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Title: Transforming the E-waste Management System: Dunedin and Otago

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Abstract

The aim of this research is to inform the transformation of the e-waste management in Dunedin by shifting the focus from recycling to activities higher in the waste hierarchy (for example, redesigning, reducing and refurbishing). Previous research has identified the importance and potential solutions of creating a circular economy for e-waste, but few have addressed the context of Dunedin's social and environmental economy. To gain insight into how Dunedin's climate influences the e-waste management system, semi-structured interviews were conducted with 12 stakeholders involved in the production, processing and diversion of e-waste. The interviews focused on understanding current e-waste management practices, identified barriers and explored opportunities for collaboration with other stakeholders. A review of global 'good practice' e-waste management provided a benchmark for evaluating and potentially replicating effective e-waste management strategies in New Zealand. This article documents Dunedin's current e-waste management practices and provides recommendations to guide stakeholders in the e-waste sector. These recommendations particularly focus on supporting product stewardship schemes, prioritising public awareness and education, and encouraging joint solutions. The findings from this article could serve as a model for other regions in New Zealand, promoting sustainable consumption and production patterns.

Keywords: ewaste, waste hierarchy, sustainability, recycling

1. Introduction

Electronic waste (e-waste) refers to any electronic product that is discarded because it is no longer operative or intended for reuse. [1] This includes items with damaged components, like a broken laptop screen or a rusty toaster, as well as still-functional products that are discarded after serving their purpose, such as disposable vapes or outdated computers.

Globally, e-waste is one of the largest growing waste streams. [1] E-waste may contain bioaccumulative toxins which do not biodegrade and accumulate up the food chain, posing environmental and health risks when landfilled. E-waste contains valuable mined materials such as gold, steel, aluminium, copper which are highly sought after for various technologies. Recovering these valuable materials is a cost-effective, environmentally friendly, and sustainable alternative to traditional mining practices. [2] Solutions that divert e-waste from landfills is therefore beneficial as it reduces its risk of harm when disposed improperly and maximises the use of our finite natural resources.

Unfortunately, e-waste currently falls under a linear economy; Natural resources have been extracted to create these products and once discarded, goes to landfills. This economy is not a renewable process and is unsustainable in the long-run as natural resources deplete. Transitioning to a circular economy is crucial for sustainable consumption. In a circular economy, non-operable products are returned to manufacturers and recycled to create new products, ensuring sustainable resource use. [3]

To achieve this transition, we emphasise the waste hierarchy, illustrated in figure 1. This circular economy principle has guided the Ministry for the Environment New Zealand in developing New Zealand's Waste Strategy. The hierarchy prioritises reducing resource use and encouraging innovative product designs that minimise waste. The next tier focuses on extending the life of products through reuse, repair, and repurposing. When reuse is no longer feasible, products should be recycled to contribute to future production. [3]

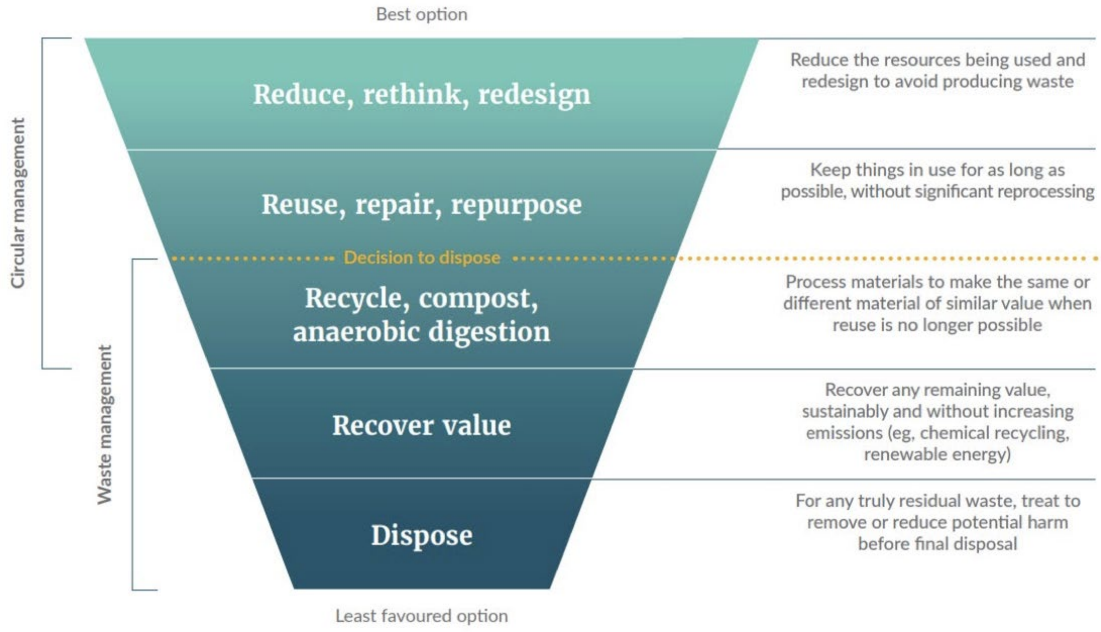

Figure 1: Waste Hierarchy. Image from Ministry for the Environment. 2023. Te rautaki para | Waste strategy. Wellington: Ministry for the Environment.

Our objective is to transition New Zealand to a circular economy for electronics, which may be an ambitious and large-scale initiative. This article will focus on the city of Dunedin to assess the feasibility of transforming its e-waste management system into a circular model, incorporating joint solutions and involving the wider Otago region.

The primary objective of this article is therefore to assess Dunedin's current e-waste management system and provide recommendations that may inform the decisions of stakeholders in the e-waste economy. Secondary objectives are to assess product stewardship reports by the Ministry for the Environment and its implications in Dunedin, and map public availability of battery and e-waste recycling.

2. Method

Data was collected via a literature review and semi-structured interviews conducted throughout December 2023 to February 2024.

The literature review consisted of 'good practice' e-waste management at a global and regional scale, serving as a benchmark for evaluating and potentially replicating effective e-waste management strategies in New Zealand.

The interviews comprised a total of 12 stakeholders including representatives from regional city councils, local businesses and entities involved in the production, management and disposal of e-waste. Stakeholders were emailed details regarding information that would be collected throughout the interview, how this information would be used, stored and presented, and requested their informed consent for participating in this research. An interview guide was created to cover key themes such as their current e-waste management practices, challenges faced, existing collaborations and potential improvements. Interviews were recorded and transcribed for analysis. Contemporary content analysis of interview data produced emerging themes related to the current state of the e-waste management system in Dunedin and perceived challenges.

Collected data informed recommendations for e-waste management and future research.

3. Data Collection & Discussion

3.1 Current E-waste Management Practices Globally

A report by the Global E-waste Statistics Partnership has predicted that global e-waste will reach 74 metric tonnes by 2030 due to higher consumption rates, shorter lifecycles of electronic products and limited repair options. As of 2019, 78 out of 193 countries have adopted national e-waste policy, legislation or regulations. Of these countries, the most mature e-waste management system can be found in the European union. Regulatory frameworks such as the Waste Electrical and Electronic Equipment Directive and the Battery Directive establishes guidelines for the proper collection, recycling, and disposal of electrical and electronic waste and batteries. The long history of e-waste management in the EU has given rise to comprehensive regulatory frameworks, well-established

collection and processing systems and higher public awareness and education. The EU can also leverage its scale for better collaboration and information sharing. [1]

Globally, community initiatives to tackle e-waste are most robust amongst tertiary institutions. Several universities across Australasia have e-waste diversion activities to manage the waste produced by their universities as seen in figure 2. [4]

University of La Trobe	● Battery and e-waste recycling program ● Donated 40 sets of computer peripherals to help roll out a project to build computers and teach programming skills in their local community. ● Campaigns to educate and advocate for waste management services
University of Melbourne	● Furniture and Equipment Reuse Centre for student and staff reuse of donated equipment
University of Otago	● Te Oraka: Laptop recycling and student reuse of donated equipment
University of Queensland	● Battery and e-waste recycling program ● Repair cafe offering mechanical repairs
University of Tasmania	● Diverted 70 laptops from landfill during the COVID-19 lockdown period, avoided 22,400kg CO_2e by donating these laptops to students in need.
RMIT University	● Most IT assets are leased and returned to supplier at the end of its life ● Battery recycling service

Figure 2: E-waste diversion community initiatives by Australasian universities

3.2 New Zealand's National E-waste Management System

Compared to the EU, New Zealand's e-waste management is still in its early days. New Zealand has a relatively smaller population and domestic market, and is a more geographically isolated country with a shorter history of e-waste management. However, New Zealand has made notable efforts in its e-waste management system. The Waste Minimisation Act (WMA) 2008 establishes a framework for waste management and minimisation. [5] It includes provisions related to product stewardship and mechanisms for monitoring and reporting on the effectiveness of waste minimisation plans. A waste disposal levy enacted by the Ministry for the Environment also generates revenue to fund initiatives that reduce waste and encourage resource recovery. Territorial authorities must allocate this funding appropriately in accordance to the WMA and their own waste management and minimisation plans.

In July 2020, the government declared e-waste as one of six 'priority products' for the establishment of product stewardship schemes under the WMA 2008. [6]

In November 2022, a national product stewardship scheme by TechCollect NZ was presented to the Ministry for the Environment with anticipation of its earliest possible in-effect date in 2026. [7]

3.2.1 TechCollect's Product Stewardship Scheme

From the TechCollect reports of the product stewardship scheme, a summary of stakeholder definitions and responsibilities was produced, outlining how these stakeholders can best support the scheme in New Zealand. TechCollect recommended territorial authorities should establish a stakeholder advisory group within their district to advise the accredited scheme manager on how best to implement various aspects of the scheme in the district and also provide insight into the current position of e-waste management. To support the scheme, territorial authorities should also work with the accredited scheme manager to establish the scheme's collection network such as establishing a collection service or procure site licence agreements with collection partners. While it may take some time for the scheme to fully be implemented by 2026, territorial authorities may support repair and reuse options in Dunedin. This may come in the form of creating a repair and reuse directory or providing a space for repair events. [8]

3.3 Otago's E-waste Management System

In the Otago region, existing collaborative efforts include WasteNet Southland which is a shared solid waste service for the Gore District Council, Invercargill City Council and Southland District Council. This program provides information to users regarding recycling options. [9] The Dunedin City Council is currently recruiting an Otago Regional Waste Officer to hopefully liaise waste solutions for the entire Otago region.

In the Otago region, Dunedin is the most populated city with more developed infrastructure including railways, an airport and educational institutions such as the University of Otago and the Otago Polytechnic. As such, Dunedin produces relatively high levels of e-waste because the tertiary sector is a significant contributor through procurement of fleets of electronic products. Due to its denser population, it receives a higher proportion of the waste levy funding to support Dunedin's waste management and minimisation. Currently, this levy is used to subsidise public costs for recycling e-waste, which is then allocated as community contestable funding to support activities that minimises waste. [10]

3.3.1 Public Availability for Household Battery Collection

In terms of public availability for household battery collection, WasteMINZ has collated this information on their website and the options are presented in figure 3. [11]

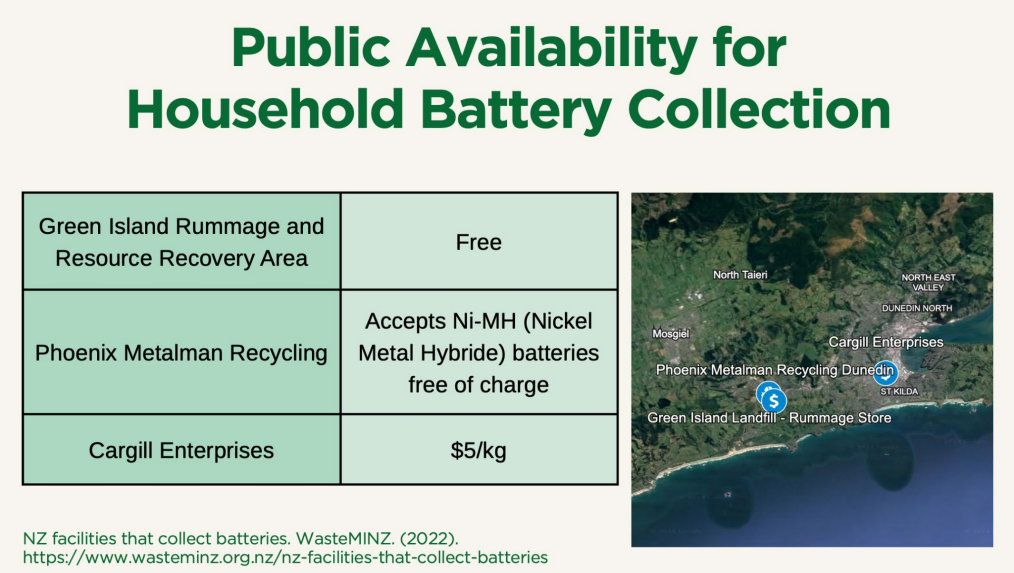

Figure 3: WasteMINZ. 2022. New Zealand facilities that accept used household batteries. https://www.wasteminz.org.nz/nz-facilities-that-collect-batteries

3.3.2 Public Availability for E-waste Collection

In terms of public availability for e-waste collection, there are no established repair options. But there are established reusers, refurbishers and recyclers, noted in figure 4.

Figure 4: Public availability for e-waste collection in Dunedin

3.4 Emerging Themes

Contemporary content analysis of interview data produced two emerging themes. Firstly, where does the responsibility in managing e-waste lie, and secondly what are the challenges for managing e-waste.

3.4.1 Responsibility for Managing E-waste

There is an understanding that tackling e-waste should always start with the producers. In this linear economy, producer responsibility stops once the product is in the hands of the consumer. However, if there are protocols in place to deliver the product to the consumer it is not unrealistic to have protocols that return the products to the manufacturer at the end of its use to be recycled.

On top of that, pressure should be placed on producers to produce sustainably. For example, producing phones where the components are not glued together such that the phone can be repairable and not discarded once damaged.

This is where the responsibility of the government may come in. The government has the power to implement legislation that ensures products brought into the country have a recovery pathway or meet a certain climate profile. Doing so prevents producers from pushing the fiscal and operational responsibility of managing end of life products to downstream stakeholders such as onto consumers and territrial authorities.

However, that does not mean that the community has no place in the e-waste economy. The community should utilise its resources in the form of sharing knowledge and upskilling. In this world of technology, it is important for individuals and communities to adapt and engage in technology. Engaging in upskilling courses in technology equips them with the skills to repair, access communication channels, and make informed decisions when purchasing technological products. With these skills, communities could be resilient in sourcing its own technological solutions.

3.4.2 Challenges in Managing E-waste

In terms of challenges, producer decisions have been a barrier in achieving a circular economy. There is a pattern of planned obsolescence – where products are designed to be unrepairable. This encourages consumers to replace their existing products with new ones, prioritising sales, with little regard for the environmental implications. Lobbying for the right to repair and having a product stewardship scheme would hold producers accountable for their environmental impact.

This ties in with the next challenge which is poor public awareness and education. There is enough flexibility in the free market for any product to come into the market regardless of its environmental impact. The quantity of natural resources extracted to produce electronic products is not well known, and therefore it is difficult for the general public to appreciate the lifespan of electronic products. A strong emphasis on convenience, fueled by unsustainable design, has unfortunately displaced the importance of sustainability in the public consciousness. The definition of e-waste is also not well understood by the general public. There is a lack of education and awareness that electronic products can be recyclable. There is a misconception that kerbside collection is capable of disposing e-waste responsibly. Improving public awareness and education in these areas would facilitate a more informed consumer base, encouraging responsible choices and create an economy that values sustainability.

Lastly, many stakeholders face a lack of resources in their e-waste diversion activities. For example, there can be a team with the skills required to refurbish a laptop. But with a large volume of broken laptops, the team is limited by the space required to hold these laptops, the time it takes to go through them, the finances to pay the mechanics and the finances to pay for the laptops to be shipped away from rural areas that lack the appropriate processing infrastructure. Ideally, a product

stewardship scheme and a shift in the economy to one that values sustainability would be able to solve these financial constraints. In the meantime, collaborative efforts may pool available resources to overcome these challenges.

4. Recommendations

The following recommendations seek to address identified barriers towards building a more circular e-waste economy in Dunedin. These recommendations were informed by data collected, in particular the views of experts who participated in the research.

4.1 Supporting the Product Stewardship Scheme

The product stewardship scheme and appropriate legislation is needed to focus on higher activities in the waste hierarchy. Although the DCC is unable to deliver this, it does play a role in advocating for a national product stewardship scheme. This can be in the form of strengthening support for the scheme by taking on TechCollect's recommendations and emphasising the importance of the scheme in waste management and minimisation plans. Participation in future consultations regarding the scheme would also better inform regulations to support the scheme.

This recommendation is supported by a significant number of interviewees from different parts of the waste sector, encompassing the views of experts that advise, manage and divert waste.

4.2 Increasing Public Awareness & Education Effectively

There are several emerging local waste minimisation initiatives that would benefit from improved communications between local stakeholders and DCC. Doing so would better inform the DCC and the public of current waste diversion options in Dunedin. This may be in the form of:

1. Creating a directory that would enable the public to access these initiatives
2. Facilitating networking events for these stakeholders that would allow information sharing and to identify opportunities for collaboration
3. Assisting in procuring spaces for storage and processing of e-waste and for events such as deconstruction or repair workshops

At the city level, e-waste management initiatives initiated or supported by the DCC should endeavour to:

1. Focus on public awareness and education. Cultivating healthy attitudes towards sustainability especially amongst younger generations would alleviate future problems regarding waste management.
2. Be data driven. For example, creating a program to raise public awareness and education should be evaluated to assess attitudes and behaviours towards sustainability after taking part, to understand the barriers and opportunities for public participation in e-waste management.

Monitoring the quantities and flows of e-waste is essential for evaluating waste management efforts, and to set and assess targets. The development of infrastructure and legislation is more efficiently implemented when supported by data. It would therefore be worthwhile to quantify e-waste diversion in Dunedin.

4.3 Joint Solutions

A regional waste manager, when appointed, should endeavour to:

1. Procure e-waste services and public education resources that may be utilised by the whole Otago region
2. Be proactive in speaking out for the Otago region in waste minimisation forums or consultations at regional and national levels

This recommendation is informed by waste managers from Central Otago District Council and Queenstown Lakes District Council.

Mature e-waste processing facilities are mainly found in larger cities like Christchurch and Auckland. Instead of establishing new infrastructure in the South Island which may not be economically viable, Dunedin should consider using freight rails to move goods to Christchurch to reduce the carbon footprint of transporting e-waste to existing facilities.

As batteries also pose a fire risk when compacted in waste transport vehicles and processing facilities, Dunedin should consider more accessible battery collection services to keep batteries out of general waste bins. Along with e-waste collection, this could involve holding specific events, such as an e-waste and battery collection service at the University at the end of semesters.

Facilities that have high foot-traffic such as supermarkets or hardware stores are also encouraged to engage with WasteMINZ to create safe battery collection facilities.

5. Future Research

5.1 Public Awareness and Education

There is a large gap in public awareness and education on e-waste, its environmental impact and the social, economic and environmental benefits of recycling, repurposing or re-using it. Research into how this knowledge can be made publicly accessible would improve the management of e-waste.

Quantifying waste is challenging especially because there is a large variation in what is considered e-waste and its possible waste diversion streams. Future research should review how other businesses or countries have successfully quantified it and whether these methods are feasible in Dunedin.

5.2 Research & Development

There are innovative companies that are developing more sustainable products. However, they must compete with established brands and can be overlooked, particularly by larger consumers, especially

where security is a top priority. For example, Fairphone is a company that has designed a phone that can be repairable, unlike most phones on the market. If the suitability and reliability of these sustainable products can be demonstrated through research, they might gain wider acceptance and use.

There is currently no ideal solution for redesigning or recycling vapes. Given the increased use of these products, and their disposable design, innovation in this area would be immensely impactful in reducing the waste produced by vapes.

6. Conclusion

This article captures Dunedin's current e-waste system as of January 2024, highlighting key strengths and challenges. Key strengths include the range of emerging reuse and recycle initiatives, and the allocation of funding to support innovation in waste diversion. Key challenges include planned obsolescence in product design, poor public awareness and education and limited resources for e-waste diversion activities. Recommendations highlight the importance of improved government legislation to drive change, a robust national product stewardship scheme, proactive engagement at both city and regional levels, strengthening communication between local stakeholders and the DCC, fostering collaboration among regional initiatives and creating waste management initiatives that prioritise public education. This article also hopes to guide future research in e-waste management and beyond. Overall, insights and recommendations from this article aim to guide stakeholders in transforming the e-waste management system, informing future waste management and minimisation activities to promote sustainability and responsible consumption in Dunedin and Otago. These findings serve as a stepping stone towards achieving a circular economy throughout New Zealand.

7. Acknowledgements

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