A practical guide*. SAGE Publications.

Bressanelli, G., Saccani, N., Pigosso, D. C., & Perona, M. (2020). Circular Economy in the WEEE industry: a systematic literature review and a research agenda. *Sustainable Production and Consumption*, *23*, 174–188. https://doi.org/10.1016/j.spc.2020.05.007

Brettkelly, S. (2025, September 2). Why we send our precious e-waste offshore. *RNZ*. https://www.rnz.co.nz/news/thedetail/571731/why-we-send-our-precious-e-waste-offshore

Brownlee, G. (2008, October). *$3.5 million PR campaign on light-bulb ban* [Press release]. https://www.scoop.co.nz/stories/PA0810/S00513.htm

Bryman, A. (2016). *Social research methods* (5th ed.). Oxford university press.

Caravanos, J., Clark, E., Fuller, R., & Lambertson, C. (2011). Assessing worker and environmental chemical exposure risks at an e-Waste recycling and disposal site in Accra, Ghana. *Journal of Health and Pollution*, *1*(1), 16–25. https://doi.org/10.5696/jhp.v1i1.22

Chatterjee, S., & Kumar, K. (2009). Effective electronic waste management and recycling process involving formal and non-formal sectors. *International Journal of Physical Sciences*, *4*(13). https://www.researchgate.net/publication/267362541_Effective_electronic_waste_management_and_recycling_process_involving_formal_and_non-formal_sectors

Cole, C., Gnanapragasam, A., Cooper, T., & Singh, J. (2019). Assessing barriers to reuse of electrical and electronic equipment, a UK perspective. *Resources Conservation & Recycling X*, *1*, 100004. https://doi.org/10.1016/j.rcrx.2019.100004

Commonwealth of Australia. (2014a). Operational review of the National Television and Computer Recycling Scheme. In *Australian Government*. https://www.dcceew.gov.au/environment/protection/waste/product-stewardship/products-schemes/television-computer-recycling-scheme/review

Commonwealth of Australia. (2014b). *The National Television and Computer Recycling Scheme- Operational Review*. https://www.dcceew.gov.au/sites/default/files/env/pages/1de81785-ce48-4671-8182-9f1d9490b5ce/files/operational-review-national-television-and-computer-recycling-scheme.pdf

Commonwealth of Australia. (2015). National Television and Computer Recycling Scheme – The role of Recyclers. In *Department of the Environment*. https://www.dcceew.gov.au/environment/protection/waste/publications/factsheet-television-and-computer-recycling-scheme-recyclers

Commonwealth of Australia. (2020). *Review of the Product Stewardship Act 2011*. https://www.dcceew.gov.au/sites/default/files/documents/product-stewardship-act-review.pdf

Commonwealth of Australia. (2023). *Wired for change: regulation for small electrical products and solar photovoltaic system waste*. Department of Climate Change, Energy, the Environment and Water. https://www.dcceew.gov.au/about/news/regulation-small-electrical-products-solar-photovoltaic-systems

Commonwealth of Australia. (2024). *National Waste Policy Action Plan 2024*. Department of Climate Change, Energy, the Environment and Water. https://www.dcceew.gov.au/sites/default/files/documents/national-waste-policy-action-plan-2024.pdf

Cordella, M., Alfieri, F., Clemm, C., & Berwald, A. (2020). Durability of smartphones: A technical analysis of reliability and repairability aspects. *Journal of Cleaner Production*, *286*, 125388. https://doi.org/10.1016/j.jclepro.2020.125388

Corsini, F., Rizzi, F., & Frey, M. (2016). Extended producer responsibility: The impact of organizational dimensions on WEEE collection from households. *Waste Management*, *59*, 23–29. https://doi.org/10.1016/j.wasman.2016.10.046

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Sage publications.

Cucchiella, F., D'Adamo, I., Koh, S. L., & Rosa, P. (2015). Recycling of WEEEs: An economic assessment of present and future e-waste streams. *Renewable and Sustainable Energy Reviews*, *51*, 263–272. https://doi.org/10.1016/j.rser.2015.06.010

Daum, K., Stoler, J., & Grant, R. (2017). Toward a more sustainable trajectory for E-Waste policy: A review of a decade of E-Waste research in Accra, Ghana. *International Journal of Environmental Research and Public Health*, *14*(2), 135. https://doi.org/10.3390/ijerph14020135

Denzin, N. K., & Linclon, Y. S. (2011). *The SAGE Handbook of Qualitative Research 4*. Sage Publications.

Department of Agriculture, Water and the Environment. (2021). National Television and Computer Recycling Scheme: Compliance Framework. In *Australian Government*. https://www.dcceew.gov.au/environment/protection/waste/publications/ntcrs-compliance-framework

Department of Climate Change, Energy, the Environment and Water. (2020). Recycling and Waste Reduction Act 2020. In *Australian Government Federal Register of Legislation*. https://www.legislation.gov.au/C2020A00119/latest/text

Department of Climate Change, Energy, the Environment and Water. (2021). Recycling and Waste Reduction (Product Stewardship—Televisions and Computers) Rules 2021. In *Australian Government Federal Register of Legislation*. https://www.legislation.gov.au/F2021L00624/latest/text

Dollisson, C., Vasconi, C., & Baker, B. (2017). *Review of the Product Stewardship Act and National Television and Computer Recycling Scheme*. Australia and New Zealand

Recycling Platform. https://www.anzrp.com.au/Downloads/ANZRP-NTCRS-and-PS-Act-Review-White-Paper-FINAL-Aug-secured.pdf

Dunn, W. N. (2015). *Public Policy analysis* (5th ed.). Routledge.

Ellen MacArthur Foundation. (2013). *Towards the Circular Economy Vol 1: An economic and business rationale for an accelerated transition*. https://www.ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an

Ellen MacArthur Foundation. (2018). *Circular Consumer Electronics: An initial exploration*. https://www.ellenmacarthurfoundation.org/circular-consumer-electronics-an-initial-exploration

Esmaeilian, B., Sarkis, J., Lewis, K., & Behdad, S. (2020). Blockchain for the future of sustainable supply chain management in Industry 4.0. *Resources Conservation and Recycling*, *163*, 105064. https://doi.org/10.1016/j.resconrec.2020.105064

European Commission. (2015a, April 29). *Environment: Commission takes POLAND and SLOVENIA to court for e-waste failings* [Press release]. https://ec.europa.eu/commission/presscorner/detail/en/ip_15_4875

European Commission. (2015b, May 28). *Environment: Commission refers GERMANY to court for e-waste failings and proposes fines* [Press release]. https://ec.europa.eu/commission/presscorner/detail/en/ip_15_5054

European Commission. (2024, December 28). EU common charger rules: Power all your devices with a single charger. *European Commission*. https://commission.europa.eu/news/eu-common-charger-rules-power-all-your-devices-single-charger-2024-12-28_en

European Environment Agency. (2025, March 3). *Waste electrical and electronic equipment (WEEE) collection rate (Indicator)*. https://www.eea.europa.eu/en/european-zero-pollution-dashboards/indicators/waste-electrical-and-electronic-equipment-weee-collection-rate-indicator

European Parliament. (2008). Directive 2008/98/EC of the European Parliament and of the Council: On waste and repealing certain directives. In *Official Journal of the European Union*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20251016

European Parliament. (2011). Directive 2011/65/EU of the European Parliament and of the Council: On the restriction of the use of certain hazardous Substances in Electrical and Electronic Equipment (RECAST). In *Official Journal of the European Union*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0065

European Parliament. (2012a, July). *DIRECTIVE 2012/19/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL* [Press release]. https://eur-lex.europa.eu/eli/dir/2012/19/oj/eng

European Parliament. (2012b). Directive 2012/19/EU of the European Parliament and of the Council: On waste Electrical and Electronic Equipment (WEEE) (recast). In *Official Journal of the European Union*. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0038:0071:en:PDF

European Parliament. (2015). Commission Delegated Directive (EU) 2015/863: Amending Annex II to Directive 2011/65/EU of the European Parliament and of the Council as regards the list of restricted substances. In *Official Journal of the European Union*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2015.137.01.0010.01.ENG

European Parliament. (2017). Directive (EU) 2017/2102 of the European Parliament and of the Council: Amending Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment. *Official Journal of the European Union*.

European Parliament. (2024a). Directive (EU) 2024/1799 of the European Parliament and of the Council: Directive on Common Rules Promoting the Repair of Goods and Amending Regulation (EU) 2017/2394 and Directives (EU) 2019/771 and (EU) 2020/1828. In *Official Journal of the European Union*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401799

European Parliament. (2024b). Regulation (EU) 2024/1781 of the European Parliament and of the Council: Establishing a framework for the setting of ecodesign requirements for sustainable products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC. In *Official Journal of the European Union*. http://data.europa.eu/eli/reg/2024/1781/oj

European Union. (2020, March). *A new circular Economy Action Plan* [Press release]. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN

Eurostat. (2025, October). *Waste statistics - Electrical and electronic equipment*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics_-_electrical_and_electronic_equipment#Highlights

E-Waste Management System. (n.d.). https://eprewaste.cpcb.gov.in/#/

Fang, B., Yu, J., Chen, Z., Osman, A. I., Farghali, M., Ihara, I., Hamza, E. H., Rooney, D. W., & Yap, P. (2023). Artificial intelligence for waste management in smart cities: a review. *Environmental Chemistry Letters*, *21*(4), 1959–1989. https://doi.org/10.1007/s10311-023-01604-3

Forsyth, P. (2006). Airport policy in Australia and New Zealand: privatization, light-handed regulation and performance. *Aviation Infrastructure Performance: A Study in Comparative Political Economy*. https://www.researchgate.net/publication/228670208_Airport_Policy_in_Australia_and_New_Zealand_Privatisation_Light_Handed_Regulation_and_Performance

Forti, V., Baldé, C. P., Kuehr, R., & Bel, G. (2020). *The Global E-Waste Monitor 2020*. https://ewastemonitor.info/wp-content/uploads/2020/11/GEM_2020_def_july1_low.pdf

Friege, H. (2012). Review of material recovery from used electric and electronic equipment-alternative options for resource conservation. *Waste Management & Research the Journal for a Sustainable Circular Economy*, *30*(9_suppl), 3–16. https://doi.org/10.1177/0734242x12448521

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2016). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*, *143*, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Ghisellini, P., Cialani, C., & Ulgiati, S. (2015). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, *114*, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Ghulam, S. T., & Abushammala, H. (2023). Challenges and opportunities in the management of electronic waste and its impact on human health and environment. *Sustainability*, *15*(3), 1837. https://doi.org/10.3390/su15031837

Gower, P. (2009, September). Goff admits: We made mistakes. *NZ Herald*. https://www.nzherald.co.nz/nz/goff-admits-we-made-mistakes/LWZCGXKTKOZT2CNI7DMX43W7GM/

Grant, K., Goldizen, F. C., Sly, P. D., Brune, M., Neira, M., Van Den Berg, M., & Norman, R. E. (2013). Health consequences of exposure to e-waste: a systematic review. *The Lancet Global Health*, *1*(6), e350–e361. https://doi.org/10.1016/s2214-109x(13)70101-3

Gu, Y., Wu, Y., Xu, M., Wang, H., & Zuo, T. (2017). To realize better extended producer responsibility: Redesign of WEEE fund mode in China. *Journal of Cleaner Production*, *164*, 347–356. https://doi.org/10.1016/j.jclepro.2017.06.168

Guo, Y., Huang, C., Zhang, H., & Dong, Q. (2009). Heavy Metal Contamination from Electronic Waste Recycling at Guiyu, Southeastern China. *Journal of Environmental Quality*, *38*(4), 1617–1626. https://doi.org/10.2134/jeq2008.0398

Gupta, A. (2022). Electronic Waste Recycling Market Research Report. In *Market Research Future*. https://www.marketresearchfuture.com/reports/electronic-waste-recycling-market-2553

Ha, N. N., Agusa, T., Ramu, K., Tu, N. P. C., Murata, S., Bulbule, K. A., Parthasaraty, P., Takahashi, S., Subramanian, A., & Tanabe, S. (2009). Contamination by trace elements at e-waste recycling sites in Bangalore, India. *Chemosphere*, *76*(1), 9–15. https://doi.org/10.1016/j.chemosphere.2009.02.056

Hagelüken, B. C. (2012). Recycling the Platinum Group Metals: A European perspective. *Platinum Metals Review*, *56*(1), 29–35. https://doi.org/10.1595/147106712x611733

Hamilton, A. B., & Finley, E. P. (2019). Qualitative methods in implementation research: An introduction. *Psychiatry Research*, *280*, 112516. https://doi.org/10.1016/j.psychres.2019.112516

Heacock, M., Kelly, C. B., Asante, K. A., Birnbaum, L. S., Bergman, Å. L., Bruné, M., Buka, I., Carpenter, D. O., Chen, A., Huo, X., Kamel, M., Landrigan, P. J., Magalini, F., Diaz-Barriga, F., Neira, M., Omar, M., Pascale, A., Ruchirawat, M., Sly, L., . . . Suk, W. A. (2015). E-Waste and harm to vulnerable populations: a growing global problem. *Environmental Health Perspectives*, *124*(5), 550–555. https://doi.org/10.1289/ehp.1509699

Herat, S. (2021). E-Waste management in Asia Pacific Region: Review of issues, challenges and solutions. *Nature Environment and Pollution Technology*, *20*(1), 45–53. https://doi.org/10.46488/nept.2021.v20i01.005

Herat, S., & Agamuthu, P. (2012). E-waste: a problem or an opportunity? Review of issues, challenges and solutions in Asian countries. *Waste Management & Research the Journal for a Sustainable Circular Economy*, *30*(11), 1113–1129. https://doi.org/10.1177/0734242x12453378

Hernandez, R. J., Miranda, C., & Goñi, J. (2020). Empowering sustainable consumption by giving back to consumers the 'Right to Repair.' *Sustainability*, *12*(3), 850. https://doi.org/10.3390/su12030850

Hill, L. (1999). Litigation versus regulation: How successful is Light-Handed Regulation? *Auckland University Law Review*, *8*(4), 1119–1146. https://www.nzlii.org/nz/journals/AukULRev/1999/7.pdf

Howell, B. (2010). Politics and the pursuit of telecommunications sector efficiency in New Zealand. *Journal of Competition Law and Economics*, *6*(2), 253–276. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1624149

Huisman, J., Leroy, P., Tertre, F., Ljunggren Söderman, M., Chancerel, P., Cassard, D., Løvik, A. N., Wäger, P., Kushnir, D., Rotter, V. S., Mählitz, P., Herreras, L., Emmerich, J., Hallberg, A., Habib, H., Wagner, M., Downes, S., & theroomrooms. (2017). *Prospecting Secondary Raw Materials in the Urban Mine and mining wastes (ProSUM) - Final Report* [Report]. Brussels, Belgium. https://collections.unu.edu/eserv/UNU:6391/DIGITAL_Final_Report.pdf

Ilankoon, I., Ghorbani, Y., Chong, M. N., Herath, G., Moyo, T., & Petersen, J. (2018). E-waste in the international context – A review of trade flows, regulations, hazards, waste management strategies and technologies for value recovery. *Waste Management*, *82*, 258–275. https://doi.org/10.1016/j.wasman.2018.10.018

Imran, M., Haydar, S., Kim, J., Awan, M. R., & Bhatti, A. A. (2017). E-waste flows, resource recovery and improvement of legal framework in Pakistan. *Resources Conservation and Recycling*, *125*, 131–138. https://doi.org/10.1016/j.resconrec.2017.06.015

International Labour Organization. (2019). Decent work in the management of electrical and electronic waste (e-waste). In *International Labour Organization*. https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40ed_dialogue/%40sector/documents/publication/wcms_673662.pdf

International Telecommunications Union. (2024). Measuring digital development: Facts and Figures 2024. In *ITU*. ITU Publications. https://www.itu.int/en/ITU-D/Statistics/pages/facts/default.aspx

Islam, M. T., & Huda, N. (2019). Material flow analysis (MFA) as a strategic tool in E-waste management: Applications, trends and future directions. *Journal of Environmental Management*, *244*, 344–361. https://doi.org/10.1016/j.jenvman.2019.05.062

James, J. (2020). The smart feature phone revolution in developing countries: Bringing the internet to the bottom of the pyramid. *The Information Society*, *36*(4), 226–235. https://doi.org/10.1080/01972243.2020.1761497

Japan International Cooperation Agency (JICA). (2009). *JICA's approach to WEEE/e-waste management*. https://gec.jp/gec/en/Activities/ietc/fy2011/e-waste/JICA.pdf

Japan International Cooperation Agency (JICA). (2018). *The project for development of Mechanism for household E-Waste management in Malaysia*. https://openjicareport.jica.go.jp/pdf/12320016_01.pdf

Japan International Cooperation Agency (JICA). (2020). *Environment management in Thailand*. https://www.jica.go.jp/english/overseas/thailand/office/others/__icsFiles/afieldfile/2025/01/27/brochure_09.pdf

Khetriwal, D. S., Kraeuchi, P., & Widmer, R. (2008). Producer responsibility for e-waste management: Key issues for consideration – Learning from the Swiss experience. *Journal of Environmental Management*, *90*(1), 153–165. https://doi.org/10.1016/j.jenvman.2007.08.019

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources Conservation and Recycling*, *127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Kumar, A., Holuszko, M., & Espinosa, D. C. R. (2017). E-waste: An overview on generation, collection, legislation and recycling practices. *Resources Conservation and Recycling*, *122*, 32–42. https://doi.org/10.1016/j.resconrec.2017.01.018

Lepawsky, J. (2014). The changing geography of global trade in electronic discards: time to rethink the e-waste problem. *Geographical Journal*, *181*(2), 147–159. https://doi.org/10.1111/geoj.12077

Li, N. J., Duan, N. H., & Shi, N. P. (2011). Heavy metal contamination of surface soil in electronic waste dismantling area: site investigation and source-apportionment analysis. *Waste Management & Research the Journal for a Sustainable Circular Economy*, *29*(7), 727–738. https://doi.org/10.1177/0734242x10397580

Liu, K., Tan, Q., Yu, J., & Wang, M. (2023). A global perspective on e-waste recycling. *Circular Economy*, *2*(1), 100028. https://doi.org/10.1016/j.cec.2023.100028

Makov, T., & Fitzpatrick, C. (2021). Is repairability enough? big data insights into smartphone obsolescence and consumer interest in repair. *Journal of Cleaner Production*, *313*, 127561. https://doi.org/10.1016/j.jclepro.2021.127561

Mason, J. (2017). *Qualitative researching* (3rd ed.). SAGE Publications Limited.

Menikpura, S., Santo, A., & Hotta, Y. (2014). Assessing the climate co-benefits from Waste Electrical and Electronic Equipment (WEEE) recycling in Japan. *Journal of Cleaner Production*, *74*, 183–190. https://doi.org/10.1016/j.jclepro.2014.03.040

Ministry for the Environment. (2008). Waste Minimisation Act 2008: Version as at 24 September 2025. In *New Zealand Legislation*. https://www.legislation.govt.nz/act/public/2008/0089/latest/dlm999802.html

Ministry for the Environment. (2019). *Proposed Priority Products and Priority Product Stewardship Scheme guidelines: Consultation document*. https://environment.govt.nz/publications/proposed-priority-products-and-priority-product-stewardship-scheme-guidelines-consultation-document/

Ministry for the Environment. (2023). Waste Minimisation (TYRES) Regulations 2023. In *New Zealand Legislation*. https://www.legislation.govt.nz/regulation/public/2023/0263/latest/whole.html#LMS865141

Ministry for the Environment. (2024). Transboundary movement control of all e waste under the Basel Convention Consultation Document. In *Ministry for the Environment*. https://consult.environment.govt.nz/waste/e-waste/

Ministry of Business, Innovation, and Employment. (1993). Consumer Guarantees Act 1993: Version as at 24 January 2026. In *New Zealand Legislation*. https://www.legislation.govt.nz/act/public/1993/0091/latest/whole.html#whole

New Zealand Gazette, & Sage, E. (2020). *Declaration of Priority Products Notice 2020* [Press release]. https://gazette.govt.nz/notice/id/2020-go3343

New Zealand Parliament. (2025). *Consumer Gurantees (Right to Repair) Amendment bill* [Press release]. https://hansard.parliament.nz/hansard-transcript/2025-02-19/karakiaprayers?sId=3e085c7ad8c7492a81565b604327e440&lang=en

NZ Telecommunication Forum INC. (2025). https://www.tcf.org.nz/industry-hub/publications

Odeyingbo, O., Nnorom, I., & Deubzer, O. (2017). *Person in the port project: Assessing import of used electrical and electronic equipment into Nigeria*. UNU-ViE SCYCLE and BCCC Africa. https://collections.unu.edu/eserv/UNU:6349/PiP_Report.pdf

Olafisoye, O. B., Adefioye, T., & Osibote, O. A. (2013). Heavy metals contamination of water, soil, and plants around an electronic waste dumpsite. *Polish Journal of Environmental Studies*, *22*(5), 1431–1439. https://www.researchgate.net/profile/Otolorin-Osibote-2/publication/281446780_Heavy_Metals_Contamination_of_Water_Soil_and_Plants_around_an_Electronic_Waste_Dumpsite/links/55e7fe0c08ae21d099c15e9c/Heavy-Metals-Contamination-of-Water-Soil-and-Plants-around-an-Electronic-Waste-Dumpsite.pdf

Organisation for Economic Co-operation and Development (OECD). (2016). *Extended producer responsibility: Updated guidance for efficient waste management*. OECD. https://doi.org/10.1787/9789264256385-en

Orlins, S., & Guan, D. (2015). China's toxic informal e-waste recycling: local approaches to a global environmental problem. *Journal of Cleaner Production*, *114*, 71–80. https://doi.org/10.1016/j.jclepro.2015.05.090

Owusu-Sekyere, K., Batteiger, A., Afoblikame, R., Hafner, G., & Kranert, M. (2021). Assessing data in the informal e-waste sector: The Agbogbloshie Scrapyard. *Waste Management*, *139*, 158–167. https://doi.org/10.1016/j.wasman.2021.12.026

Panzarino, M. (2017, February 23). Apple says iOS 10.2.1 has reduced unexpected iPhone 6s shutdown issues by 80%. *TechCrunch*. https://techcrunch.com/2017/02/23/apple-says-ios-10-2-1-has-reduced-unexpected-iphone-6s-shutdown-issues-by-80/?guccounter=1

Parajuly, K., Fitzpatrick, C., Muldoon, O., & Kuehr, R. (2020). Behavioral change for the circular economy: A review with focus on electronic waste management in the EU. *Resources Conservation & Recycling X*, *6*, 100035. https://doi.org/10.1016/j.rcrx.2020.100035

Patil, R. A., & Ramakrishna, S. (2020). A comprehensive analysis of e-waste legislation worldwide. *Environmental Science and Pollution Research*, *27*(13), 14412–14431. https://doi.org/10.1007/s11356-020-07992-1

Patterson, R., & Cornwell, C. (2000). Light-Handed regulation of electricity networks in New Zealand: The failure of the New Zealand Model. *Competition and Regulation in Network Industries*, *1*(1), 89–99. https://doi.org/10.1177/178359170000100105

Patton, M. Q. (2014). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). Sage Publications.

Perkins, D. N., Drisse, M. B., Nxele, T., & Sly, P. D. (2014). E-Waste: a global hazard. *Annals of Global Health*, *80*(4), 286. https://doi.org/10.1016/j.aogh.2014.10.001

Philips Lighting. (2017). *New business models in the circular economy*. https://images.philips.com/is/content/PhilipsConsumer/PDFDownloads/Global/Services/ODLI20170929_001-UPD-en_AA-business.pdf

Portugaise, M. K., Jóhannsdóttir, L., & Murakami, S. (2023). Extended producer responsibility's effect on producers' electronic waste management practices in Japan and Canada: drivers, barriers, and potential of the urban mine. *Discover Sustainability*, *4*(1). https://doi.org/10.1007/s43621-023-00124-y

Poushter, J. (2016). Smartphone ownership and internet usage continues to climb in emerging economies. *Pew Research Centre*, *22*(1), 1–44. https://diapoimansi.gr/PDF/pew_research%201.pdf

Pradhan, J. K., & Kumar, S. (2014). Informal e-waste recycling: environmental risk assessment of heavy metal contamination in Mandoli industrial area, Delhi, India. *Environmental Science and Pollution Research*, *21*(13), 7913–7928. https://doi.org/10.1007/s11356-014-2713-2

Product Stewardship Sector Group. (n.d.). *Position Paper on e-Waste*. https://techcollect.nz/Downloads/WasteMINZ-Product-Stewardship-Sector-Group-Position-Paper-on-E-Waste.pdf

Rene, E. R., Sethurajan, M., Ponnusamy, V. K., Kumar, G., Dung, T. N. B., Brindhadevi, K., & Pugazhendhi, A. (2021). Electronic waste generation, recycling and resource recovery: Technological perspectives and trends. *Journal of Hazardous Materials*, *416*, 125664. https://doi.org/10.1016/j.jhazmat.2021.125664

Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (2013). *Qualitative research practice: A guide for social science students and researchers* (2nd ed.). SAGE Publications.

RNZ. (2020, February 17). Our gigantic e-waste problem. *RNZ*. https://www.rnz.co.nz/news/thedetail/552048/our-gigantic-e-waste-problem

Robinson, B. H. (2009). E-waste: An assessment of global production and environmental impacts. *The Science of the Total Environment*, *408*(2), 183–191. https://doi.org/10.1016/j.scitotenv.2009.09.044

Sahoo, S., Mukherjee, A., & Halder, R. (2021). A unified blockchain-based platform for global e-waste management. *International Journal of Web Information Systems*, *17*(5), 449–479. https://doi.org/10.1108/ijwis-03-2021-0024

Saphores, J. M., Ogunseitan, O. A., & Shapiro, A. A. (2012). Willingness to engage in a pro-environmental behavior: An analysis of e-waste recycling based on a national survey of U.S. households. *Resources Conservation and Recycling*, *60*, 49–63. https://doi.org/10.1016/j.resconrec.2011.12.003

Satyro, W. C., Sacomano, J. B., Contador, J. C., & Telles, R. (2018). Planned obsolescence or planned resource depletion? A sustainable approach. *Journal of Cleaner Production*, *195*, 744–752. https://doi.org/10.1016/j.jclepro.2018.05.222

Saunders, M. N. K., Lewis, P., & Thornhill, A. (2023). *Research methods for business students* (9th ed.). Pearson.

https://www.researchgate.net/publication/240218229_Research_Methods_for_Business_Students

Schluep, M., Hagelüken, C., Kuehr, R., Magalini, F., Maurer, C., Meskers, C., Mueller, E., & Wang, F. (2009). *Recycling - from e-waste to resources.: Sustainable Innovation and Technology Transfer Industrial Sector Studies*. United Nations Environment Programme & United Nations University. https://www.researchgate.net/publication/278849195_Recycling_-_from_e-waste_to_resources

Schumacher, K. A. (2016). *Electronic Waste management in the U.S. practice and policy*. ProQuest. https://www.proquest.com/docview/1840890548?pq-origsite=gscholar&fromopenview=true

Schumacher, K. A., & Agbemabiese, L. (2020). E-waste legislation in the US: An analysis of the disparate design and resulting influence on collection rates across States. *Journal of Environmental Planning and Management*, *64*(6), 1067–1088. https://doi.org/10.1080/09640568.2020.1802237

Shahabuddin, M., Uddin, M. N., Chowdhury, J. I., Ahmed, S. F., Uddin, M. N., Mofijur, M., & Uddin, M. A. (2022). A review of the recent development, challenges, and opportunities of electronic waste (e-waste). *International Journal of Environmental Science and Technology*, *20*(4), 4513–4520. https://doi.org/10.1007/s13762-022-04274-w

Shevchenko, T., Laitala, K., & Danko, Y. (2019). Understanding consumer E-Waste recycling behavior: Introducing a new economic incentive to increase the collection rates. *Sustainability*, *11*(9), 2656. https://doi.org/10.3390/su11092656

Shimada, T., & Van Wassenhove, L. N. (2016). Closed-Loop supply chain activities in Japanese home appliance/personal computer manufacturers: A case study. *International Journal of Production Economics*, *212*, 259–265. https://doi.org/10.1016/j.ijpe.2016.11.010

Sidique, S. F., Joshi, S. V., & Lupi, F. (2009). Factors influencing the rate of recycling: An analysis of Minnesota counties. *Resources Conservation and Recycling*, *54*(4), 242–249. https://doi.org/10.1016/j.resconrec.2009.08.006

SLR Consulting NZ Limited. (2015). *E-Waste Product Stewardship Framework for New Zealand Final Report*. https://www.globalpsc.net/wp-content/uploads/2015/08/eWasteNZ_Final_Report_0615_EN.pdf

Smith, N. (2008, October). *Showers latest target of Labour's nanny state* [Press release]. https://www.scoop.co.nz/stories/PA0810/S00187.htm

Stempel, J. (2020, March 3). Apple to pay up to $500 million to settle U.S. lawsuit over slow iPhones. *Reuters*. https://www.reuters.com/article/technology/apple-to-pay-up-to-500-million-to-settle-us-lawsuit-over-slow-iphones-idUSKBN20P2D7/

Sthiannopkao, S., & Wong, M. H. (2012). Handling e-waste in developed and developing countries: Initiatives, practices, and consequences. *The Science of the Total Environment*, *463–464*, 1147–1153. https://doi.org/10.1016/j.scitotenv.2012.06.088

Sun, Z., Cao, H., Xiao, Y., Sietsma, J., Jin, W., Agterhuis, H., & Yang, Y. (2016). Toward Sustainability for Recovery of Critical Metals from Electronic Waste: The Hydrochemistry Processes. *ACS Sustainable Chemistry & Engineering*, *5*(1), 21–40. https://doi.org/10.1021/acssuschemeng.6b00841

Tanskanen, P. (2013). Management and recycling of electronic waste. *Acta Materialia*, *61*(3), 1001–1011. https://doi.org/10.1016/j.actamat.2012.11.005

TCF. (2025). TCF Annual Report 2025. In *NZ Telecommunication Forum INC (TCF)*. https://www.tcf.org.nz/news/tcf-annual-report-2025

Tech Collect NZ. (2021). *PRODUCT STEWARDSHIP AND EXTENDED PRODUCER RESPONSIBILITY FOR E-PRODUCTS AND E-WASTE*. https://techcollect.nz/Downloads/International-Research-Paper-%E2%80%93-Product-stewardship-and-extended-producer-responsibility-for-e-products-and-e-waste_WEB-compressed_3.pdf

TechCollect NZ. (2023a). E-product stewardship in Aotearoa New Zealand: Report one. In *TechCollect NZ*. https://techcollect.nz/Downloads/E-Product-Stewardship-in-Aotearoa-New-Zealand-Report-One-Scheme-Framing-and-Design-Options.pdf

TechCollect NZ. (2023b). E-product stewardship in Aotearoa New Zealand: Report two. In *TechCollect NZ*. https://techcollect.nz/Downloads/E-Product-Stewardship-in-Aotearoa-New-Zealand-Report-Two-Scheme-Framing-and-Design-Recommendations.pdf

Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic analysis. In *The SAGE Handbook of Qualitative Research in Psychology* (2nd ed., pp. 17–35). SAGE Publication.

The Economic Development, Science and Innovation Committee. (2025). Consumer Guarantees (Right to Repair) Amendment Bill. In *New Zealand Parliament*.

https://bills.parliament.nz/v/6/aa85fbe0-e290-46f8-9344-08dc59cb8c95?Tab=history&lang=en

Tisdell, E. J., Merriam, S. B., & Stuckey-Peyrot, H. L. (2025). *Qualitative research: A guide to design and implementation* (5th ed.). John Wiley & Sons.

Tripe, D. (2013). Light-handed Regulation in New Zealand Banking and Financial Services: Has it worked? *Applied Finance Letters*, *2*(2), 20. https://doi.org/10.24135/afl.v2i2.15

Tsetsi, E., & Rains, S. A. (2017). Smartphone Internet access and use: Extending the digital divide and usage gap. *Mobile Media & Communication*, *5*(3), 239–255. https://doi.org/10.1177/2050157917708329

Tsydenova, O., & Bengtsson, M. (2010). Chemical hazards associated with the treatment of waste electrical and electronic equipment. *Waste Management*, *31*(1), 45–58. https://doi.org/10.1016/j.wasman.2010.08.014

Tukker, A. (2013). Product services for a resource-efficient and circular economy – a review. *Journal of Cleaner Production*, *97*, 76–91. https://doi.org/10.1016/j.jclepro.2013.11.049

Tyrewise. (2025). Tyrewise Annual Report 2025. In *Tyrewise*. https://www.tyrewise.co.nz/wp-content/uploads/2025/11/Tyrewise_Annual-Report-2025_RGB_web_final.pdf

Tyrewise. (2026). https://www.tyrewise.co.nz

Unmanaged e-waste per capita. (2025). OECD Going Digital Toolkit. https://goingdigital.oecd.org/indicator/53

Walker, L., Cocklin, C., & Heron, R. L. (2000). Regulating for environmental improvement in the New Zealand forestry sector. *Geoforum*, *31*(3), 281–297. https://doi.org/10.1016/s0016-7185(99)00051-2

Wang, F., Huisman, J., Meskers, C. E., Schluep, M., Stevels, A., & Hagelüken, C. (2012). The Best-of-2-Worlds philosophy: Developing local dismantling and global infrastructure network for sustainable e-waste treatment in emerging economies. *Waste Management*, *32*(11), 2134–2146. https://doi.org/10.1016/j.wasman.2012.03.029

Wang, Z., Zhang, B., & Guan, D. (2016). Take responsibility for electronic-waste disposal. *Nature*, *536*(7614), 23–25. https://doi.org/10.1038/536023a

Wong, C. S., Wu, S., Duzgoren-Aydin, N. S., Aydin, A., & Wong, M. H. (2006). Trace metal contamination of sediments in an e-waste processing village in China. *Environmental Pollution*, *145*(2), 434–442. https://doi.org/10.1016/j.envpol.2006.05.017

Wu, Q., Leung, J. Y., Geng, X., Chen, S., Huang, X., Li, H., Huang, Z., Zhu, L., Chen, J., & Lu, Y. (2014). Heavy metal contamination of soil and water in the vicinity of an abandoned e-waste recycling site: Implications for dissemination of heavy metals. *The Science of the Total Environment*, *506–507*, 217–225. https://doi.org/10.1016/j.scitotenv.2014.10.121

Xavier, L. H., Giese, E. C., Ribeiro-Duthie, A. C., & Lins, F. a. F. (2019). Sustainability and the circular economy: A theoretical approach focused on e-waste urban mining. *Resources Policy*, *74*, 101467. https://doi.org/10.1016/j.resourpol.2019.101467

Xavier, L. H., Ottoni, M., & Abreu, L. P. P. (2023). A comprehensive review of urban mining and the value recovery from e-waste materials. *Resources Conservation and Recycling*, *190*, 106840. https://doi.org/10.1016/j.resconrec.2022.106840

Yanow, D. (2000). *Conducting interpretive policy analysis*. Sage Publications.

Yanow, D. (2007). Interpretation in policy analysis: On methods and practice. *Critical Policy Studies*, *1*(1), 110–122. https://doi.org/10.1080/19460171.2007.9518511

Yin, J., Gao, Y., & Xu, H. (2013). Survey and analysis of consumers' behaviour of waste mobile phone recycling in China. *Journal of Cleaner Production*, *65*, 517–525. https://doi.org/10.1016/j.jclepro.2013.10.006

Ylä-Mella, J., Keiski, R. L., & Pongrácz, E. (2015). Electronic waste recovery in Finland: Consumers' perceptions towards recycling and re-use of mobile phones. *Waste Management*, *45*, 374–384. https://doi.org/10.1016/j.wasman.2015.02.031

Yoshida, A., Terazono, A., Ballesteros, F. C., Nguyen, D., Sukandar, S., Kojima, M., & Sakata, S. (2015). E-waste recycling processes in Indonesia, the Philippines, and Vietnam: A case study of cathode ray tube TVs and monitors. *Resources Conservation and Recycling*, *106*, 48–58. https://doi.org/10.1016/j.resconrec.2015.10.020

Yoshida, F., & Yoshida, H. (2014). E-Waste management in Japan: a focus on appliance recycling. *Advanced Materials Research*, *878*, 420–423. https://doi.org/10.4028/www.scientific.net/amr.878.420

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

Zhang, K., Schnoor, J. L., & Zeng, E. Y. (2012). E-Waste Recycling: Where Does It Go from Here? *Environmental Science & Technology*, *46*(20), 10861–10867. https://doi.org/10.1021/es303166s

Zheng, G., Xu, X., Li, B., Wu, K., Yekeen, T. A., & Huo, X. (2012). Association between lung function in school children and exposure to three transition metals from an e-waste recycling area. *Journal of Exposure Science & Environmental Epidemiology*, *23*(1), 67–72. https://doi.org/10.1038/jes.2012.84