# The e-waste management behaviours of household consumers in Whangarei, New Zealand

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**Vicktoria Marie Blake**

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# Abstract

E-waste is known to have detrimental environmental, social and economic impacts, and its volume is growing up to three times faster than any other waste stream. Despite this growing problem, and the concurrent increase in detrimental impacts, New Zealand relies on voluntary schemes to manage the estimated 98,000 tonnes of e-waste generated in the country annually. While New Zealand could apply mandatory product stewardship of e-waste under the Waste Minimisation Act 2008, a recent report argued that there was insufficient data available to meet the requirements to enforce the labelling of e-waste as a priority product.

This research aimed to generate first-time data on Whangarei household e-waste options, knowledge and behaviours, to inform e-waste management policy, resources and services which could be specifically designed for the district, with the intention that it would work towards providing sufficient data to allow for the mandatory product stewardship of e-waste. Research was conducted by way of online survey which asked Whangarei District residents questions specifically relating to how their households managed e-waste, and what influenced these management decisions. The survey was informed by international literature on the subject, as well as a review local and central government policies, and of the e-waste management resources services available both in the Whangarei District and in New Zealand as a whole.

The research found that in the Whangarei District, cost and lack of knowledge of the services available are barriers to engagement in e-waste recycling, similar to international findings. However, contrary to international literature, general recycling behaviours and socio-demographic factors did not significantly influence e-waste behaviours in the district. The research also found that only 1.8% of the estimated e-waste generated in the Whangarei District each year was being recycled through the municipal services available. This figure could be improved via mandatory product stewardship at best, or e-waste recycling goals being set by the district council enable steps towards better services, resources and infrastructure at the very least. Whangarei and New Zealand as a whole are a long way from the appropriate management

of e-waste. It is hoped this research, coupled with other information already available in the field, will allow the planning stage to begin toward adaptation to appropriate e-waste management, encompassing the waste hierarchy principles, if not nationally, then at least in the Whangarei District.

**Keywords:** e-waste, WEEE (waste electronic and electrical equipment)**,** e-waste management, behaviour change, Whangarei, New Zealand

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But the greatest thanks of all must go to my 11-year-old son, Matthew, for being so patient while I completed the most challenging part of my learning journey to date. My son, I am so proud to be your Mum and I love you to the moon…and back.

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# List of Abbreviations

| | |
|---|---|
| ADF | Advance Deposit Fee |
| CANZ | Computer Access New Zealand |
| CRT | Cathode Ray Tube |
| EEE | Electrical and Electronic Equipment |
| EOL | End-of-life / End of Useful Life |
| EPR | Extended Producer Responsibility |
| EU | European Union |
| GDP | Gross Domestic Product |
| ICT | Information and Communication Technology |
| ISWA | International Solid Waste Association |
| MFE | Ministry for the Environment |
| NEP | New Ecological Paradigm |
| NRC | Northland Regional Council |
| NZ | New Zealand |
| OECD | Organisation for Economic Co-operation and Development |
| PBDE | Polybrominated Diphenyl Ethers |
| PCB | Printed Circuit Board |
| RoHS | Restriction of Hazardous Substances |
| SLR | SLR Consulting New Zealand Limited |
| SWMB | Solid Waste Management Bylaw |
| TV | Television |
| UK | United Kingdom |
| UNEP | United Nations Environment Programme |
| US | United States of America |
| WDC | Whangarei District Council |
| WEEE | Waste Electrical and Electronic Equipment |
| WMA | Waste Minimisation Act 2008 |
| WMF | Waste Minimisation Fund |
| WMMP | Waste Minimisation and Management Plan |

# Chapter 1 – Introduction

E-waste is an international problem which is growing by the year. There are a number of reasons that e-waste is considered a problem, including the environmental and health impacts of the waste stream (ISWA, 2017; Jaiswal, Samuel, Patel, & Kumar, 2015; Mavropoulus, Newman, & ISWA, 2015; Kiddee, Naidu, & Wong, 2013; Robinson, 2009; Wilson, Rodic, Modak, Soos, Carpintero, Velis, Iyer, Simonette, 2015), and the considerable volumes being generated internationally (Baldé, Forti, Gray, Kuehr, & Stegmann, 2017; Cucchiella et al., 2015; Jaiswal et al., 2015; Kiddee, Naidu, & Wong, 2013). In New Zealand (NZ), one of the problems is the amount of e-waste that is being landfilled due to the lack of mandatory management schemes. Currently, in NZ, any e-waste recycling schemes in place are of a voluntary nature.

The Whangarei District (Whangarei) is found in NZ's northern most region of Northland. It has an estimated population of 86,754 people and has many coastal communities that are a tourism destination, which causes the population to increase by up to 20% over the summer months (Whangarei District Council, 2013a). Whangarei District Council (WDC) offers drop-off e-waste recycling services, for a disposal fee (see Appendix 1.1), at each of its rural transfer stations and at its central Re:Sort waste facility. However, this research shows these services manage only 1.8% of the estimated e-waste generated in the district each year.

## 1.1 Why Focus on E-waste?

E-waste management and its impacts have been of interest to academics for a number of years, with over 500 scientific articles discussing the negative environmental effects published before 2006 (Robinson, 2009), and many more since. In NZ, there is a lack of data preventing the prioritisation of the e-waste waste stream, which would enforce mandatory product stewardship. This research aims to provide some of this data by focusing on Whangarei as a case study. The reason mandatory e-waste management schemes are required are outlined throughout this thesis. However, to set the scene, Section 1.2.1 explains what e-waste is, and Section 1.2.2 describes

what influences e-waste generation, the volume of which grows significantly each year, and is one of the reasons that robust management is required.

### 1.1.1 What is E-waste?

Electronic waste, also known as e-waste or waste electronic and electrical equipment (WEEE), is a term that describes any household or commercial/industrial item that contains circuitry, a battery, or a plug, that has reached the end of its useful life (EOL) (Jaiswal et al., 2015; Saphores, Ogunseitan, & Shapiro, 2012). This thesis employs the term 'e-waste' as this is the most commonly accepted term in NZ[1]. The European Union (EU) WEEE Directive (European Parliament and the Council of the European Union, 2012) divides e-waste into 10 specific categories (see Table 1.1) covering more than 100 product types.

E-waste is acknowledged as the fastest growing waste stream internationally (Baxter, Lyng, Askham, & Hanssen, 2016; Cucchiella, D'Adamo, Koh, & Rosa, 2015; Darby & Obara, 2005; Kiddee, Naidu, & Wong, 2013; Saphores, Ogunstein, & Shapiro, 2012), with the United Nations University StEP Initiative predicting that by 2017 the global e-waste produced annually would reach 59.3 million tonnes (StEP Initiative, 2013). This is of global concern, particularly due to the tendency of e-waste to contain hazardous materials. Hazardous chemicals are predominantly found in information and communication technology (ICT), consumer equipment (CE), and small e-waste (Robinson, 2009). These materials can pose a threat to human health and the environment (Mehta, Chauhan, Kumar, & Gour, 2015; Song, Wang, & Li, 2012). Widmer, Oswald-Krapf, Sinha-Khetriwal, Schnellmann, and Böni (2005) found that of the 10 categories listed in Table 2.1, the first four account for close to 95% of all e-waste generated. A Western Europe year 2000 case study (Figure 1.1), shows that of this 95%, ICT, CE, and small (household) e-waste makes up over 52.3%, with large household e-waste at 42.1%.

[1] A google search of "WEEE New Zealand" came up with 473,000 results compared with 45,500,000 results for "e-waste New Zealand" on 2 October 2018.

*Table 1.1 Indicative list of EEE which falls into the EU Directive WEEE categories (Source: European Parliament and the Council of the European Union, 2012, Annex II)*

| **WEEE Category** | **Indicative list of WEEE that falls into each category** |
|---|---|
| Large Household Appliances | Large cooling appliances; refrigerators; freezers; other large appliances used for refrigeration, conservation and storage of food; washing machines; clothes dryers; dishwashers; cookers; electric stoves; electric hot plates; microwaves; other large appliances used for cooking and other processing of food; electric heating appliances; electric radiators; other large appliances for heating rooms, beds, seating furniture; electric fans; air conditioner appliances; other fanning, exhaust ventilation and conditioning equipment. |
| Small Household Appliances | Vacuum cleaners; carpet sweepers; other appliances for cleaning; appliances used for sewing, knitting, weaving and other processing for textiles; irons and other appliances for ironing, mangling and other care of clothing; toasters; fryers; grinders, coffee machines and equipment for opening or sealing containers or packages; electric knives; appliances for hair-cutting, hair drying, tooth brushing, shaving, massage and other body care appliances; clocks, watches and equipment for the purpose of measuring, indicating or registering time; scales. |
| IT and Telecommunications Equipment | Centralised data processing: mainframes; minicomputers; printer units. Personal computing: personal computers (CPU, mouse, screen and keyboard included); laptop computers (CPU, mouse, screen and keyboard included); notebook computers; notepad computers; printers; copying equipment; electrical and electronic typewriters; pocket and desk calculators; and other products and equipment for the storage, processing, presentation or communication of information by electronic means; user terminals and systems; facsimile; telex; telephones; pay telephones; cordless telephones; cellular telephones; smart phones; answering systems; and other products or equipment of transmitting sound, images or other information by telecommunications. |
| Consumer Equipment | Radio sets; television sets; video cameras; video recorders; Hi-Fi recorders; audio amplifiers; musical instruments; and other products or equipment for the purpose of recording or reproducing sound or images, including signals or other technologies of sound and image than by telecommunications; photovoltaic panels. |
| Lighting Equipment | Luminaires for fluorescent lamps with the exception of luminaires in households; straight fluorescent lamps; compact fluorescent lamps; high intensity discharge lamps, including pressure sodium lamps and metal halide lamps; low pressure sodium lamps; other lighting or equipment for the purpose of spreading or controlling light with the exception of filament lightbulbs. |
| Electrical and Electronic Tools (with the exception of large-scale stationary industrial tools) | Drills; saws; sewing machines; equipment for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making holes, punching, folding, bending or similar processing of wood, metal and other materials; tools for riveting, nailing or screwing or removing rivets, nails, screws or similar uses; tools for welding, soldering or similar use; equipment for spraying, spreading, dispersing or other treatment of liquid or gaseous substances by other means; tools for mowing or other gardening activities. |
| Toys, Leisure and Sports Equipment | Electric trains or car racing sets; hand-held video game consoles; video games; computers for biking, diving, running, rowing, etc.; sports equipment with electric or electronic components; coin slot machines. |
| Medical Devices | Radiotherapy equipment; cardiology; dialysis; pulmonary ventilators; nuclear medicine; laboratory equipment for in-vitro diagnosis; analysers; freezers; fertilisation tests; other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability |
| Monitoring and Control Instruments | Smoke detector; heating regulators; thermostats; measuring, weighing or adjusting appliances for household or as laboratory equipment; other monitoring and control instruments used in industrial installations (e.g. in control panels). |
| Automatic Dispensers | Automatic dispensers for hot drinks; automatic dispensers for hot or cold bottles or cans; automatic dispensers for solid products; automatic dispensers for money; all appliances which delivery automatically all kind of products. |

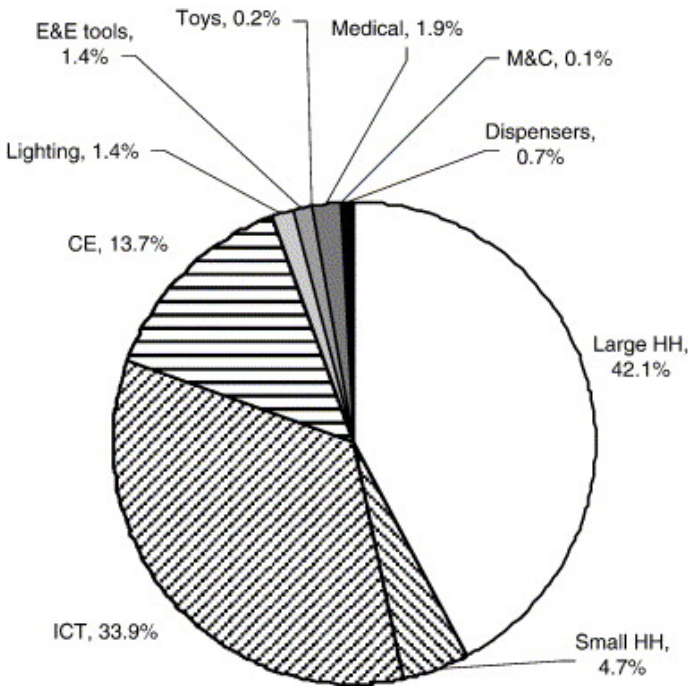



*Figure 1.1 Composition of e-waste in Western Europe in 2000 (Source: International Copper Study Group, 2003, as cited by Widmer et al., 2005, p. 440)*

### 1.1.2 What Causes E-waste Generation?

There are several factors contributing to the rapidly rising volumes of e-waste generated internationally. These include consumer purchasing and consumption behaviours (Gurauskienė, 2008; Hamilton, 2010; Kutz, 2006), planned obsolescence and other product design factors (Gurauskienė, 2008; Slade, 2006; Ubeda, Barrat, & Dannoritzer, 2010), increased reliance on information technology, and the frequency of technological changes (Ansari, Ashraf, Malik, & Grunfeld, 2010; Jaiswal et al., 2015; Kiddee, Naidu, & Wong, 2013).

The cultural shift in the developed world towards a consumerist society, has seen a transformation of consumption for necessity to consumption as a way to create and exhibit an authentic personal identity (Hamilton, 2010). Marketers have used this "desire for authentic identity" (Hamilton, 2010, p. 572) to their full advantage to increase product sales. The impact of this behaviour on the generation of e-waste is significant, as the consumer's 'need' to have, for example, the latest iPhone, leads to large amounts of obsolete electronics that are generally still operational (Gurauskienė, 2008; Kutz, 2006). Furthermore, developing countries are rapidly

adopting a consumerist culture, and this will further increase the environmental issues caused by e-waste (Hubacek, Guan, & Barua, 2007), and waste generation in general. As illustrated in Figure 1.2, product designers and manufacturers responding to the desire for authentic identity, by releasing new models of products each year for example[2], has been a driver in greatly reducing the desirable, and therefore useful, life of electronic products, and, as such, significantly increased waste generation.

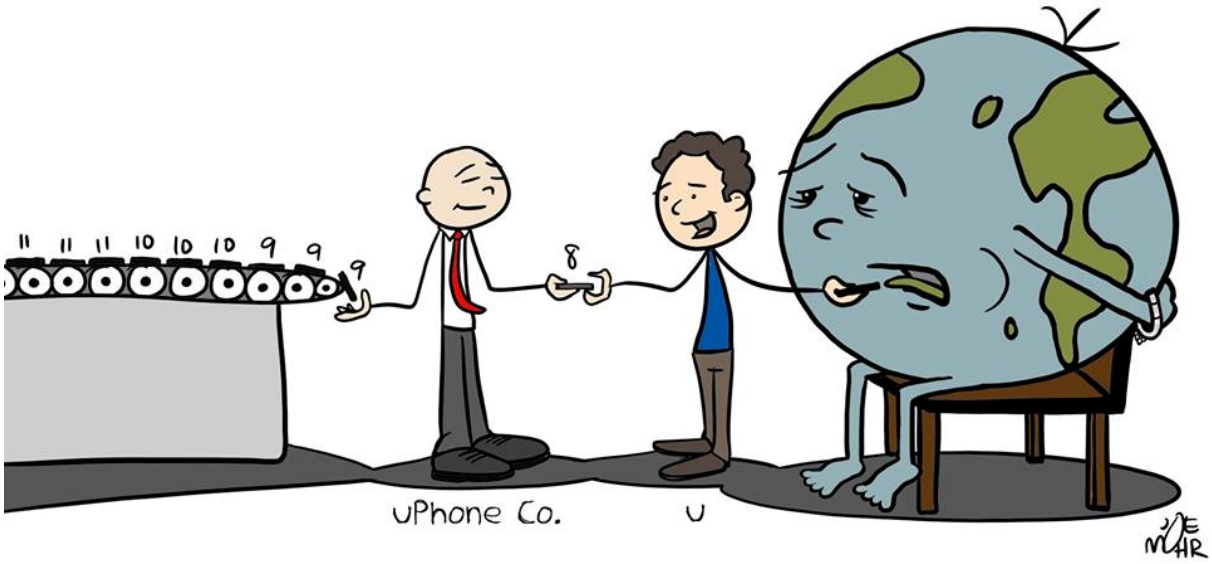



*Figure 1.2 An illustration of the planned obsolescence of cell phones. (Source: Mohr, J., 2017. Rethink It - End Planned Obsolescence. Retrieved 30 September 2017, from https://www.facebook.com/Joe-Mohr-246170232187930/)*

Figure 1.2 also illustrates the 'throw-away society' that consumerism promotes, where convenience, and consumer identity, outweigh environmental impact in the decision-making process (Martin, Williams, & Clark, 2006). Martin, Williams and Clark (2006) found that 90% of people would spend more on a product with a longer lifespan. However, they also found that over 50% of people would not repair an item that they paid less than £50 for (approximately NZD$90), likely due to the cost to repair matching or exceeding the cost of purchasing a replacement product. For example, it costs less to purchase a desktop printer as a whole unit than an ink cartridge (see Appendix 1.2 for an example). This pricing structure promotes the purchase of a whole new unit, rather than the replacement part (Ubeda, Barrat, & Dannoritzer,

[2] In September 2018 Apple released three new iPhones, the XS, XR and XS Max (Dolcourt, 2018)

2010). In addition, some common consumer products are designed so that they cannot be economically repaired, or even actually physically repaired, and/or can have a limited life span built into the product (Slade, 2006), thus forcing consumers to buy another one if their current item breaks.

This concept of 'planned obsolescence' was designed as a way for the economy to recover after the Great Depression, when Bernard London, a New York real estate broker, often cited as coining the term, recommended that obsolescence be built into products "at the time of their production" (1932, p. 2). This concept, also known as 'death dating', is common in electrical products such as home printers (Ubeda, Barrat, & Dannoritzer, 2010). Gurauskiene (2008) found that other design factors, such as incompatibility among products and lack of upgrade ability, are also examples of planned obsolescence. These issues are something that Apple, for example, is often challenged about in the media (for examples see Jones, 2011; Sulleyman, 2017). Product design factors considered under the term planned obsolescence, such as those illustrated, have a considerable impact on e-waste volumes.

In ICT, evolving consumer expectations, changes in infrastructure enabling increased and faster 'connectivity', and product design, all influence the rates of e-waste generation in interrelated ways. The global reliance on ICT, and the speed of the technological changes related to this, has a serious impact on the generation of e-waste (Jaiswal et al., 2015; Kiddee, Naidu, & Wong, 2013). Most business models include the frequent upgrading of ICT equipment (Ansari et al., 2010). For example, the NZ Inland Revenue Department (IRD) (2015) estimates the useful life of most computer equipment at only four years, and smart phones at only three. According to 2012 statistics (Bascand, 2013), 1.3 million homes in NZ have some form of internet connection, and 40 % of these homes use more than one device to connect to the internet. While these statistics exclude business products, this means that there are approximately 1.8 million internet-capable devices reach the end of their useful life over a four-year period in NZ homes alone.

## 1.2 Research Approach

This thesis aimed to generate first-time data on Whangarei household e-waste options, knowledge and behaviours, in order to inform e-waste management policy, resources and services which could be specifically designed for the district, and to work towards filling the data gap recently identified by the consulting firm engaged by the NZ Ministry for the Environment (MFE) to investigate whether e-waste should be considered a priority product therefore enforcing product stewardship (SLR Consulting, 2015). To meet this aim, the research had five objectives:

1. Identify the possible environmental, social and economic impacts of e-waste.
2. Identify the options (resources and services) available to Whangarei households for the disposal of e-waste.
3. Identify the types and volumes of e-waste, currently being disposed of or stored by Whangarei households, and how.
4. Identify the e-waste knowledge and behaviours of Whangarei household consumers, and factors influencing e-waste knowledge and behaviours.
5. Make recommendations based on the research for changes to e-waste policy that may improve the e-waste behaviours and knowledge of households in the Whangarei District.

In order to meet the research aim, and subsequent objectives, an online survey utilising a mixed method approach that was open to all Whangarei District residents from 9 March 2018 to 13 April 2018. An extensive literature review informed the survey questions and structure, and an understanding of the local and national context was also applied to ensure that the research objectives could be met. Mixed method analysis techniques were undertaken on the collected data, and this analysis informed the research discussion, conclusions, and recommendations.

## 1.3 Thesis Approach

This thesis is broken into eight chapters, with Chapter 1 being this introduction. Chapter 2 investigates the problems caused by e-waste on an international scale and introduces some possible solutions to manage these problems.

Chapter 3 examines e-waste in a NZ context, briefly discussing the national 'e-waste scape'[3]. Chapter 3 goes on to investigate the current situation in the Whangarei District, including what services and policies exist, and specific issues with waste that are already apparent in the district, such as illegal waste disposal and low levels of recycling. Chapter 4 reviews literature relating to household waste behaviours and what influences these behaviours in relation to both general household recycling and e-waste recycling. Chapter 4 also introduces a framework for working towards solutions for the e-waste management problem.

The methods used for this research, including the research tool description, sample size, selection criteria etc., are outlined in Chapter 5, with the results examined in Chapter 6. Chapter 7 discusses the research findings in relation to the literature reviewed for Chapter 4, and the current 'e-waste scape' in Whangarei and, to a lesser extent, NZ as a whole, as outlined in Chapter 3. Chapter 8 provides recommendations for policy makers both locally for the Whangarei District, and nationally for NZ as a whole. Chapter 8 also illustrates the overall conclusions of this thesis and highlights areas for future research.

[3] The 'e-waste scape' is based on the term "wastescape", a term grounded in the work of Appadauri (1996, as cited by Farrelly & Tucker, 2014) which describes scapes as "cultural flows". Farrelly and Tucker (2014, p. 12) describe wastescapes as "dynamic political, historical, economic, social, and environmental spaces where waste is culturally interpreted and mobilised … [that]… are informed and structured by groups and individuals and include those at regional, national, and global scales".

# Chapter 2 – E-Waste Problems and Solutions

E-waste is considered a problem due to its growing volume and its environmental and health impacts. The purpose of this chapter is to give an overview of international e-waste generation, impacts and management. Scant academic research has been conducted in NZ in relation to e-waste, therefore this chapter focuses on international literature, and aims to identify the possible environmental, social and economic impacts of e-waste that could exist in Whangarei. Chapter 3 will introduce the current and historical context of e-waste in NZ.

## 2.1 Volumes of E-waste

One of the greatest concerns with e-waste is the pattern of growth in the volume generated. Broadly speaking the growth of waste (which includes e-waste) is reported to be strongly correlated with rising GDP, and this trend was found likely to continue by the Organisation for Economic Co-operation and Development (OECD) in their 2007 report on environmental performance of NZ. However, e-waste alone is growing up to three times faster than other waste streams (Sustainability Victoria, 2017). Specifically, e-waste has an estimated annual international growth rate of 3 – 10% (Cucchiella et al., 2015; Jaiswal et al., 2015; Kiddee, Naidu, & Wong, 2013)[4]. The development status of a nation can also affect e-waste volumes. For example, e-waste generation is estimated at 0.2 kg per person per annum for a resident of Malawi, an African country in the developing world, the lowest recorded disposal rate, and at 28.3 kg per person for an inhabitant of Norway, a European (developed world) country with the highest recorded disposal rate (Baldé, Wang, Kuehr, & Huisman, 2015). The difference in rates is likely due to the differing levels of adaptation to the consumerist society lifestyle discussed in Chapter 1. The 2014 *Global E-Waste Monitor* (Baldé et al., 2015) estimated that for each NZ resident, 19kg of e-waste is generated annually, however, according to the 2017 report, this rate

[4] NZ GDP was 2.7% to the year ended March 2018, which is lower only to Australia at 3.1% and the US at 2.8%. (StatsNZ, 2018a)

had grown by 1.1% to 20.1kg[5] (Baldé et al., 2017). To further illustrate this point, Gurauskiene (2008) predicted that an individual in the United Kingdom (UK) who is born in 2003 and living until 2080, will generate 8 tonnes of e-waste in their lifetime. As suggested in Chapter 1, a contributor to these growing rates of e-waste is the lifespan of electrical and electronic equipment (EEE). If EEE lifespans decrease e-waste generation will continue to increase.

NZ-based researcher, Brett H. Robinson (2009), identifies EEE lifespans in Table 2.1, which highlights, in particular, the significantly short life spans of mobile phones and computers, and small kitchen appliances (an e-waste category that is often overlooked in e-waste research). In 2010, Ansari et al. observed that more than 130 million mobile phones are retired globally each year. In 2013, a Massachusetts Institute of Technology study found that approximately 258.2 million computers, monitors, televisions (TVs), and mobile phones reached EOL in the United States (US) alone (Duan, Miller, Gregory, Kirchain, & Linnell, 2013), at a possible weight of 6.5 million tonnes (258.2 million items x 25kgs). It is likely that that numbers have increased since these publications, particularly if the StEP Initiative's[6] estimation of global e-waste reaching over 59.3 million tonnes in 2017 is considered (StEP Initiative, 2013).

However, it is not just lifespan that effects e-waste volumes; manufacturing and production also contribute to increasing rates of e-waste generation (Kiddee, Naidu, & Wong, 2013). Technical and design innovation, and the development in mass production capacity, has meant that the number of electronic items available on the market has increased significantly over the past three decades (Zlamparet et al., 2017). Darby and Obara (2005) found that households surveyed in the UK had increased the number of EEE products they owned by approximately 60% over

[5] This equates to a total of 97,913.13 tonnes of e-waste estimated to be created in NZ on an annual basis. Calculated as volume per resident 20.1kg (Baldé et al., 2017) x NZ population of 4,871,300 (NZ Stats estimate as at March 2018, 2018b).

[6] The StEP Initiative is an independent, multi-stakeholder platform who design strategies to address all aspects of electronics. "StEP envisions being an agent and steward of change, uniquely leading global thinking, knowledge, awareness and innovation in the management and development of environmentally, economically and ethically-sound e-waste resource recovery, re-use and prevention." (StEP Initiative, n.d.)

five years, and it seems likely that since this research was conducted, this number will have continued to grow.

*Table 2.1 Lifespan and weights of common e-waste items (Source: Robinson, 2009, p. 184)*

| Item | Weight of Item (kg) | Typical Life (year) |
|---|---|---|
| Computer | 25 | 3 |
| Facsimile machine | 3 | 5 |
| High-fidelity system | 10 | 10 |
| Mobile telephone | 0.1 | 2 |
| Electronic games | 3 | 5 |
| Photocopier | 60 | 8 |
| Radio | 2 | 10 |
| Television | 30 | 5 |
| Video recorder/DVD player | 5 | 5 |
| | | |
| Air conditioning unit | 55 | 12 |
| Dishwasher | 50 | 10 |
| Electric cooker | 60 | 10 |
| Electric heater | 5 | 20 |
| Food mixer | 1 | 5 |
| Freezer | 35 | 10 |
| Hair dryer | 1 | 10 |
| Iron | 1 | 10 |
| Kettle | 1 | 3 |
| Microwave | 15 | 7 |
| Refrigerator | 35 | 10 |
| Telephone | 1 | 5 |
| Toaster | 1 | 5 |
| Tumble dryer | 35 | 10 |

## 2.2 Environmental and Health Impacts

E-waste affects the natural environment in several ways. It has only been in the last 25 years that the presence of toxic substances in e-waste has been recognised and begun to be more fully understood. Regardless, e-waste remains poorly managed in many regions (Kiddee, Naidu, & Wong, 2013). Table 2.2 identifies common hazardous substances found in e-waste and illustrates their application and potential health impacts. Incineration and landfill in the developed world, alongside open and uncontrolled dumping and burning in the developing world, create risks of toxic contamination of air, and landfill leachate can transport toxins into soil and ground water, affecting both human and non-human life, particularly when e-waste is

*Table 2.2 Common hazardous substances found in e-waste and their possible health impacts. (Source: Kiddee, Naidu, & Wong, 2013, p. 1239)*

| Substance | Applied in e-waste | Health impact |
|---|---|---|
| Antimony (Sb) | A melting agent in CRT glass, plastic computer housings and a solder alloy in cabling | Antimony has been classified as a carcinogen. It can cause stomach pain, vomiting, diarrhoea and stomach ulcers through inhalation of high antimony levels over a long-time period. |
| Arsenic (As) | Gallium arsenide is used in light emitting diodes | It has chronic effects that cause skin disease and lung cancer and impaired nerve signalling. |
| Barium (Ba) | Sparkplugs, fluorescent lamps and CRT gutters in vacuum tubes | Causes brain swelling, muscle weakness, damage to the heart, liver and spleen through short term exposure. |
| Brominated flame retardants (BFRs): (polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs) and tetrabromobisphenol (TBBPA)) | BFRs are used to reduce flammability in printed circuit boards and plastic housings, keyboards and cable insulation | During combustion printed circuit boards and plastic housings emit toxic vapours known to cause hormonal disorders. |
| Cadmium (Cd) | Rechargeable NiCd batteries, semiconductor chips, infrared detectors, printer inks and toners | Cadmium compounds pose a risk of irreversible impacts on human health, particularly the kidneys. |
| Chlorofluorocarbons (CFCs) | Cooling units and insulation foam | These substances impact on the ozone layer which can lead to greater incidence of skin cancer. |
| Hexavalent chromium/chromium VI (Cr VI) | Plastic computer housing, cabling, hard discs and as a colourant in pigments | Is extremely toxic in the environment causing DNA damage and permanent eye impairment. |
| Lead (Pb) | Solder, lead-acid batteries, cathode ray tubes, cabling, printed circuit boards and fluorescent tubes | Can damage the brain, nervous system, kidney and reproductive system and cause blood disorders. Low concentrations of lead can damage the brain and nervous system in foetuses and young children. The accumulation of lead in the environment results in both acute and chronic effects on human health. |
| Mercury (Hg) | Batteries, backlight bulbs or lamps, flat panel displays, switches and thermostats | Mercury can damage the brain, kidneys and foetuses. |
| Nickel (Ni) | Batteries, computer housing, cathode ray tube and printed circuit boards | Can cause allergic reaction, bronchitis and reduced lung function and lung cancers. |
| Polychlorinated biphenyls (PCBs) | Condensers, transformers and heat transfer fluids | PCBs cause cancer in animals and can lead to liver damage in humans. |
| Polyvinyl chloride (PVC) | Monitors, keyboards, cabling and plastic computer housing | PVC has the potential for hazardous substances and toxic air contaminants. The incomplete combustion of PVC releases huge amounts of hydrogen chloride gas which form hydrochloric acid after combination with moisture. Hydrochloric acid can cause respiratory problems. |
| Selenium (se) | Older photocopy machines | High concentrations cause selenosis. |

managed under poor or absent health and safety regulations (ISWA, 2017; Jaiswal et al., 2015; Mavropoulus, Newman, & ISWA, 2015; Kiddee, Naidu, & Wong, 2013; Wilson et al., 2015). E-waste can be "a potential source of genetic mutation and may induce cytogenetic damage" (Robinson, 2009, p.189), and blood, hair, human milk, serum, and urine samples taken from people who live in areas where e-waste is inappropriately recycled, predominantly developing countries where health and safety regulations are weak, show "the presence of significant concentrations of toxic substances" (Kiddee, Naidu, & Wong, 2013, p. 1238). For example, high levels of lead (Pb), a known endocrine disruptor, and cadmium (Cd), a cause of kidney problems among others, have been found in blood samples of children living close to e-waste recycling sites in Guiyu, China (Kiddee, Naidu, & Wong, 2013; Zheng et al., 2013), perceived as the largest e-waste dumpsite in the world (Greenpeace East Asia, 2012).

E-waste pollution does not just affect humans and animals that live near e-waste disposal sites. In 2009, Robinson's heavily cited research[7] found that e-waste may potentially "affect the whole of humanity" (p.189) by hazardous and bio-accumulative chemicals entering the food chain, due to the possibility (or probability) of soil contamination affecting exported food sources. Figure 2.1 shows the fluxes of contaminants during e-waste recycling processes, particularly the effect of low-tech recycling and inappropriate disposal techniques, such as the dumping and burning of e-waste in the developing world (see Figure 2.2 for example of this practice). However, soil leachate issues may not be isolated to developing countries. Developed countries also have landfills which are not currently, or have not historically, been appropriately managed. For example, Thomsen, Milosevic, and Bjerg (2012) found that approximately 675,000 sites across Europe may be contaminated due to innappropritate handling of municipal waste including e-waste, such as the use of poorly lined, or even unlined, landfills. They found that in Denmark alone, 2000 landfill sites were found without liners or leachate collection, with

[7] Robinson's 2009 work *E-waste: an assessment of global production and environmental impacts* had been cited over 1074 times on 3 October 2018 according to Google Scholar.

a number of these sites located close to streams and wetlands, contamination of which can pose an threat to human health (see Figure 2.1) .

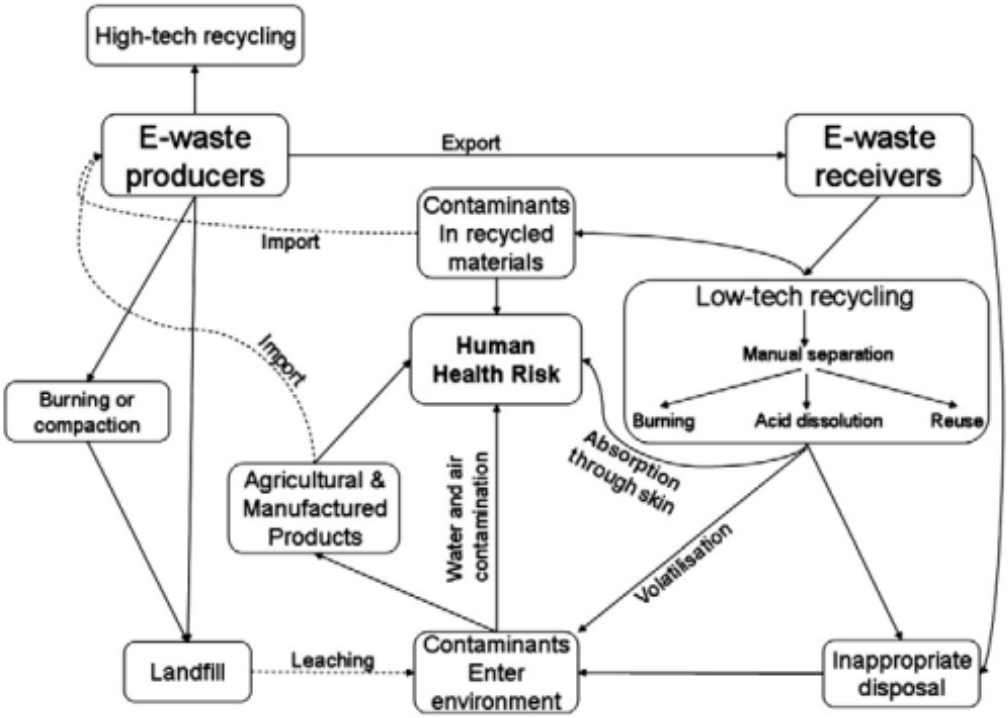



*Figure 2.1 Fluxes of contaminants associated with e-waste from producers to receivers and ultimately to humans. (Source: Robinson, 2009, p.189)*

*Figure 2.2 Children burn the plastic casings of e-waste in Accra, Ghana, to access the precious metals inside (Source: Curtis, S. (2011). Ghana slum faces growing e-waste problem. Retrieved from http://www.techweekeurope.co.uk/ workspace/ghana-slum- faces)*

## 2.3 Current Management Practices

Currently recycling is one of the most commonly available e-waste management techniques (Baldé et al., 2017; Kiddee, Naidu, & Wong, 2013; Ladou & Lovegrove, 2008). However, the quality of these techniques vary, beginning at rudimentary scavenging, where up to 90% of global e-waste recycling may sit (Nichols, 2015), through to high standard approaches such as those adopted in the EU (European Parliament and the Council of the European Union, 2012). While e-waste management can be considered at all levels of the waste hierarchy (excluding treatment) (see Figure 2.3), recycling is currently the predominant management technique after reuse. However, it has been found that 'reuse' has been used as a guise for the transboundary shipment of hazardous waste causing detrimental effects on underdeveloped countries (i.e. EOL EEE is being exported citing reuse) (Kutz, 2006; Mehta et al., 2015), so is perhaps not as effective at diverting e-waste from landfill as it is for other forms of waste.

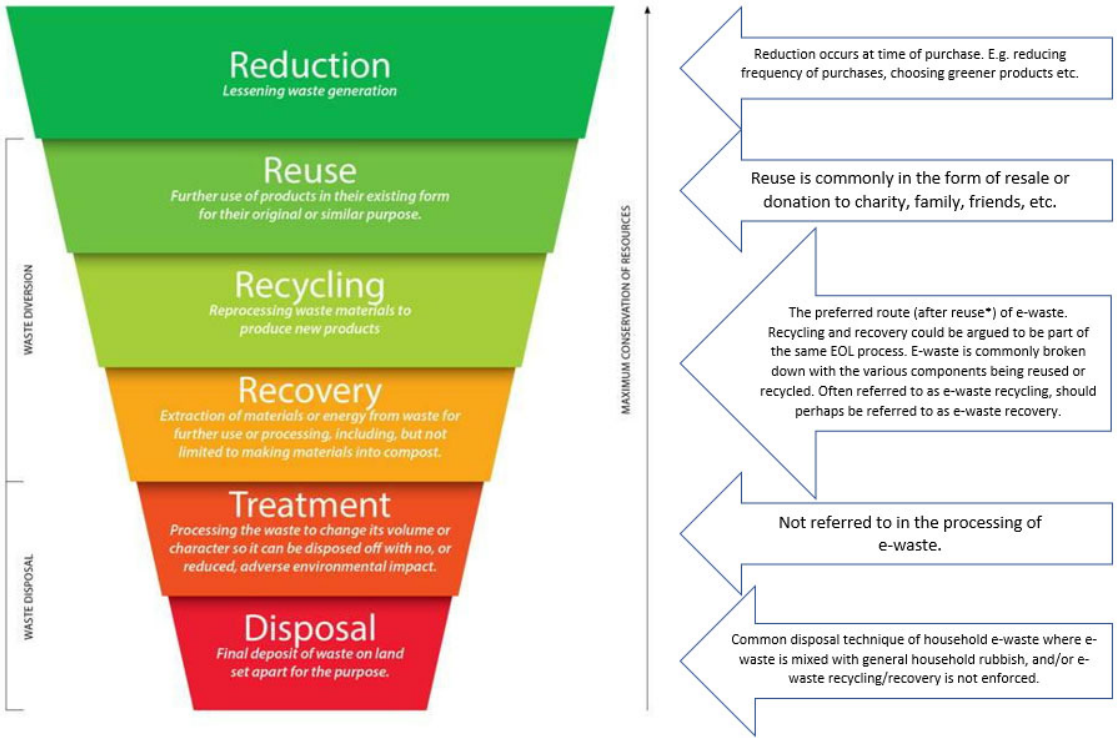



*Figure 2.3 The 'Waste Hierarchy' and its relationship with e-waste. (Source: Image adapted from https://greenerneighbourhoods.net/resources/waste/)*

Due to the nature of consumerism and obsolescence, and the literature related to e-waste growth, waste reduction is unlikely to have the required impact in the current e-waste

environment, as waste reduction would require a reduction in consumption, which would require a significant cultural shift away from a consumerist society that is currently unrealistic. However, e-waste recycling and circular economy principles have the potential to manage the current e-waste issue by ensuring that materials stay in the resource cycle and are not landfilled, hence this focus of discussion here and as a management technique in Section 2.5.

Most e-waste items, but in particular EOL notebooks, tablets, desktop computers, servers, and smartphones, have a measure of value due to the high content of metals such as gold, silver, palladium, platinum, cobalt, and copper (Figure 2.4; Cucchiella et al., 2015; Kiddee, Naidu, & Wong, 2013). The recovery of these materials can offset the use of virgin resources being mined for the manufacturing of new EEE. This recovery approach could have significant environmental (Dudka, & Adriano, 1997; Ogola, Mitullah & Omulo, 2002; Thornton, 1996) and economic impacts (Saphores, Ogunstein, & Shapiro, 2012). Despite the holistic value proposition of e-waste recycling (see Section 2.5), in reality very little e-waste is recycled. Saphores, Ogunstein, and Shapiro (2012) found that in 2007, only 18% of computer and TV products and only 10% of cell phones were recycled in the US. However, in the EU, where there is significant policy relating to e-waste management, recycling rates were much higher "ranging from 60% to 90% depending on the product category" (Saphores, Ogunstein, & Shapiro, 2012, p. 50). More recent figures show that globally only 12.5% of generated e-waste is recycled each year (Jaiswal et al., 2015), with the remainder landfilled, incinerated, or exported to developing countries, where, as previously mentioned, the recycling processes are generally sub-standard (Ansari et al., 2010).

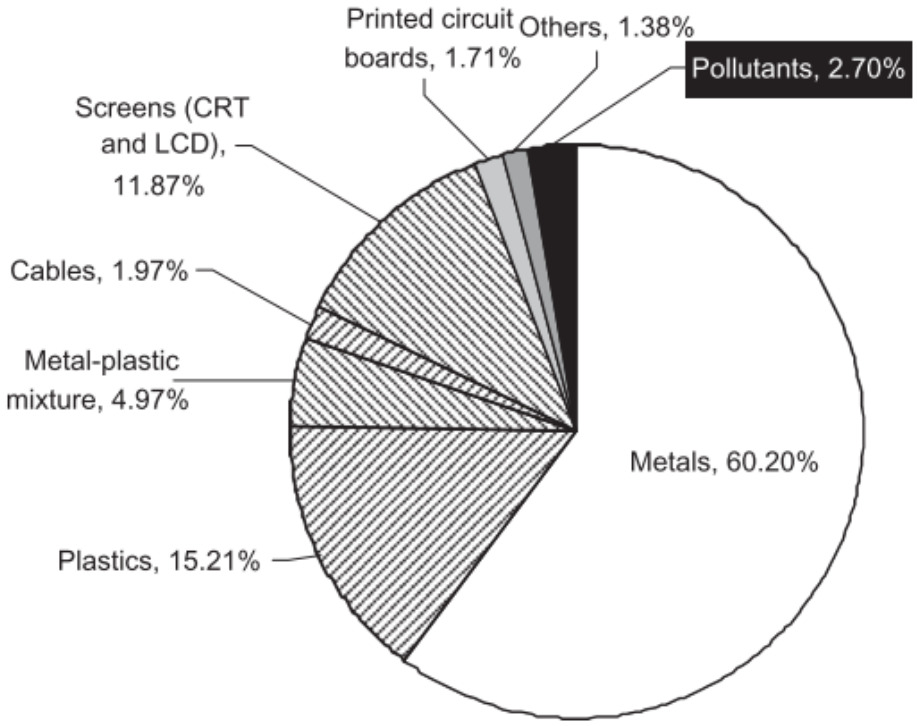



*Figure 2.4 An example of the typical material fraction in WEEE (Source: Empa, 2005, as cited by Widmer et al. 2005, p. 445)*

While most researchers agree that a reduced environmental footprint is created by recycling e-waste, these benefits are challenging and complex to realise in practice. For example, some researchers point out that the embedded nature of the materials, particularly in printed circuit boards (PCBs) and screens, can be difficult to extract during the recycling process (Cucchiella et al., 2015; Kiddee, Naidu, & Wong, 2013). These difficulties may lead to inappropriate recycling methods, specifically those observed in developing countries where acid and incineration is used to dissolve plastic to retrieve valuable metals (see Figure 2.2; Mehta et al., 2015; Robinson, 2009). These practices can have negative environmental and health effects as discussed in Section 2.2. Kiddee, Naidu, and Wong (2013) argue that some of the world's largest e-waste recycling sites found in China, South Africa, India, Ghana, and Pakistan emit extensive amounts of pollution from the recycling process, and while prohibited by the Basel Convention, a large amount of the world's e-waste is shipped to these regions (Widmer et al., 2005), often deliberately and illegally classified as "used goods" in order to avoid the costs of

legitimate recycling. The US alone exported 14.4 million used electronic products in 2010 to Asia, Africa, and Latin America (Duan et al., 2013).

This movement of e-waste, to developing countries, contravenes the Basel Convention, an international treaty ratified by 186 nations including NZ, but of which the US is significantly not one. The Basel Convention prohibits the transboundary movements of hazardous substances such as e-waste, from one state or nation to another (UNEP, n.d.). Internationally, nations are at various stages of introducing policy to manage transboundary flows of e-waste. The *Global E-Waste Monitor* (Baldé et al., 2015) shows that of the 185 countries identified, only 28.1% have regulation in place relating to e-waste management practices. Figure 2.5 shows, by continent, what percentage of countries had adopted e-waste regulation by 2013. Europe leads the way with 87.2% of its countries enforcing some kind of e-waste regulation, however Africa and Oceania are weakest with 5.8% and 8.3% respectively, indicating little to no e-waste regulation. Furthermore, of the 10 largest nations by population (China, India, US, Indonesia, Brazil, Pakistan, Nigeria, Bangladesh, Russia and Mexico; Miniwatts Marketing Group, 2017), only China and Nigeria have e-waste regulation in place (Baldé et al., 2015). This lack of robust and enforced environmental policy, both internationally, and nationally (the impacts in the NZ context are discussed further in Chapter 3), has a negative impact on the appropriate management of e-waste globally.

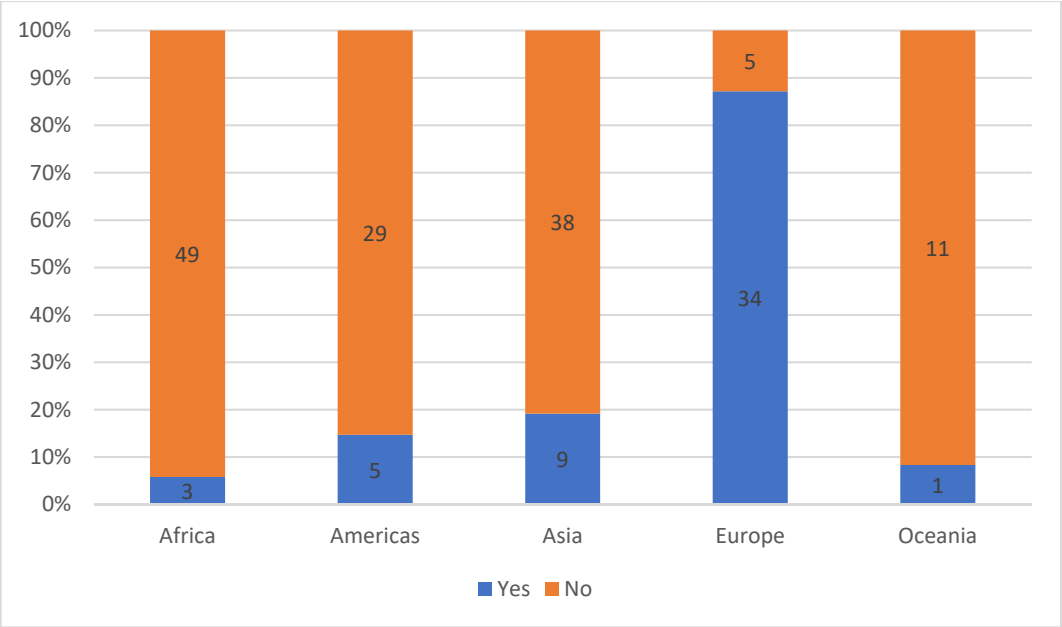



*Figure 2.5 Percentage of countries with e-waste regulation in force up to 2013 by continent - numbers indicate the number of countries with or without e-waste regulation (Source: Adapted from Baldé et al., 2015, pp. 62–67)*

## 2.4 Other Impacts

E-waste management is impacted by regulation, politics, and economics in various ways. Firstly, the resource value of the materials found in e-waste can fully or partially fund the recycling process and, more broadly, potentially provide a driver for economic development (Cucchiella et al., 2015). However, due to a concerning combination of a current lack of effective regulation; a lack of recycling sector training and occupational health and safety; and inappropriate/inadequate recycling methods and technologies, this economic opportunity is undermined (Cucchiella et al., 2015; Kiddee, Naidu, & Wong, 2013). This issue is most acute, and of particular concern, in developing countries (Kiddee, Naidu, & Wong, 2013). Secondly, the national and global economic and market environments can impact the success of environmental policies. The resources recovered from e-waste recycling programmes are traded on international commodity markets and these markets can fluctuate wildly according to a range of external factors. The economic benefits and possibilities of e-waste recycling programmes, are discussed in Section 2.5.

While e-waste is constituted of valuable resources which could be harnessed to boost economies and reduce environmental degradation (see Section 2.2), there are financial (as well as environmental and social) costs associated with e-waste disposal. Landfilling, for example, is a cheap way to manage e-waste which explains why this method of disposal is most commonly used (Kiddee, Naidu, & Wong, 2013), particularly in under-regulated countries. For example, in NZ, the national levy cost to dispose of waste to landfill is only $10/tonne (Ministry for the Environment, n.d.a), though there has been a recent proposal to increase this rate. Currently there is no legislation in NZ preventing the disposal of e-waste in landfill. Appendix 1.1 illustrates the recycling charges for e-waste in the Whangarei District, largely based on covering the cost to recycle, where, for example, the cost to recycle one cathode ray tube (CRT) TV is $26. Kiddee, Naidu, and Wong (2013) found that while the international community gains awareness of and moves towards principles such as zero waste and a circular economy (Ellen Macarthur Foundation, 2018; ISWA, 2017; Zaman, 2015), in practice landfills and illegal dump sites are increasing in the developed and developing world. Landfilling of e-waste, while cheaper for domestic and commercial waste disposal, can contribute significantly to toxic substances reaching the wider ecosystem (see Section 2.2; Kiddee, Naidu, & Wong, 2013; Robinson, 2009). The social, environmental, and economic costs associated with appropriate e-waste disposal generally sit with municipalities and consumers, as opposed to product producers, particularly in areas where appropriate national and local government policies are absent.

The cost of appropriate disposal could be managed by extended producer responsibility (EPR) (see Section 2.5.1), however the economic environment can prevent countries from adopting EPR policies. For example, trade and competition concerns, difficulty implementing fees, understanding of full-cost recovery systems, and difficulty in assessing cost effectiveness of systems (OECD, 2014), all have an impact on the implementation and design of environmental policy. Furthermore, the political environment can affect whether environmental policy is adopted or enforced. For example, the NZ Ministry for the Environment (MFE) recently used a

'lack of data' as an argument against prioritising e-waste as a waste stream, and therefore enforcing product stewardship schemes (see: Chapter 3; SLR Consulting NZ Ltd., 2015).

## 2.5 What are the Solutions?

Due to the significant impacts of e-waste, its management is of crucial importance. There are several possible solutions to the management of e-waste when it reaches the end of its useful life. While waste reduction principles are not discussed specifically here, there are several possible waste reduction techniques that could be applied, including reduction in consumer consumption, and better design which reduces obsolescence factors (Gurauskienė, 2008; Hamilton, 2010; Kutz, 2006). However due to the current constraints on reduction principles, particularly consumption stemming from the consumerist societal values, solution focus is generally put on methods of e-waste management by governments and municipalities. Solutions include EPR, economic instruments, and recycling services, such as those already commonly in use, or that could be adopted more widely across the globe.

### 2.5.1 Product Stewardship and E-waste Prioritisation

A tool that can be utilised for the management of e-waste is EPR (see for example: Table 2.3; European Parliament and the Council of the European Union, 2012). EPR is the concept that the responsibility for the entire lifecycle of a product should sit with the producers, including, and perhaps most importantly, the EOL stage (Lindhqvist, 2000, as cited by Khetriwal, Kraeuchi, & Widmer, 2009). However, as illustrated in Figure 2.6, EPR begins with the regulatory prioritisation of e-waste, whereby product stewardship is introduced by way of government initiatives including the design, operation and financing of programmes that divert waste from landfill, and into a circular economy. Currently, as discussed in Chapter 3, the NZ government has the ability to enforce product stewardship for priority products, via the Waste Minimisation Act 2008 (WMA) but at the time of writing has not yet declared any products a priority under this legislative clause. There is, however, some discussion relating to end-of-life tyres (Tyrewise, 2018).

*Table 2.3 Some e-waste management approaches to EPR (not including EU Directives) (Sources: Kiddee, Naidu, & Wong, 2013; Yu, Williams, Ju, & Shao, 2010)*

| Country | Policy | Target (where applicable) |
|---|---|---|
| The Netherlands | Take back (large household and IT equipment) | Recycling rate 45 – 75% by weight |
| United Kingdom | Take back (electronic appliances) | Recycle and recovery 50 – 80% |
| Germany | Take back (electronic appliances) | |
| Switzerland | Takeback (electronic appliances)<br>Disposal ban in landfill<br>Advance Recycling Fee | |
| Japan | Take back (four large household appliances: TVs, refrigerators, air conditioners, and washing machines) | Recycling rate 50 – 60% by weight |
| | Product re-design (lead free solders and bromine free printed circuit boards) | |
| United States | Take back household appliances in some states, such as Maine (take back only TVs and computer monitors) | |
| Canada | Takeback household appliances in some provinces including Alberta and Ontario<br>Develop advanced EPR programme | |
| India | Feasibility Study | |
| Thailand | Developing legal framework | |
| China | Regulation on management of recycling and disposal of WEEE<br>Circular economy law | |

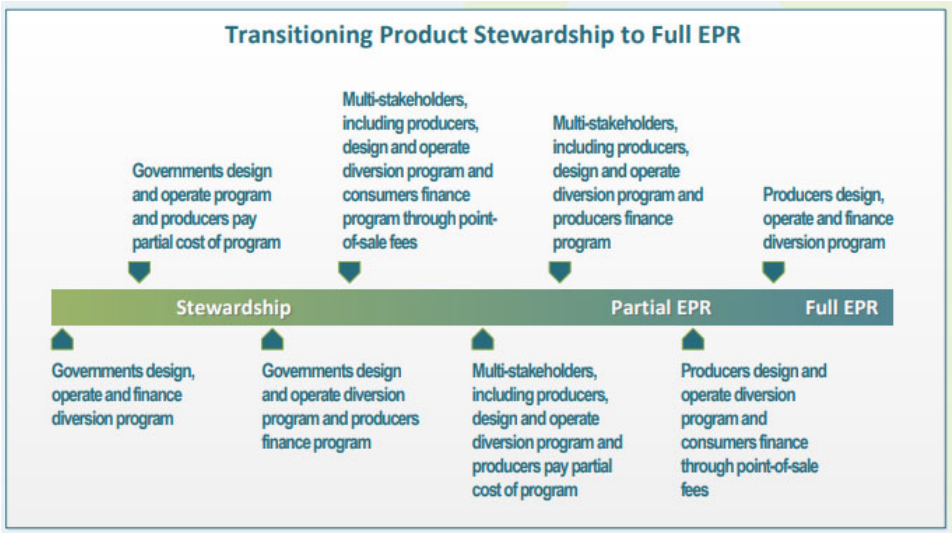



*Figure 2.6 The transition from product stewardship to full EPR (Source: EPR Canada, 2017, p, 2)*

Full EPR expects that all responsibility for reclaiming or disposal of the product should sit with producers, and not with the consumer or the government (see Figure 2.6). While full EPR would impact on how EOL e-waste is dealt with, it would also affect the beginning of the EEE

lifecycle, the design phase (Li, Liu, Ren, Duan & Zheng, 2012; Jang & Kim, 2010; Kiddee, Naidu, & Wong, 2013). As EPR puts the complete onus on the producer for EOL responsibilities, producers begin to focus more on the circular economy model (see Figure 2.7), where the resources used in the life cycle of a product can re-enter the resource stream at EOL (Braungart & McDonough, 2008; Ellen Macarthur Foundation. 2018). This may also impact on the reduction of planned obsolescence or 'death dating' as discussed in Section 1.1.2. Some countries, such as Japan, the US (some states only), and members of the EU, have introduced policy that principally follows the EPR concept (Table 2.3; Dwivedy & Mittal, 2013), but other countries, NZ included, have been slower to adopt the concept in regulation.

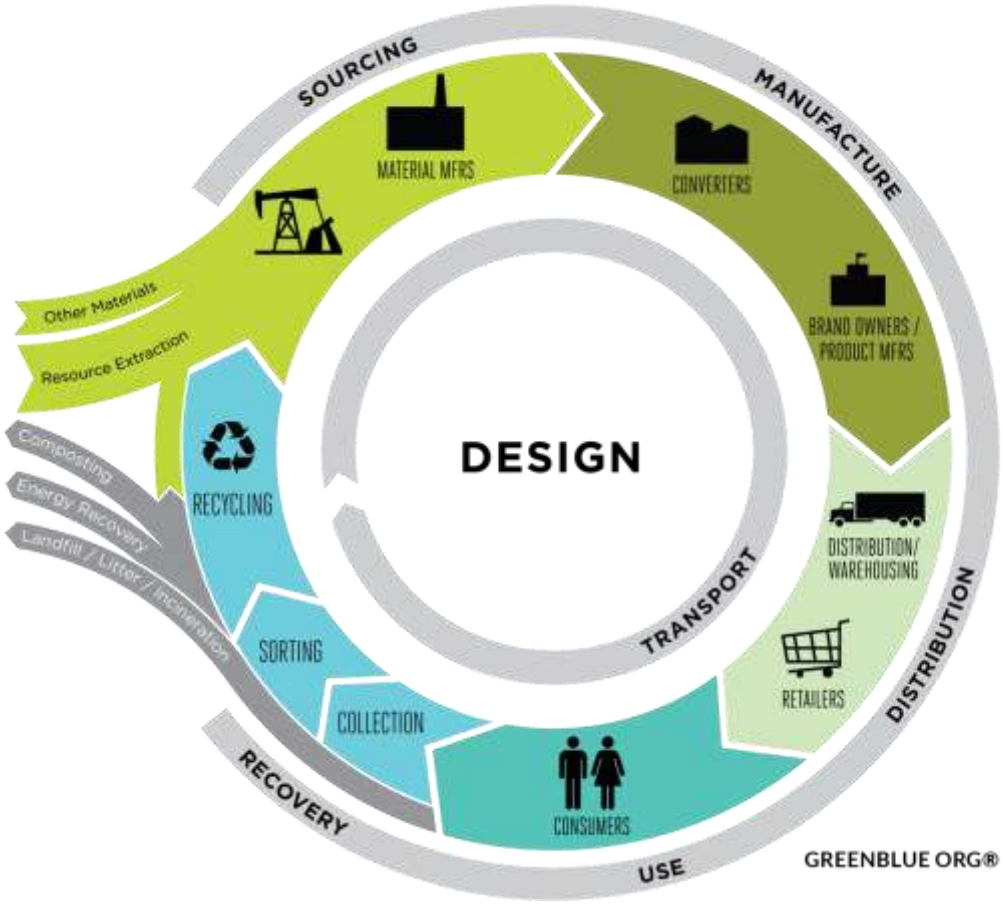



*Figure 2.7 The circular economy model (Source: Image retrieved from www.GreenBlue.org)*

The EU prioritised the e-waste waste stream in 1991 (Kiddee, Naidu, & Wong, 2013). Since then the EU has introduced two significant policies which embrace the EPR concept. The first of these policies is the EU WEEE Directive which came into force in 2003 with an aim to

increase the recycling or reuse of e-waste by creating collection schemes. In 2008, the Directive was revised "in order to tackle the fast-increasing waste stream" (European Commission, 2017, para. 5). The WEEE Directive categorises e-waste into ten categories (see Table 1.1) and has very specific guidelines regarding how each of these e-waste categories should be managed. These guidelines highlight significant responsibilities for the e-waste producers (Directive 2012/19/EU). The second policy, the Restriction of Hazardous Substances (RoHS) Directive, focuses more on the design of EEE products, and restricts the use of various hazardous materials, such as lead (Pb), mercury (Hg), and polybrominated diphenyl ethers (PBDE) (European Commission, 2017). The aforementioned EU Directives have had a significant impact on how e-waste is managed in European countries, the former as a mandatory targeted EPR and the latter, a command and control tool[8]. These policy approaches, combined with other management tools, see EU members leading the globe in e-waste management practices (Baxter & Gram-Hanssen, 2016).

### 2.5.2 Economic Instruments

There are several economic instruments that can be adopted to ensure the appropriate management of e-waste, and are often part of a product stewardship/EPR system. These include deposit refund systems, monthly recycling fees, and pay on disposal. Of these three tools, advance deposit refund systems (ADF), where a consumer pays a fee when they purchase a product which is returned when the EOL product is recycled or are applied to cover the recycling costs, are argued to be superior (Saphores, Ogunstein, & Shapiro, 2012). This is due to consumers being "less sensitive to product prices than to recycling fees" (Dwivedy & Mittal, 2013, p.65). For example, a consumer may be happy to pay an extra $25 on top of a purchase price of $2,519 for a 65" smart TV, rather than at the EOL where the joy of the purchase has now diminished. Dwivedy and Mittal found that incorporating ADF into take-back programmes "motivates and stimulates consumer participation in e-waste collection" (2013, p.65). Yu,

[8] A command and control tool is "the direct regulation of an industry or activity by legislation that states what is permitted and what is illegal" (McManus, 2006, p. 546).

Williams, Ju and Shao (2010) however raise the concern ‘orphaned’ products. Orphaned products are those that have not had a deposit allocated to them as they entered the market place before the instrument was utilised, where manufacturers are no longer in business, or where it is no longer cost effective to recycle particular products. A solution to this could be a centrally managed deposit system for all EEE products (see Kahhat, Kim, Xu, Allenby, & Williams, 2008), and due to the current and growing volume of EEE sales, ADF collected should cover the cost of the orphan legacy.

Figure 2.8 introduces two further economic instrument concepts: a monthly recycling fee, and the pay afterwards (pay on disposal) option. The monthly recycling fee is a concept where the local municipalities charge a fee to households and businesses to cover solid waste disposal costs including e-waste (Dwivedy & Mittal, 2013). Pay on disposal is self-explanatory and is found to be the least preferred economic instrument to manage e-waste disposal costs (Gurauskienė, 2008; Martin, Williams & Clark, 2006; Yu et al., 2010). Martin, Williams and Clark argue pay on disposal methods “often leads to increased fly tipping and illegal burning” (2006, p. 364). Further to this, consumers are becoming broadly aware of the fact that EOL EEE products, particularly tablets and mobile phones, hold some economic value. It is believed that an increasing number of consumers may expect to receive payment for their e-waste, regardless of the scheme in use (Baxter and Gram-Hanssen, 2016). Overall, it is important to consult the both consumers and producers before any scheme is implemented (Farrelly & Tucker, 2014; Martin, Williams & Clark, 2006).

### 2.5.3 Economic Possibilities

Gurauskiene (2008) noted that e-waste should not be considered waste but should be considered a resource. Significant economic benefits could be realised if all e-waste was recycled, rather than the 12.5% currently recycled annually. A steady stream of e-waste product entering a cradle-to-cradle (circular economy) cycle could ensure a reduction in resource mining, create jobs, decrease negative health impacts, and reduce the environmental impacts of inappropriate

disposal (Braungart & McDonough, 2008; ISWA, 2017; Kiddee, Naidu, & Wong, 2013). However, the net economic value only becomes apparent once the combined cost of collection, disassembly, recycling process, hazard mitigation, and waste treatment and disposal are accounted for (Baxter et al., 2016; Kiddee, Naidu, & Wong, 2013). Beyond just narrow economic considerations, it is clear that, holistically, the cost benefit equation of comprehensive, quality assured e-waste management (including resource recovery recovering materials) significantly outweighs "the negative consequences of irresponsible disposal" (Baxter et al., 2016, p. 17). Furthermore, having funding available to ensure robust and appropriate management practices can exist, has the potential to build local economies where recycling infrastructure is established.

### 2.5.4 Resources and Services

E-waste recycling services need to be convenient, affordable, and easy to use, to ensure consumer engagement (Darby & Obara, 2005). Currently, few countries have the infrastructure in place to deal with e-waste appropriately. However, a number of countries have services available for this purpose, particularly in EU countries, such as Sweden who is reported to have collected 78% of e-waste generated in 2013 (see Figure 2.9). Norway and Switzerland, who are not EU members but may benefit from systems and policies introduced by the EU Directive (European Parliament and the Council of the European Union, 2012), collected 72% and 60% of e-waste volume respectively in the same year (2013). Other countries are also illustrated in Figure 2.9, with varying levels of collection rates. However, this is not an exhaustive list, and more countries may also collect significant amounts of e-waste, including NZ, but no data could be located to be reported on the *Global E-Waste Monitor 2015* where this information is taken from (Baldé et al., 2015). This lack of data is of considerable concern and is discussed in more detail in Chapter 3.

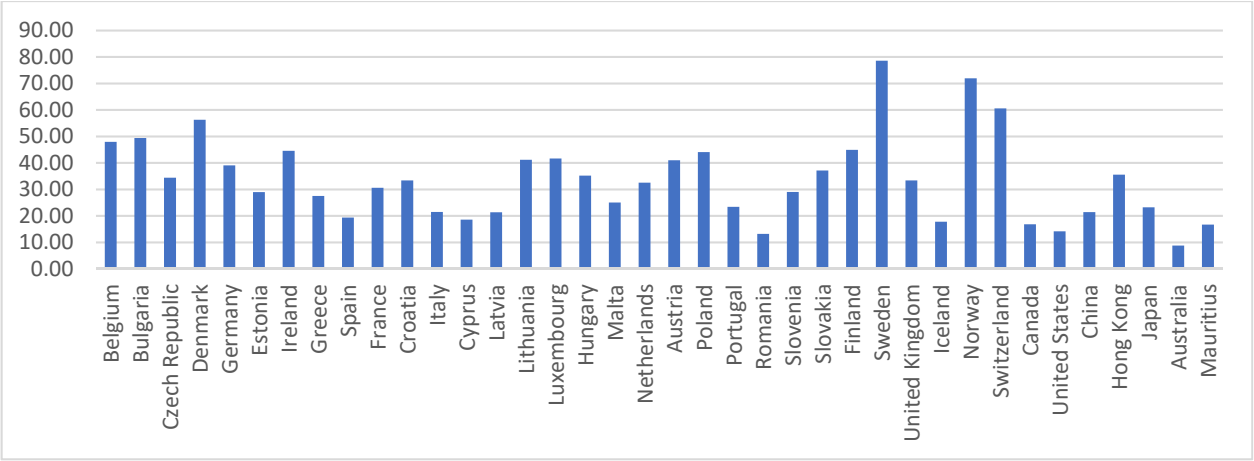



*Figure 2.8 Percentage of e-waste collected via official takeback systems versus e-waste generated per nation (Source: Adapted from Baldé et al., 2015)*

Recycling drop-offs, either to dedicated recycling centres or takeback schemes, is the most common e-waste collection method (Dwivedy & Mittal, 2013; Saphores, Ogunstein, & Shapiro, 2012). However, the international volume of commercial and domestic e-waste recycled is low (Cucchiella et al., 2015), and this low of volume e-waste collected at drop-off sites may lead to poor investment in infrastructure to treat e-waste appropriately (Cucchiella et al., 2015). "The reality is that recycling may not proceed exactly as intended in best practice" (Baxter et al., 2016, p.18) if required volumes are not met. Recyclers are taking a keen interest in legislation and education as it would be to their benefit to increase collection rates, particularly from private households (Gurauskienė, 2008), a significant contributor to e-waste volumes (Song et al., 2012). Ensuring consumers do what they say they will do is also a priority for environmental policy makers (Barr, Ford, & Gilg, 2003), and governments need to improve laws that deal with e-waste disposal, utilising an EPR framework, publicise any existing legislation, resources, and services, and enforce their use and application (Kutz, 2006; Saphores, Ogunstein, & Shapiro, 2012). For example, the banning of hazardous waste, including e-waste, from landfill, would force changes to current e-waste management behaviours by municipalities, and therefore consumer behaviours would also need to change. There are various reasons household consumers may be reluctant or unmotivated to engage in appropriate e-waste behaviours, such as e-waste recycling. These reasons are explored in Chapter 4.

## 2.6 Conclusion

This chapter aimed to give an overview of the e-waste problem and to work towards outlining the possible environmental, social and economic impacts of e-waste in Whangarei and NZ as whole. The chapter showed that e-waste is a significant concern due to its volume and the negative environmental, social and economic impacts it can create. If growth patterns continue the same trajectory, between 64.8 and 78.9 million tonnes of e-waste could be generated globally each year by 2020[9]. The continual growth of e-waste will mean continual increases in environmental and health impacts if appropriate e-waste management techniques are not adopted internationally. There are solutions available to manage e-waste appropriately, but they require commitment from government, producers, and consumers alike.

To further the e-waste inquiry, the following chapter analyses e-waste management in a NZ context. It investigates how e-waste is currently managed, what policy and recycling standard frameworks exists, and what non-government e-waste initiatives are currently active in the country. It then drills down into how e-waste is currently managed in the Whangarei District specifically. Understanding the resources and services available for e-waste management locally and nationally, and what engagement in these services look like, will allow recommendations to take place relating to the behaviour change of both the creators of these resources and services (such as central and local government), but also for those who engage in these services.

[9] Based on the StEP Initiative estimation of 59.3 million tonnes of e-waste generated by 2017 x a 3% increase per annum and a 10% increase per annum over three years to illustrate growth volume range as highlighted in Section 2.1.

# Chapter 3 – E-Waste Management in the Whangarei District and in New Zealand as a Whole

New Zealanders' common knowledge of e-waste and its impacts significantly increased in 2007 when the Computer Access NZ Trust (CANZ) began publicising their eDay e-waste collection. Since then the subject of e-waste has remained in the media, enjoying various degrees of attention, with the high point of public awareness of e-waste occurring around the time of the 'digital switch over'[10] in 2012 – 2013[11]. Contrary to media coverage however, little peer reviewed research has been conducted in the NZ e-waste space. Only four articles in total were located during a Massey University Library Discover search of scholarly journals that covered the 20 years from 1997 to 2017[12] (see: Helm, 2007; Hoeveler, 2008; Petridis, Stiakakis, Petridis & Dey, 2016; Robinson, 2006), none of which had a specific focus on the NZ context. Possibly for this reason, among others, a recent report indicated that the central government does not consider e-waste a significant enough threat to the health of New Zealanders or its environment to enforce compulsory product stewardship (see Section 9 of the WMA) (SLR Consulting NZ Limited. [SLR], 2015). In addition to media and journal articles, three significant reports have been authored on e-waste in NZ (see MacGibbon & Zwimpfer, 2006; Gertsakis, Hannon, MacGibbon, Nixon, Tripathi, Wilkinson, & Zwimpfer, 2011; SLR, 2015).

This chapter reflects on information provided in these reports alongside gathered resources and discusses the NZ 'e-waste scape'. The 'e-waste scape' is based on the term "wastescape", a term grounded in the work of Appadurai (1996, as cited by Farrelly & Tucker, 2014), which describes scapes as "cultural flows". Farrelly and Tucker (2014, p. 12) describe wastescapes as

[10] The 'digital switch over' occurred when analogue television broadcasting was discontinued in NZ and moved to digital transmission. The switchover was rolled out via region and began in September 2012 and concluded in December 2013 (freeviewnz.tv, n.d.).

[11] Confirmed by a Factiva search of e-waste media articles in NZ from 1997 to 2017. Some further media attention has occurred since this initial search was completed in late-2017 stemming from the release of Baldé et al.'s 2017 report.

[12] Scholarly (peer reviewed) journals were searched using the terms 'WEEE', 'e-waste', 'electronic waste', 'electrical waste', 'Aotearoa', and 'New Zealand'. Only articles that referred to e-waste in NZ were considered for this list. Unfiltered 112 articles were found.

"dynamic political, historical, economic, social, and environmental spaces where waste is culturally interpreted and mobilised … [that] … are informed and structured by groups and individuals and include those at regional, national, and global scales". For this research e-waste scape refers to the state of adaptation to appropriate e-waste management currently observed in the Whangarei District and in NZ as a whole. This chapter aims to provide context for the research outlined in this thesis, and is divided into two main sections, which builds on information presented in Chapter 2, in order to meet the first two of the aims of the research:

1. Identify the possible environmental, social and economic impacts of e-waste.
2. Identify the options (resources and services) available to Whangarei households for the disposal of e-waste.

Understanding the current e-waste scape in both locally and nationally will help to ascertain possible behaviours being exhibited by Whangarei households in relation to e-waste management. These possible behaviours are examined in Chapter 4, and combined with this and the previous chapter, will provide the basis for the research methodology.

## 3.1 E-waste Management in New Zealand

There are no formal methods of e-waste management in NZ. Product stewardship and EPR are not mandatory, however a number of voluntary schemes are currently in place. E-waste recycling is the most common management method considered appropriate for the managing of e-waste both internationally and in NZ, however, reliable data could not be located to determine how much of the total amount of e-waste produced in NZ is recycled and/or diverted from landfill. Similarly, it was not possible to determine how many e-waste recyclers were operating in NZ nor to what standard these operations were processing/recycling e-waste (see Section 3.1.4), due to a lack of regulation. This is a concern as, during research conducted for the Minister for the Environment, SLR (2015) found insufficient data to recommend e-waste be considered a priority product under Section 9 of the Waste Minimisation Act 2008 (WMA).

The WMA is a piece of NZ legislation that aims to encourage a reduction in the amount of waste generated and disposed of in the nation. This act stemmed from a Private Members Bill (Waste Minimisation [Solids] Bill), that was introduced to parliament by the NZ Green Party in May 2006 (Ministry for the Environment, n.d.b). The lack of data highlighted by the SLR report contravenes Part 6 of the WMA, which requires that records and information are provided to the Ministry for the Environment (MFE) Secretary by "any class of person" relating to the "progress in waste management and minimisation", "the state of NZ's environment", assessment of "performance in waste minimisation and decreasing waste disposal", and identification of "improvements needed in infrastructure for waste minimisation" (WMA, 2008, s86).

### 3.1.1 New Zealand E-waste Policy Framework

In their 2015 report, the United Nations University *Global E-Waste Monitor* estimated that NZ disposed of 19kg/inhabitant of e-waste in 2014 (Baldé et al., 2015). However, this figure had risen to 20.1kg per NZ resident in their 2017 report (Baldé et al., 2017). The 2015 report pointed out that most e-waste in NZ is going to landfill, and that e-waste is classed as a 'non-priority' waste stream, unlike its trans-Tasman counterpart, Australia, who has enforced product stewardship. The *E-waste Monitor* report found that there are not currently, nor have ever been, restrictions in place in NZ to prevent e-waste (as a hazardous waste stream) (see Chapter 2), entering landfills, due to lack of legislation and regulation to manage e-waste.

However, NZ does have a legislative framework which potentially enables the appropriate management of e-waste, as highlighted in Table 3.1. The main Acts of Parliament that relate to waste management are the WMA; the Resource Management Act 1991; and the Local Government Act 2002. Further to this, the NZ Waste Strategy 2010 (NZWS) outlines the two strategic waste goals of the current central government: to reduce the harmful effects of waste, and to improve the efficiency of resource use. NZ is also party to various supranational directives including the Basel Convention; the Noumea Convention; the Minimata Convention on Mercury (MFE, 2016); and the Rotterdam and Stockholm Conventions (Secretariat of the

Basel, Rotterdam and Stockholm Conventions, 2017), which are all relevant to the management of e-waste.

While NZ's legislation and policy has the tools to manage e-waste appropriately, it relies on data. Both the 2006 and 2007 OECD reviews raised concerns regarding the lack of data available to allow central government to set waste management targets (MFE, 2009). Ten years later, the OECD environmental review of NZ (2017) still observes that the collection of data relating to waste management in NZ could be improved, for the same purposes. While the WMA makes provision for compulsory and accredited product stewardship schemes for priority products (Parliament of NZ, 2008), to this date, no products have been declared as 'priority product' and any current product stewardship or recycling schemes for e-waste are voluntary (see Table 3.2). Gertsakis et al. (2011, p. 94) found that while some organisations did provide 'take-back' schemes[13] in NZ for household consumers, they were largely ineffective, as they were often inaccessible, particularly for consumers who reside outside municipal centres. These issues, and others relating to waste, have risen recently in NZ politics, with the Associate Environment Minister, Eugenie Sage, discussing the need to use the "tools in the Waste Minimisation Act" that were, in her opinion, inadequately adopted by the previous government (Sage, 2018, para. 15). At the launch of the Green Party waste strategy, Sage made specific reference to the requirements of broadening the waste levy, and the introduction of compulsory product stewardship schemes.

[13] A form of product stewardship where producers 'take-back' electronic and electrical equipment at the end of the products useful life.

*Table 3.1 The NZ e-waste scape: key national waste management policy documents, legislation, non-governmental initiatives, and supranational waste directives (Sources: Farrelly & Tucker, 2014, p.13; MFE, n.d.)*

| **Governmental Initiatives** | **Key Details** |
|---|---|
| Resource Management Act (1991) | Addresses waste management through controls on the environmental effects of waste management facilities through local policy, plans and consent procedures. In 2004, new environmental standards introduced into the Act included improvements in the standards of landfills (e.g. requirements for large landfills to collect and destroy greenhouse gas emissions) |
| Waste Minimisation Act (2008) | • Levy imposed on all waste sent to landfill<br>• Clarification of role of territorial authorities regarding waste minimisation<br>• Promotes product stewardship schemes with the opportunity to define priority products for compulsory schemes<br>• Imposes some mandatory waste reporting<br>• The establishment of a Waste Advisory Board |
| New Zealand Waste Strategy (2010) | Aims to reduce the harmful effects of waste and to improve the efficiency of resource use |
| Local Government Act (2002) | Includes a requirement for territorial authorities to complete their own Waste Management Plans. |
| Ministry for the Environment Community Environment Fund | Funds projects that support partnerships between parties and increase community-based advice, educational opportunities, and public awareness on environmental issues. |
| Ministry for the Environment Waste Minimisation Fund | Funds projects that promote or achieve waste minimisation. By supporting these projects, the fund increases resource efficiency, reuse, recovery and recycling and decreases waste to landfill. |
| **Non-Governmental Initiatives** | **Key Details** |
| eDay New Zealand Trust (2010) | • Replaced Computer Access New Zealand Trust (CANZ) (1999)<br>• Promotes best practice e-waste collection and recycling<br>• Promotes education initiatives and e-waste awareness<br>• Ran annual e-waste collection days (eDay) in main centres from 2007 - 2010 |
| The Zero Waste New Zealand Trust (1997) | • Promotes zero waste in schools, businesses, councils and households<br>• Acts as a funding manager, distributing funds sources from The Tindall Foundation, Community Employment Group (CEG), and the Sustainable Management Fund to over 300 community groups, schools, etc. |
| Zero Waste Network (2017) | • Replaced Community Recycling Network (CRN) (2006)<br>• Represents community enterprises focused on zero waste with members from Northland (CBEC – Community Business & Environment Centre) to Southland |
| **Relevant Supranational Waste Directives** | **Key Details** |
| Basel Convention (1989, NZ ratified 1994) | Promotes<br>• The reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal<br>• The restriction of transboundary movements of hazardous materials except where it is perceived to be in accordance with the principles of environmentally sound management; and a regulatory system applying to cases where transboundary movements are permissible. |
| Minimata Convention on Mercury (2013, not yet ratified) | This convention addresses issues relating to the mining, movement, and emissions of mercury. It promotes:<br>• The protection of human health and the environment from mercury exposure<br>• Reducing mercury emissions from human activity |
| Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (Noumea Convention) (1986, NZ ratified 1990) | Aims to protect and manage the natural resources and environment of the South Pacific region from polluting and dumping. Also discusses the storage of toxic and hazardous wastes |

*Table 3.2 Current New Zealand consumer voluntary e-waste recycling methods/schemes (Sources: Fisher & Paykel Appliances Ltd, 2017; Gertsakis et al., 2011; Spark New Zealand, n.d.; Starship, 2017; TCF New Zealand, 2018; Two Degrees Mobile Limited, 2017; Vodafone, 2017; Whangarei District Council, n.d.)*

| Type of Disposal | Organisations | Product | Cost |
|---|---|---|---|
| Service Provider Take-Back Scheme | Spark<br>Vodafone<br>2 Degrees | Smart phones<br>Cell phones | No charge |
| Service Provider Trade-In Scheme | Spark<br>Vodafone<br>2 Degrees | Some smart phones | Consumer may be given credit or discount |
| Supplier Take-Back Scheme | Dell<br>HP<br>Apple | All products provided by supplier | No charge |
| Supplier Take-Back Scheme | Fisher & Paykel | Refrigerators and freezers<br>Any other e-waste (except computers and TVs) | No charge if collection includes a fridge or freezer |
| Supplier Trade-In Scheme | Dell | Any make of used computer or printer equipment when purchasing new from supplier | No charge |
| Drop-off Recycling | District Council Recycling Schemes | All e-waste | Most products will incur charges |
| Drop-off Recycling | e-Waste Recyclers | Most e-waste | Most products will incur charges |
| Drop-off Recycling | TCF New Zealand Re:Mobile Initiative | Smart phones<br>Cell phones | No charge – contribution made to charity |

### 3.1.2 E-waste Initiatives

There are several non-government organisations (NGOs) and initiatives in the e-waste scape in NZ, as outlined in Table 3.1[14]. The most prominent of NGOs in the e-waste space is the eDay NZ Trust which replaced CANZ in 2010 ("Computer Access New Zealand", 2009). From 2007 to 2010, CANZ was responsible for organising eDay: an annual collection day, funded by the MFE Waste Minimisation Fund (WMF), where household consumers could drop off their e-waste in main centres to be recycled free of charge. In their 2011 report, Gertsakis et al. claimed that the series of community based participatory eDays were very successful. The eDay NZ

[14] Table 3.1 outlines the most prominent NGOs in the e-waste space, does not provide an exhaustive list of NGOs with an interest in e-waste in NZ.

Trust stated participant numbers and drop-off volumes increased each year and estimated that 3,220 tonnes of e-waste was recycled over the four-year period (2010). However, despite these claims, Hoeveler (2008) found that the amount collected was barely 10% of the EEE imported over the same number of years.

2012 saw the introduction of another e-waste collection initiative the 'TV TakeBack' programme, which ran from 2012 to 2014 during the switch over from analogue to digital television. Collection hubs were set up throughout NZ, as move to digital television rendered a large number of CRT TVs obsolete, with at least 320,000 TVs expected to be collected during the campaign (MFE, 2013).

Further to the aforementioned programmes, Starship Hospital (Starship) in partnership with Re:Mobile, ran a mobile phone collection appeal as part of its fundraising activities from 2009 to 2014. Starship (2017) claimed that the scheme successfully diverted over 150 tonnes of e-waste from landfill, however this figure could not be confirmed. Starship discontinued fundraising in this way in 2015, citing both the diminishing supply and the diminishing value of phones. Starship stated that from their experience "people are holding onto new smartphones for longer, selling them, or passing them on to family and friends" (2017, para, 2), and therefore collection was no longer an effective fundraising technique. However, the Re:Mobile initiative remained committed to the collection of cell and smart phones despite the conclusion of the partnership with Starship, and now works with a new charity partner, Sustainable Coastlines (TCF NZ, 2018).

Since the conclusion of these e-waste collection initiatives, excluding the Re:Mobile scheme, there have been no national schemes to promote the collection of e-waste. However, in 2011, then Minister for the Environment, Nick Smith, stated that the government would explore the possibility of a mandatory product stewardship scheme for e-waste (Radio New Zealand News, 2011). The outcome of this investigation did not recommend that e-waste was designated as a 'priority product' and therefore found that mandatory product stewardship was unnecessary (SLR, 2015), as there was insufficient data available to meet the requirements of the WMA for

this designation. This is not the first time this has been the outcome of proposals to prioritise waste streams in NZ (see for example Hannon, 2018).

### 3.1.3 Mandatory Product Stewardship and Data Implications

While mandatory product stewardship could ensure appropriate disposal of e-waste, a recent report by SLR (2015) found that "the level of robustness of NZ specific data for e-waste products is currently insufficient to satisfy the requirements of the priority product designation criteria". Farrelly and Tucker also found lack of data an issue during their research on the recycling behaviours of Palmerston North residents and suggested that "not only is more residential waste data needed…but also *the right kind of data* needs to be produced" (2014, p. 15). For e-waste to be prioritised under the WMA, significant data showing that e-waste "will or may cause significant harm" and "can be effectively managed under a product stewardship scheme" (WMA, 2008, s9) must become available.

As previously stated, current e-waste recycling schemes in NZ are voluntary, and international evidence that shows that small e-waste, in particular, is commonly mixed in with household waste at disposal (Baxter & Gram-Hanssen, 2016; Darby & Obara, 2005). In NZ, the majority of household waste is landfilled (MFE, 2007), and in 2011 the eDay NZ Trust estimated that approximately "80,000 tonnes of electrical and electronic waste [is] disposed of into landfills [each year] in NZ" (Gertsakis et al., 2011, p.10). However, if we consider the estimated e-waste volume generated by each NZ resident and the estimated rate of recycling of e-waste, the 2018 figure could be closer to 88,100 tonnes[15][16]. While this significant estimated growth rate of landfilled e-waste (10.1% in 7 years) is lower than estimated international e-waste growth rates

[15] Calculated as volume per resident 20.1kg (Baldé et al., 2017) x NZ population of 4,871,300 (NZ Stats estimate as at March 2018, 2018b) x 90% of e-waste likely landfilled (recycled e-waste max. 10%; Hoeveler, 2008).

[16] There are other ways of predicting e-waste generation rates including the market supply method (for example see: Jain & Sareen, 2006; Liu, Tanaka, & Matsui, 2006), however this would require the availability of NZ EEE importing, production, and sales rates.

(between 3 – 10% per annum; see Chapter 2), continual e-waste growth could impact NZ substantially.

### 3.1.4 Recycling Standards in New Zealand

E-waste recycling is not regulated in NZ. This means that where consumers may believe that they are acting in an environmentally responsible manner by taking their e-waste to recycling drop off centres, or having it collected from their homes, the recycling activity may actually have a comparably detrimental environmental and health impact to disposing of e-waste in landfills. Standards for e-waste recycling do exist in NZ. 2013 saw the updating of the *AS/NZS 5377:2013 collection, storage, transport and treatment of end-of-life electrical and electronic equipment* standard, which "provides guidance and specifies requirements for the safe and environmentally sound collection, storage, transport, and treatment of e-waste" (Standards NZ, 2013, para. 2). Interviews conducted during previous research undertaken by the author, found that reputable NZ e-waste recyclers are calling for this standard to become compulsory for e-waste recycling practices, especially in the absence of compulsory product stewardship (Blake, 2016). However, as this standard is itself a voluntary instrument, and is not monitored nor enforceable, less reputable recyclers are known to be stripping the valuable components of e-waste and landfilling the rest (Hoeveler, 2008). Both e-waste recyclers interviewed for previous research by the author (Blake, 2016), and scoping discussions undertaken for this research, found that inappropriate recycling methods are known to be happening in NZ, and are also likely in the Whangarei District.

## 3.2 E-waste management in the Whangarei District

In 2016, the Whangarei District disposed of 67,000 tonnes of waste. Of this total only 30% was diverted from landfill (Whangarei District Council [WDC], 2017a). Waste management services are offered primarily in the district by the WDC with approximately 75% of households using WDC services, and the remaining households utilising private waste management operators. As the main provider of services for household consumers, WDC offers three household waste

disposal options for waste in the district: kerbside recycling collection to all households for 1 and 2 grade plastics (PET and HDPE), glass, cardboard, paper, aluminium and cans; kerbside pick-up of WDC branded rubbish bags, or bags with WDC rubbish stickers; and a network of transfer stations where residents can drop off their waste (WDC, 2018). There is a transfer station within 15 kilometres of the homes of 90% of all Whangarei District residents (see Appendix 3.1 for map). Figure 3.1 shows the pathway of waste in the Whangarei District as illustrated in the 2012 Whangarei Waste Minimisation and Management Plan (WMMP), which is still relevant in 2018, with the exception of the more recent addition of Abilities Group who manage the recycling of 'SCREENS' (see Section 3.2.1). This flow chart implies that e-waste can be deposited in kerbside recycling, however this is not the case. E-waste must be dropped-off at Re:Sort or at one of the transfer stations.

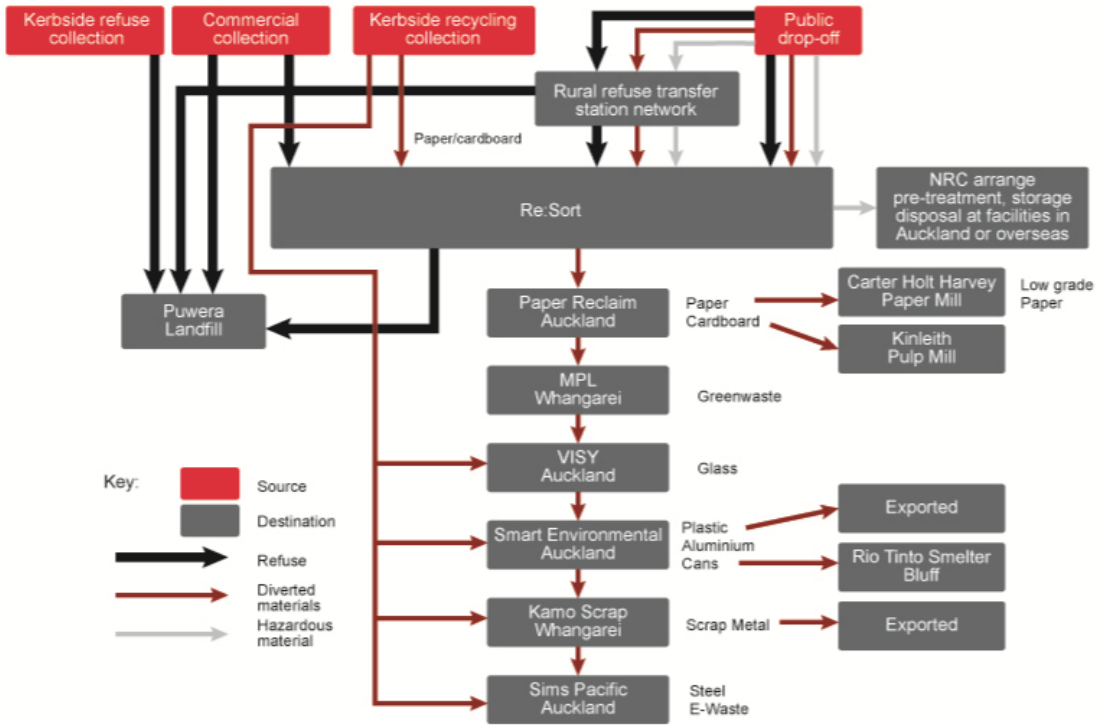



*Figure 3.1 Sources and destinations of refuse and diverted materials. (Whangarei District Council, 2012, p. 36)*

### 3.2.1 E-waste Services in the Whangarei District

Like the rest of NZ, e-waste management in the Whangarei District is voluntary, however recycling services are provided for by the WDC. Scoping conversations suggested there may

also be other "less reputable"[17] e-waste recycling services available, but this was not confirmed. Whangarei households are given access to e-waste recycling drop-off points, either utilising transfer stations, which are managed by Northland Waste (Northland Regional Council (NRC), n.d.), or Re:Sort, which is owned by Northland Regional Landfill Limited: a joint venture between WDC and Northland Waste. The e-waste recycling service is a user pays scheme. Appendix 1.1 highlights waste disposal costs in the Whangarei District. E-waste is charged at normal waste disposal prices with the exception of some whiteware which is free of charge, refrigerators and freezers at $7 to pay for degassing processes, and CRT TVs and monitors which have a cost of $26 each (WDC, n.d.). Once collected from drop-off stations, the 2012 WMMP indicated that e-waste items are transported to the Re:Sort centre, and then on to Sims Pacific Ltd. in Auckland for recycling (as indicated in Figures 3.1 and 3.2). However, information received for WDC via personal communication in early 2018 indicated that Abilities Group were now engaged to recycle 'SCREENS'. The Whangarei District e-waste management framework is more specifically defined in Figure 3.2.

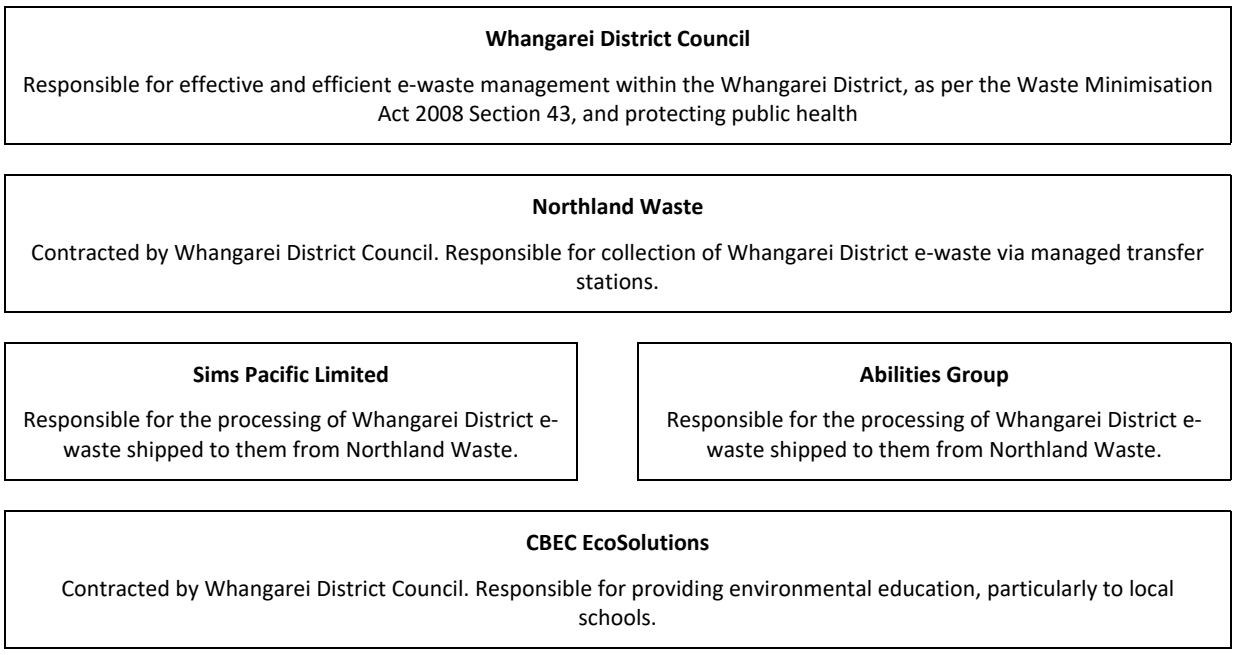



*Figure 3.2 Whangarei District e-waste management framework*

[17] 'Less reputable' e-waste recyclers are likely to strip e-waste for materials of value, such as copper, and landfill the rest.

Figure 3.2 illustrates that WDC utilise EcoSolutions as an environmental education provider to provide environmental education in the district, of which e-waste is a topic (CBEC, n.d.). Unfortunately, this programme is not currently available in all schools, and publications are not widely available to the public (i.e. distributed to households). Furthermore, very little publicity relating to appropriate disposal of e-waste in the district, other than simple information on the WDC and NRC websites (see: WDC, n.d.; NRC, n.d.), was found. This could have an impact on the household e-waste behaviours (see Chapter 4), and how much e-waste is being generated and/or recycled in the district.

Potentially over 1743 tonnes of e-waste is generated in Whangarei each year[18]. It is not known how much of this e-waste ends up in landfill, however, Table 3.3 illustrates figures provided from WDC[19] showing the volume of e-waste that is collected from transfer stations (including Re:Sort) and sent on to Abilities Group ('SCREENS'; screens including CRT, and smaller items), a new arrangement for WDC, and Sims Pacific ('E WASTE'; larger items), for recycling (WDC, personal communication, July 17, 2018). These figures show that in a 11-month period from June 2017 to April 2018[20], 16,860kgs of 'E WASTE' and 14,860kgs of 'SCREENS' were sent for recycling, representing only 1.8%[21] of the potential e-waste generated in the district. Furthermore, the figures provided by WDC did not clarify what proportion of the contained materials were recycled and what was landfilled during the recycling process, however Abilities Group advertise on their website that they are ISO9001[22] and Eco Warranty[23] certified and are part of the NZ Sustainable Business Network. Sims Pacific, however, make no such claims.

[18] Based on a 2017 estimated population of 86,754 (WDC, 2013a) and using the estimated annual e-waste rate of 20.1kg/person (Baldé et al., 2017).
[19] Received via email 16 July 2018 and used with written permission.
[20] E-waste is shipped to Abilities Group and Sims Pacific ad hoc when WDC feels there is enough collected to necessitate shipment hence the fluctuations in dates.
[21] 31.72 tonnes recycled annually / 1743 tonnes estimated annual volume of e-waste created in the district.
[22] see: https://www.iso.org/iso-9001-quality-management.html
[23] see: http://intlcert.com/eco-warranty/

*Table 3.3 E-waste sent for recycling from WDC managed processes. (Source: WDC, personal communication, July 17, 2018)*

| Date | TYPE | kg |
|---|---|---|
| 3/02/2018 | E WASTE | 3320 |
| 20/01/2018 | E WASTE | 1580 |
| 14/10/2017 | E WASTE | 4020 |
| 18/09/2017 | E WASTE | 3240 |
| 3/06/2017 | E WASTE | 2480 |
| 24/06/2017 | E WASTE | 2220 |
| **TOTAL** | | **16860** |
| 21/04/2018 | SCREENS | 1780 |
| 17/02/2018 | SCREENS | 2040 |
| 16/12/2017 | SCREENS | 2820 |
| 25/11/2017 | SCREENS | 3040 |
| 18/11/2017 | SCREENS | 2380 |
| 22/07/2017 | SCREENS | 2800 |
| **TOTAL** | | **14860** |

### 3.2.2 Whangarei District Waste Policies

Whangarei District has a Solid Waste Management Bylaw (SWMB), which discusses collection requirements, recycling, and the storage, separation, transfer and management of solid waste in the district, but does not include any specific stipulations relating to e-waste (WDC, 2013). The 2012 WDC WMMP discussed the recycling of electronic equipment, claiming that charges set "recover only part of the recycling and disposal costs" of processing e-waste in order to "incentivise appropriate disposal" (WDC, 2012, p. 40). During the study period, the replacement for the 2012 WMMP was being drafted. Concerns were raised during public meetings, part of the consultation process, about the lack of specific detail in the newly drafted WMMP, in particular around the lack of significant targets in relation to waste minimisation. Furthermore, there was no mention in the draft WMMP of e-waste management.

The 2012 WMMP included a recommendation from the Medical Officer of Health that central government be lobbied to introduce a levy on electronic products that require expensive disposal techniques[24] (WDC, 2012). There was no mention of the requirement for a local

[24] As stated in Chapter 2, the embedded nature of the materials, particularly in printed circuit boards and screens, can cause difficulties during recycling processes which can be expensive to conduct safely and appropriately.

government role in lobbying central government for action as a specific function of the WDC in the draft WMMP, nor was there any mention of continuing initiatives such as eDay in the district, another recommendation of the Medical Officer. However, after the conclusion of the consultation period, and possibly in part due to the author's hearing presentation (see Appendix 3.2), the term e-waste occurred six times (up from zero) in the 2017 WMMP, and special mention was made of "advocating for product stewardship schemes for challenging waste streams" which referred to e-waste specifically (WDC, 2017c, p. 40). Further to this, the new WMMP included an infrastructure action to "work with producers and importers to improve the management of hazardous waste, including providing options in the District for specific waste streams like e-waste" (WDC, 2017c, p. 23).

### 3.2.3 Illegal Disposal of E-waste

Another issue significant mentioned in the 2017 WMMP is illegal dumping, also known as fly-tipping. During the public meetings as part of the WMMP consultation process, WDC acknowledged that there are between 60 to 80 instances of illegal dumping in the district each month, approximately 70% of which is household waste, including e-waste, sometimes as large as refrigerators. Previous research conducted by the author (Blake, 2016) provided evidence of e-waste fly tipping in Whangarei, NZ (see Figure 3.3). The illegal dumping of e-waste is found across NZ, with recent media articles representing Rotorua, Palmerston North and Hamilton (see for example Guy, 2018; Leaman, 2015; Rankin, 2018). It is believed fly-tipping occurs when "perceived benefits exceed perceived costs", and where the services or infrastructure available has weaknesses, or the consumers are not aware of the impacts of inappropriate disposal (Webb, Marshall, Czarnomski, & Tilley, 2006, p. iii). This is supported by Martin, Williams and Clark (2006) who found that pay on disposal, Whangarei current option, leads to flytipping. While the 2017 WMMP discusses the issues with illegal dumping, and has some actions in place, most of the data collected considers volumes overall, and does not specify that the waste types that are included in each of the fly-tipping events should be reported.

*Figure 3.3 Two instances of fly-tipping witnessed in Parua Bay, Whangarei, NZ, both containing CRT TVs, October 2015. (Blake, 2016)*

## 3.3 Conclusion

There is some e-waste recycling happening in Whangarei. However, referring to the WDC data for the past year (see Table 3.3), and using the estimated rate of e-waste generated each year (Baldé et al, 2017), only 1.8% of the possible e-waste generated in the district each year is being recycled. If left unchecked, this may have a detrimental environmental, economic, and social impacts on both the district, and NZ as a whole. An issue preventing improvement in the way e-waste is managed in NZ is the lack of reliable data needed to enforce mandatory product stewardship. WDC also acknowledges there are issues with a lack of usable data. The 2017 WMMP states one of its policy actions as the formalisation of reporting requirements for licensed waste managers, as per the SWMB (WDC, 2017, p. 36). The literature surveyed for this study has shown no reports or commentary on the current state of e-waste management in Whangarei. Furthermore, no examples of district-wide education schemes on e-waste were located.

A review of the available literature pertaining to the NZ e-waste scape, and the e-waste scape of Whangarei, highlights a lack of e-waste data, specifically volumes of e-waste being disposed of, and the disposal method/s, and this lack of reliable data is preventing appropriate management of the waste stream (e.g. mandatory product stewardship and the enforcement of e-waste

recycling standards), not only in Whangarei, but in NZ as a whole. The overall aim of this research is to generate first-time data on Whangarei household e-waste options, knowledge and behaviours, in order to inform e-waste management policy, resources and services which could be specifically designed for the district. The research methodology for this study set out to obtain a set of complex data, derived from mixed methods, that investigated how households are disposing of e-waste, and why. Understanding both the how and the why of household disposal provides guidance to not only improve the way e-waste is managed, and therefore reduces the environmental, economic, and public health hazards associated with it (see Chapter 2), but may also help with message framing and information/education schemes (see Chapter 4).

The following chapter investigates household e-waste behaviours specifically, which, combined with the understanding of the Whangarei and wider NZ e-waste scapes, as laid out in this chapter, and the international e-waste scape as discussed in Chapter 2, will guide the research methodology. This chapter introduced the importance of enforcing national legislation in order for local government to have the frameworks to make the changes needed to improve e-waste management. It is hoped that, once data is collected, the research results should assist the WDC to make informed decisions on how best to manage household e-waste in their district without the national frameworks in place, and may contribute to national data sets to enable better systems of management of e-waste, and the adoption of the tools required that are already in place in legislation, to allow NZ to respond to, and adopt, international solutions and standards.

# Chapter 4 – Household E-waste Behaviours and Influences

Household consumers (householders) are significant contributors to e-waste volumes (Song, Wang, & Li, 2012). Australian based e-waste recycler, 1800ewaste, states that "80% of all e-waste created" is made up of household items (1800ewaste Pty Ltd, 2016, para. 2). This figure is supported by Widmer et al. (Widmer, Oswald-Krapf, Sinha-Khetriwal, Schnellmann, & Böni, 2005) who showed that in Western Europe almost 50% of all e-waste generated is small and large household appliances, with a further 47% made up of IT and telecommunication equipment, and consumer equipment (for a description of what is included in the e-waste groups see Table 2.1). Farrelly and Tucker (2014) believe the voice of householders needs to be heard and considered to ensure relevant and practical policies are generated, to manage this waste stream. Recycling is currently the most common option for e-waste disposal considered appropriate (see Chapters 2 and 3), and drop-off recycling services can be, and often are, provided to householders (see Chapter 2). However, understanding the attitudes of these consumers is crucial to ensuring engagement in these services (Barr, Ford, & Gilg, 2003; Dwivedy & Mittal, 2013; Martin, Williams, & Clark, 2006; Saphores, Ogunseitan, & Shapiro, 2012).

To meet aims 4 and 5 of the research (4. Identify the e-waste knowledge and behaviours of Whangarei household consumers, and factors influencing e-waste knowledge and behaviours; 5. Make recommendations based on the research for changes to e-waste policy that may improve the e-waste behaviours and knowledge of households in the Whangarei District), this chapter focuses on international literature relating to household e-waste recycling knowledge and behaviours, due to a lack of locally available literature available in this field (see Chapter 3). This literature will be applied to the localised case study, by informing the methodology and findings of the research. There is, however, some NZ based research on environmental behaviour change in its broader sense, and this will also be drawn upon. The chapter is broken into three main parts: the first reviews the literature relevant to general recycling behaviours and influences; the second presents literature relevant to consumer influences and behaviours

specifically relating to e-waste recycling, and includes discussion on consumer knowledge of the impacts of e-waste, particularly the environmental impacts; and the final section discusses other potential barriers to environmentally-sound behaviours, and provides a framework for overcoming these barriers. The findings of this chapter, combined with the previous chapters, will guide the methodology for this research (see Chapter 5).

## 4.1 Household Recycling Behaviours and Influences

Tonglet, Phillips, and Bates (2004) found that consumer attitudes to recycling are influenced firstly by access to, and knowledge of, resources and services; and secondly, by convenience. Barr et al. (2003) agree, stating that the householders involved in their 1999 questionnaire conducted in Exeter, Devon, UK, accepted recycling as a normative behaviour. However, Barr et al. also point out that there are a significant number of factors that influence the decision to recycle. They highlight the distinction between intention to recycle and actual recycling behaviour. The factors presented in Figure 4.1, show that convenience/effort is just one of many that create a gap between recycling intentions and consequent actions.

This gap between intention and action is known as the value-action gap (Blake, 1999), and could be explained by intrinsic factors such as motivation, knowledge, awareness, values, attitudes and priorities (Kollmuss & Agyeman, 2002). The value-action gap considers that while consumers may have the knowledge and understanding that, for instance, recycling is good for the environment, this may not necessarily translate into actual recycling behaviour. For example, in 1999, Waste Watch found, in a survey of 1000 UK household consumers (householders), that while up to 79% considered themselves environmentally conscious, only 41% recycled regularly, citing the main reasons they were not recycling as laziness (30%) and a lack of convenience (19%) (as cited by Evison & Read, 2001, p. 277). Cost can also be a significant factor affecting pro-environmental behaviours (for example see: Chapter 3; Fahy & Davies, 2007; Kollmuss & Agyeman, 2002; Rice, 2014). These findings imply that for householders to engage in recycling programmes, they must be convenient, cheap (or free), and easy to use.

Householder's perceptions of inconvenience and lack of time, and lack of knowledge, both environmental and relating to available services, are contributing to barriers in both recycling and waste minimisation behaviours (Tonglet et al., 2004). Perception of an activity versus the reality can be very different, particularly if the convenience, ease, cost, and availability of recycling is considered. Farrelly and Tucker believe that the gap between attitude and action involve "complex social factors" (2014, p. 14), such as sociodemographic and socioeconomic factors, rather than these perceptions or pro-environmental influences necessarily. Some of these factors can include age, gender, income, and level of formal education.

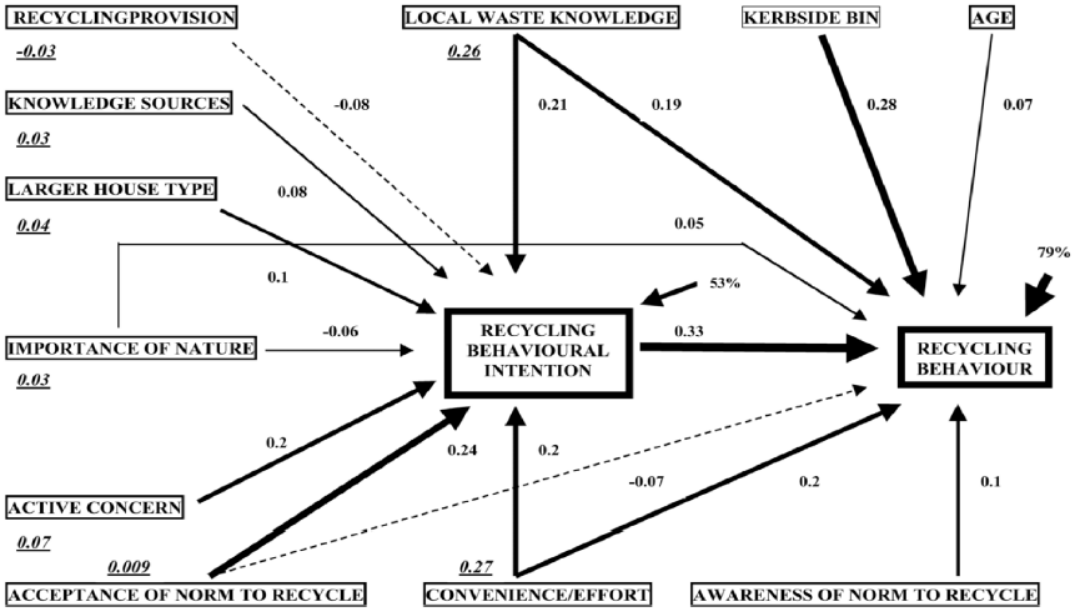



FIGURE 3. Path diagram of recycling behaviour. *Notes*: Arrows increase with size according to their predictive power. A dashed line indicates a negative relationship. Coefficients alongside arrows indicate the movement of one standard deviation unit in the dependent variable for a unit move in the independent variable. Coefficients adjacent to variable names in italics and underlined indicate the overall effect of that variable on recycling behaviour.

Figure 4.1 Barr et al.'s path diagram of recycling behaviour (Source: Barr et al., 2003, p. 413).

There is some disagreement among researchers relating to which of the sociodemographic factors affect environmental behaviours. Martin, Williams and Clark (2006) found that age, in particular, impacts recycling values and actions. For example, Williams and Kelly found the time rich lifestyle of older people allows them more time to recycle, where those in the 25 – 44 age group may be less inclined, "due to their familial commitments" (2003, as cited by Martin, Williams & Clark, 2006, p. 361). However, Coggins' 1994 Sheffield, UK-based research argues that young families were the most likely recyclers, due to pressure from their children (as cited by Martin, Williams & Clark, 2006). Further to age, Martin, Williams and Clark found gender

may also affect recycling behaviour. They found that in the UK, recycling was more likely to be a female task, as women are "more likely to be in charge of domestic waste management" (2006, p. 361). Hunter, Hatch, and Johnston, stated in their research into gender variation in environmental behaviours across 22 nations, that women tend to "display higher levels of environmental concern" than men, and are more "actively-engaged in household-oriented … pro-environment behaviours", such as recycling (2004, p. 677).

According to Schultz, Oskamp and Mainieri (1995), household income can play a more significant role in recycling behaviour than gender or age. They found lower income households were more likely to recycle than higher income households. Martin, Williams and Clark (2006), however, contradicts this finding, citing the research of four surveys conducted in the UK between 1999 and 2002 that found that recyclers were likely to be "better-off" (p. 361), indicating a higher income. In research into the political ecology of climate change governance, Rice (2014) stated that pro-environmental behaviours, such as reducing carbon footprint, may be exhibited by those that can "afford [to], both in time and financial resources" (p. 388). Rice found that lower socio-economic groups may be more concerned with "mak[ing] ends meet" (2014, p. 388) than being concerned with their personal carbon footprint, for example. Rice's finding implies that appropriate environmental action could be a privilege of the wealthy. This theory could be applied to recycling behaviour, in particular e-waste recycling which often has a cost involved and requires transportation to a drop-off point (see previous chapters). However, Darby and Obara (2005) found that higher income households generated more waste overall and lower income households tend to keep items for longer. This increase in waste creation could also explain the increase in recorded recycling amounts for higher income households.

Further to income, research has found that higher education levels may also contribute positively to recycling rates (Schultz et al., 1995), including the recycling of e-waste (Song et al., 2012). "Most authors agree that demographics are less important than knowledge, values and attitudes in explaining ecologically friendly behaviour" (Laroche et al., 2001, as cited by Dwivedy & Mittal, 2013, p. 51), such as recycling. Nonetheless, Baxter and Gram-Hanssen

(2016) found that environmental variables/values may play only a marginal role in whether householders participate in recycling programmes. While the arguments in relation to sociodemographic impacts on waste management are logical and considered, the contradictory nature of these findings highlights that more research into e-waste behaviour influences is still required.

Consumers generally understand that recycling is better for the environment as it reuses resources and reduces waste (Martin, Williams & Clark, 2006). However, Hamilton (2010) believes that in order for consumers to become more ecologically minded, and therefore exhibit environmentally conscious behaviours, society will need to recognise that humans are 'a part' of the natural eco-system and "not *apart* from it" (Cairns, 1999, p. 333). The New Ecological Paradigm (NEP) (Dunlap, Liere, Mertig, & Jones, 2000) is a scale that is often used in research of an environmental nature to ascertain survey respondents' environmental beliefs (for example see: Saphores, Ogunstein, & Shapiro, 2012), and investigates whether consumers hold an *exemptional*[25] or an *environmental*[26] view (Cairns, 1999). Understanding the environmental beliefs of householders could help to inform education programmes, and may help the with message framing, as understanding the environmental impact of not recycling has been shown to increase recycling rates (see: Saphores, Ogunstein, & Shapiro, 2012). For example, if NEP scale type questions were used, and the majority of survey respondents showed they tended towards the *exemptional* end of the scale, messages to engage householders in recycling behaviours may include more information relating to the technical requirements of the metals included in e-waste to re-enter the materials cycle (see: circular economy – Chapter 2), therefore giving technology the ability to solve the problem for 'us'. However, if survey results showed more *environmental* respondents, messages stating that by not engaging in recycling behaviours damage is being done to the environment (e.g. resource mining etc.), and that technology alone

[25]The idea that any problem created by technology can be resolved by technology (Cairns, 1999)

[26] The idea that human wellbeing is connected with the wellbeing of the natural environment (Cairns, 1999)

will not ‘save us’, may be more appropriate. Message framing can be a crucial factor for increasing engagement in e-waste recycling programmes (Baxter & Gram-Hanssen, 2016).

Message framing can be part of the “marketing approach” to pro-environmental behaviour change, where market segmentation[27] techniques are utilised to tailor messages that fit the values of the target market (WWF-UK). In 2008, WWF UK reported that while marketing approaches to pro-environmental behaviour change may be effective when promoting a specific change, such as a move toward e-waste recycling, “the evidence … suggests that such approaches may actually serve to defer, or even undermine, prospects for the more far-reaching and systemic behavioural changes that are needed” (WWF-UK, 2008, p. 5), such as the move away from consumerism/excessive consumption.

In NZ, recycling is the most common form of household pro-environmental behaviour. 90% of respondents in a 2008 survey stated that they recycle household waste (Hughey, Kerr & Cullen, 2008, as cited by Farrelly & Tucker, 2014). However, Farrelly and Tucker (2014) disputed this figure due to the self-reporting nature of the survey and argued that quantitative surveys alone are insufficient to determine recycling realities. This could also relate to the value-action gap, as highlighted in Figure 4.1, where the intention to recycle does not always equate in recycling behaviour. Darby and Obara (2002) found that if general household recycling behaviours are to be considered in relation to e-waste recycling behaviours, there are several aspects that are specific to e-waste that need to be considered to achieve robust e-waste management systems.

## 4.2 Household E-Waste Recycling Behaviours and Influences

Householders dispose of e-waste in various ways, often depending on product type. For example, Darby and Obara found, in their 2005 survey conducted in Devon, UK, that while a home stereo may be given away or sold, small e-waste items, such as electric toothbrushes, and

[27] Market segmentation is where the broader consumer market is broken into sub-groups dependant on some type of shared characteristics, such as household makeup, demographics, etc. therefore identifying the target market.

batteries, are often disposed of with general household waste. As discussed in Chapter 2, the most common method for collecting e-waste is drop-off recycling (Saphores, Ogunstein, & Shapiro, 2012), and this is also true for NZ (see Chapter 3). Drop-off recycling requires significantly more effort and commitment than kerbside recycling programmes. In addition to extra commitment, drop-off recycling often passes the financial cost of recycling and other externalities on to consumers, via recycling fees, which can be a considerable barrier to engaging in e-waste recycling practices (Dwivedy & Mittal, 2013), particularly if we consider income as a factor (see Section 4.1). Barr et al. (2002) believe that the role of service provision is vital to the success of a waste management programme, and that the services available for e-waste recycling must fit with the needs and behaviours of the household consumer.

There is considerable debate about the provision of e-waste recycling services, in particular how recycling services should be paid for (see: Chapter 2). This can be a significant barrier to engagement in e-waste recycling services both being supplied by municipalities and engaged in by householders, and could be resolved by EPR (see Chapter 3). The provision, or lack thereof, of e-waste recycling services, could be a direct reaction to consumer behaviour. Baxter and Gram-Hanssen (2016) found that the storage (rather than disposal) of e-waste in homes, garages, and personal storage units (for example), can have an impact on the availability of e-waste management services due to the reduction of available resources entering the 'resource cycle'[28]. There are various reasons that householders may store their e-waste, including data security concerns, and the need for a spare/back-up (Baxter et al., 2016; Baxter & Gram-Hanssen, 2016). Cell phones, in particular, are often kept by householders, rather than disposed of. For example, Ongondo and Williams (2011) found that up to 60% of EOL cell phones are sitting in cupboards and drawers in the UK alone. Stored e-waste is rarely used again (Baxter et al., 2016). If lifespans and market saturation[29] are considered, this means that, for NZ alone,

[28] See "circular economy", Chapter 2.
[29] Market saturation is how a product is distributed within a market (e.g. how many New Zealanders own a smart phone).

there could be approximately 752,000 EOL cell phones[30] sitting in drawers or cupboards in households throughout the country. Baxter and Gram-Hanssen (2016, p. 98) claim e-waste storage, also referred to as 'waste stockpiling', is considered a safe, environmentally neutral (neither damaging nor helping) at worst, option for EOL EEE products. However, the 'null' or 'do nothing' option may have a more detrimental environmental impact than realised by householders, particularly when resource-mining effects are considered (Baxter & Gram-Hanssen, 2016). Baxter et al. believe that if consumers were aware of the implications of stockpiling e-waste, such as the requirement for ongoing precious metal mining and therefore further environmental degradation, or low levels of recycled product entering the resource cycle reducing the recycling opportunities available to them, they "may be encouraged to recycle more" (2016, p. 25).

Perrin and Barton believe the key to increasing e-waste recycling rates starts with understanding influences, knowledge and behaviours of householders towards general recycling practices (2001, as cited by Martin, Williams & Clark, 2006). This information is particularly important when the intended outcome is the implementation of the best management practices for end-of-life (EOL) e-waste products. Saphores, Ogunstein, & Shapiro (2012) found that householders who undertake general recycling activities, such as kerbside recycling, are more likely to engage in e-waste recycling practices. However, there is a concern that householders do not commonly know the detrimental environmental impacts of e-waste. While consumers may be aware of the content of valuable materials in some e-waste (Baxter & Gram-Hanssen, 2016), Song et al. (2012) found during their research in Macau that many residents surveyed did not know what e-waste was and around 30% of respondents did not think that e-waste caused environmental harm. This again highlights the need for "more general education and information about the broader issues underlying waste management" (Martin, Williams & Clark, 2006, p. 366). To encourage more engagement in e-waste recycling, consumers need to be able to access

[30] Calculated as adult population 3.58M x market saturation 70% (Research New Zealand, 2014) x stored phones 60% / lifespan 2yrs (Table 2.1)

information to enable them to understand three core concepts: ‘waste = resources’; that there are advantages from any positive change in e-waste recycling behaviour including economic, community, health, and environmental benefits (Darby & Obara, 2005; Gurauskienė, 2008; Martin, Williams & Clark, 2006); and that there are negative consequences of not engaging in e-waste recycling behaviour.

## 4.3 Adaptation to E-waste Management

While international literature has looked at household consumer attitudes and behaviours in relation to e-waste, little research has been conducted which aligns consumer behaviours with specific ‘e-waste scapes’ (for example of the Whangarei and NZ e-waste scapes see Chapter 3), particularly the political aspect of these scapes. Therefore, some barriers to appropriate household management of e-waste may be overlooked. Moser, Ekstrom, and Kasperson, (2010) created a framework to diagnose barriers to climate change adaptation which could be applied to diagnosis of the barriers preventing appropriate e-waste management. There are two parts to the research of Moser, Ekstrom, and Kasperson that will be investigated here: the adaptation phases and stages; and the scope and scale of adaptation.

Moser, Ekstrom, and Kasperson (2010) show that the adaptation phases and subprocesses are a cycle (see Figure 4.2), and present this cycle as three phases, which must be approached in succession (i.e. you cannot move on to the next phase until the previous stage is successfully completed). The first is the ‘Understanding’ phase. During this phase, the problem is detected, information is gathered and then utilised to help (re)define the problem. The ‘Planning’ phase follows with options for resolution of the problem beginning to be developed and assessed. Once complete an option is selected. Finally, at the ‘Management’ phase, the selected option is implemented, monitored and evaluated. This is a simple problem-solving model that can be attributed to a problem of any nature. Presently, it could be argued that the international e-waste problem lies between the understanding and the planning stages, however various countries are

at various stages of appropriate e-waste management (see: Chapter 2; Baldé et al., 2015; Baldé et al., 2017).

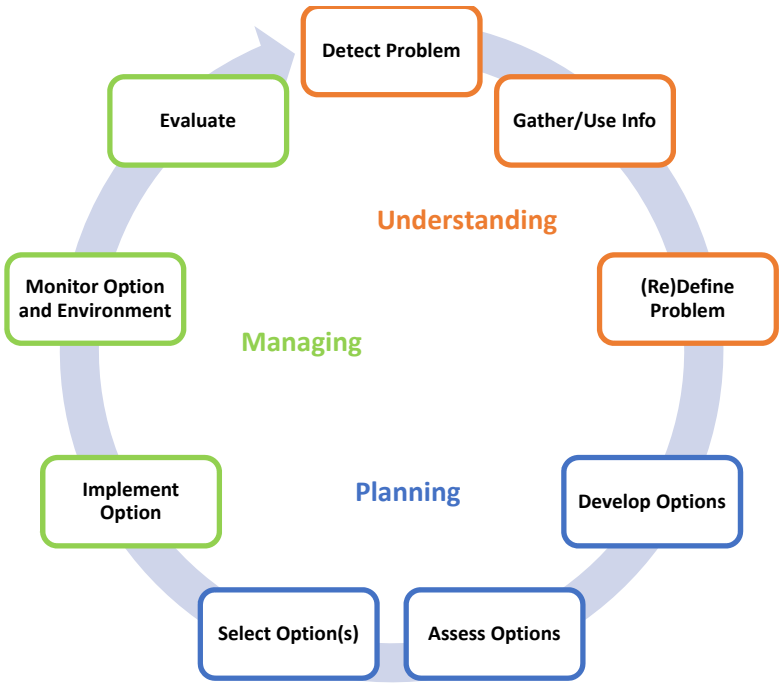



*Figure 4.2 Moser, Ekstrom and Kasperson's phases and subprocesses throughout the adaptation process. (Source: Moser, Ekstrom, & Kasperson, 2010, p. 22027)*

After investigation of the above process, Moser, Ekstrom, and Kasperson discovered that there are structural elements to this framework which influence the outcome (see Figure 4.3), specifically the "interacting actors, the governance and larger socio-economic context, and the system of concern" (2010, p. 22028). In the case of this research, the system of concern would be appropriate e-waste management. Moser, Ekstrom, and Kasperson (2010, p. 22028) found that "a lack of high level leadership [for example] could undermine the capacity and willingness" to make the required decisions to impact the system of concern (i.e. appropriate e-waste management). They also observed that barriers to behaviour change could arise from one or all three sources of the framework (context, actors, system of concern). There may be a number of barriers that prevent progression between the stages of the problem-solving cycle (see Appendix 4.1). However, without targeted research, it is difficult to determine which phase of adaptation to appropriate e-waste management a country may be in. This is true for NZ and is a desired output from this research.

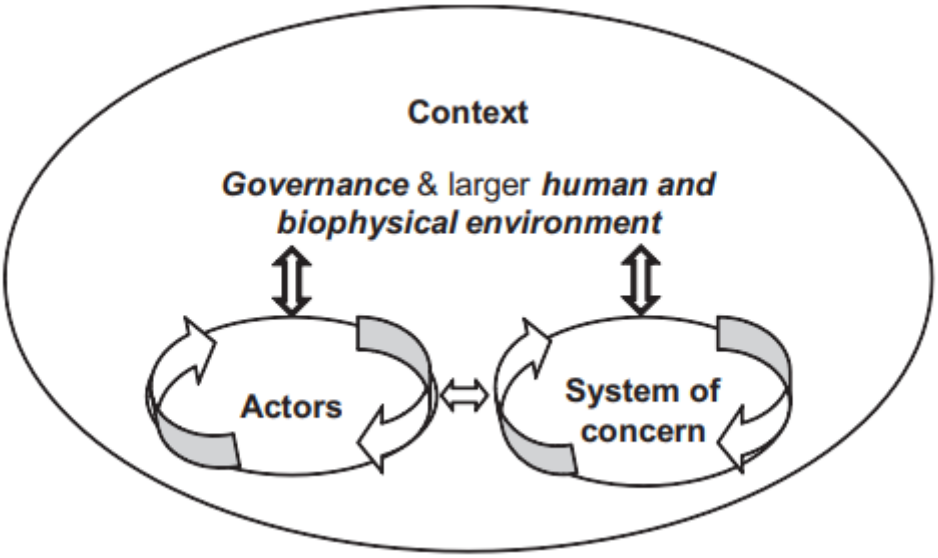



*Figure 4.3 The structural elements of the diagnostic framework: interacting actors, the governance and larger socio-economic context, and the system of concern. (Source: Moser, Ekstrom, & Kasperson, 2010, p. 22028)*

The scope and scale of environmental issues can begin to dictate how an issue is dealt with. Figure 4.4 illustrates Moser, Ekstrom, and Kasperson's (2010) model of the scope and scale of adaptation to climate change. Without significant goals for the management of environmental issues, e-waste management may never move from coping measures (see Figure 4.4), such as voluntary drop-off recycling, to full system transformation, which could possibly occur via internationally applied EPR. Internationally, some countries may not have reached the point of goal setting at all and may not yet appear on this scale, however other countries, including those in the EU, would be found somewhere between long term and short-term goals, as more substantial adjustments, such as EPR principles, have been applied. However, a complete paradigm shift has not yet occurred, possibly due to consumerism and obsolescence (see Chapter 2), and the fact that mandatory EPR is not internationally applied. NZ currently does not possess an understanding of the actual volumes of e-waste being produced, the actual household consumer behaviours, and barriers that may prevent appropriate disposal at the EOL stage, therefore substantial system changes have not been made. This could be attributed to the

fact that the problem is not yet fully understood due, in NZ's case, to a lack of reliable data.

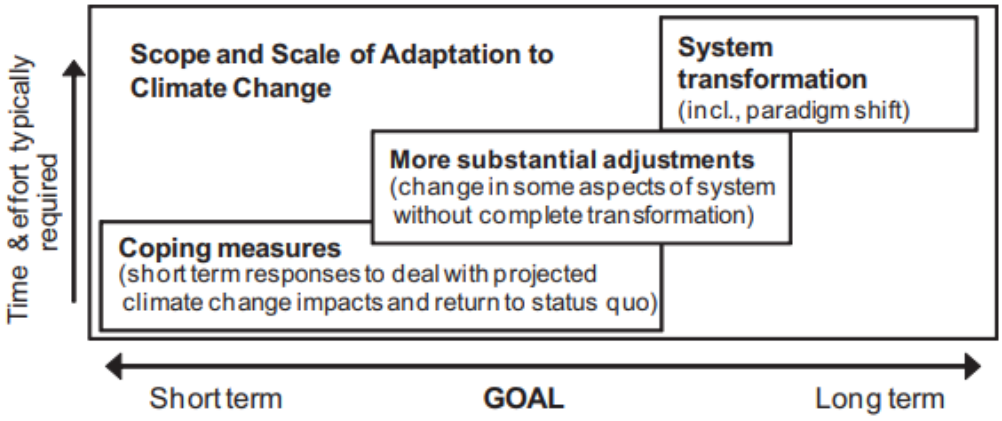



*Figure 4.4 Moser, Ekstrom and Kasperson's scope and scale of adaptation to climate change (Source: Moser, Ekstrom, & Kasperson, 2010, p. 22027)*

## 4.4 Conclusion

Overall, several aspects affect the e-waste knowledge and behaviours of householders. As understanding household consumer knowledge and behaviours specific to e-waste is imperative to enabling the creation of robust policy and services to manage the issue, this thesis set out to investigate Whangarei, a town like many in NZ, to ascertain what e-waste management-related policies, resources, and services are available to residents, and what e-waste management behaviours Whangarei householders are currently exhibiting. It aimed to identify whether the barriers to engaging in environmentally sound e-waste practices in NZ are similar to those found overseas, and if this was found to be the case, international literature could also guide the solutions. Understanding the e-waste knowledge and behaviours of Whangarei householders, and the resources that are currently available to them, should provide valuable data for more targeted local, and perhaps even national, policy design which may better meet the needs of individuals, communities, and the environment.

The literature reviewed in this, and the previous two chapters, has informed the methods for this research, discussed in Chapter 5. Literature, including the work of Barr et al. (2003), Darby and Obara (2005), and Dwivedy and Mittal (2013), who utilised similar methods, has guided the research method chosen (mixed-method online survey), the survey question structure, and

analysis approaches used in this research. The Whangarei findings will be compared with international literature in Chapters 6 and 7.

# Chapter 5 – Methodology

This chapter outlines the research design undertaken for this thesis. It describes the methods undertaken to meet the overall aim of the research:

> To generate first-time data on Whangarei household e-waste options, knowledge, and behaviours, in order to inform e-waste management policy, resources, and services which could be specifically designed for the district.

To meet this overall aim, the methods are designed to produce data which meet the following three of the five overall objectives of the research (for full description see Chapter 1):

> 2. Identify the options (resources and services) available to Whangarei household consumers for the disposal of e-waste;
>
> 3. Identify the types and volumes of e-waste, currently being disposed of or stored by Whangarei households, and how;
>
> 4. Identify the e-waste knowledge and behaviours of Whangarei household consumers, and factors influencing e-waste knowledge and behaviours.

This chapter explains the rationale for the research design and discusses how the data was generated. This includes research tool design, sampling procedures, validity of the data, and data analysis methods.

## 5.1 Research Method

The literature reviewed in Chapters 2, 3 and 4 informed the methods of this research. Table 5.1 shows where, for example, specific literature has guided questions, and where the survey is mapped to meet the aims as illustrated above. Literature also guided the decision to utilise a combination of quantitative and qualitative research methods in order to paint a holistic picture, as qualitative data can contextualise data obtained through quantitative methods.

*Table 5.1 Question, research aim, and literature map*

| Question(s) | Research Aim | Relevant Literature |
|---|---|---|
| **PART ONE: DEMOGRAPHICS** | | |
| 1. Which area of Whangarei do you live in? | 2, 3, 4 | Whangarei District Council, 2013 |
| 2. Which age group do you fit into? | 4 | "5 examples of survey demographic questions," n.d.; Martin, Williams & Clark, 2006; Welch, 2013; Whangarei District Council, 2013 |
| 3. Are you: male/female/other | 4 | Hunter, Hatch, & Johnson, 2004; Martin, Williams & Clark, 2006; Welch, 2013; Whangarei District Council, 2013 |
| 4. Which ethnic group(s) do you belong to? | 4 | Welch, 2013; Whangarei District Council, 2013 |
| 5. Who lives in your household? | 4 | "5 examples of survey demographic questions," n.d.; Martin, Williams & Clark, 2006; Whangarei District Council, 2013 |
| 6. What is your highest completed qualification? (e.g. trade certificate, bachelor's degree, etc.) | 4 | Schultz, Oskamp, & Mainieri, 1995; Song, Wang, & Li, 2012 |
| 7. What is your household income? | 4 | "5 examples of survey demographic questions," n.d.; Darby & Obara, 2005; Dwivedy & Mittal, 2013; Martínez-Torres & Rosset, 2010; Rice, 2014; Schultz et al., 1995; Whangarei District Council, 2013 |
| 8. Which political party do you support? | 4 | Cairns, 1999; Dunlap, 2000; Hamilton, 2010; Saphores, Ogunstein, & Shapiro, 2012 |
| **PART TWO: GENERAL RECYCLING BEHAVIOURS** | | |
| 9. How often do you recycle the following household waste items? | 4 | Darby & Obara, 2005; Evison & Read, 2001; Farrelly & Tucker, 2014; Martin, Williams & Clark, 2006; Saphores, Ogunseitan, & Shapiro, 2012 |
| **PART TWO: ENVIRONMENTAL BELIEFS** | | |
| 10. Please rate whether you agree with the following statements relating to household waste management | 4 | Baxter & Gram-Hanssen, 2016; Cairns, 1999; Dwivedy & Mittal, 2013; Hamilton, 2010; Martin, Williams & Clark, 2006; Rice, 2014; Saphores, Ogunstein, & Shapiro, 2012 |
| **PART THREE: E-WASTE BEHAVIOURS** | | |
| 11. Why might you dispose of the following types of e-waste?<br>12. How do you currently dispose of [categories of e-waste] in your household? | 2, 3, 4 | Darby & Obara, 2005 |
| 13. If you stated that your household stores e-waste on the previous page, please indicate what type of e-waste you currently have in storage, and how many items.<br>14. If you stated that your household stores e-waste, please rate the following statements for your household. | 2, 3, 4 | Baxter & Gram-Hanssen, 2016; Baxter, Lyng, Askham, & Hanssen, 2016; Ongondo & Williams, 2011 |
| 15. I would change the way that I/we manage e-waste in my/our household if... | 2, 4 | Barr et al., 2003; Evison & Read, 2001; Kollmuss & Agyeman, 2002; Tonglet, Phillips, & Bates, 2004 |

| Question(s) | Research Aim | Relevant Literature |
|---|---|---|
| 16. When was the last time you disposed of e-waste? And how did you do it? | 2, 3, 4 | Dwivedy & Mittal, 2013 |
| **PART FOUR: E-WASTE MANAGEMENT** | | |
| 17. Are you satisfied with the effectiveness of e-waste recycling services available in your community?<br>18. Do you know where the nearest waste transfer station is to your home? And have you used it to dispose of e-waste?<br>19. If consumers are expected to pay for user friendly, quality assured, environmentally sound, healthy and safe e-waste recycling, how much would you be willing to pay?<br>20. How would you rate the 'overall effectiveness' of the current approach in dealing with e-waste in New Zealand as a whole?<br>21. In your opinion, what is the best approach for New Zealand in dealing with e-waste issues? | 2, 3, 4 | Barr et al., 2003; Dwivedy & Mittal, 2013; Evison & Read, 2001; Hannon, 2014; Tonglet et al., 2004 |

Quantitative research is the application of statistical techniques and tools that describe and interpret data that can be measured in numbers. Qualitative research, on the other hand, often has social applications, and is not as straightforward to analyse due to its complexity and layers which stem from the individual voices of the participants. Qualitative research utilises methods that may have no definitive answers, and therefore is more difficult to interpret and analyse, as the data is represented through the participant's own words or actions (Somekh & Lewin, 2011), which can be time consuming to evaluate. When used together, the combination of qualitative and quantitative research methods can feed into each other to paint a holistic picture that provides layers and depth, particularly in relation to social, economic, and personal aspects such as perceptions, values, and knowledge.

To meet the aim and objectives of this research, primarily quantitative data was collected, with 18 of the 21 questions utilising tools such as Likert scales and multiple choice. Statistics exhibiting the Whangarei District household e-waste behaviours was a key output of the research project, therefore closed questions that collected numerical data was required. This statistical reference allows for a baseline for future research. However, to provide depth and allow richness in the findings (Creswell & Miller, 2000), qualitative aspects were also applied to the research tool, allowing the individual voices of participants to be heard. For example, six

of the quantitative questions allowed respondents to select "other" as an option and elaborate on these answers in their own words. Furthermore, three survey questions were solely qualitative, asking respondents to use their own words to answer questions relating to opinions and behaviours. It was expected that qualitative answers would give a better understanding of the overall data collected and would also allow for triangulation against the quantitative data (Somekh & Lewin, 2011), and the literature.

## 5.2 Context of Research

This research took place within the Whangarei District, located in Northland, New Zealand. The research was undertaken as a voluntary online survey between 9 March 2018 and 13 April 2018.

## 5.3 Data Generation Methods

A case study is research undertaken to understand "complex real-life activities in great-depth" (Noor, 2008, p. 1602), such as what is happening in a specific community at a specific point in time, and can investigate behaviours, attitudes, and opinions (Lavrakas, 2008). It was important for this research to provide an insight (or snapshot) of how e-waste is managed in Whangarei, as there is a significant lack of e-waste data available in New Zealand (see: SLR Consulting NZ Limited, 2015), illustrated by the recent *Global E-waste Monitor* stating the official collection rate of e-waste in NZ at 0% (Baldé et al., 2017, p. 76). Chapter 3 provides evidence that the e-waste collection rate in NZ is not 0% as posited by Baldé et al. (2017). Understanding the behaviours, attitudes, and opinions of Whangarei households in relation to e-waste, may help to provide a social baseline for future research opportunities, and understand why the recycling rate in Whangarei only reached 1.8% (not the 0% speculated by Baldé et al.) of the estimated e-waste generated in the district in the same year (see Section 3.2.1).

### 5.3.1 Sampling

The target population for this research was all households in the Whangarei District [31]. The survey was, however, only open to respondents over the age of 16, in order for this research to

[31] 30,204 occupied dwellings in the 2013 census (NZ Stats, n.d.)

meet low risk ethics requirements (see Section 5.3.7). This was not considered to be detrimental to the outcomes of the research as literature indicated that, for those under 16, it is more likely an adult would take the responsibility of household waste management (Hunter, Hatch, & Johnson, 2004; Martin, Williams, & Clark, 2006).

This research used 'convenience sampling'[32] in order to easily obtain results (Triola, 2014). This was managed through email and social media, inviting participation from any Whangarei householder, over the age of 16, who saw the link to the online survey. Snowballing techniques, often used in qualitative social research, were also deployed: survey respondents were asked to share the survey link with their local friends, whanau and colleagues, to ensure a statistically valid sample size (see discussion on validity in Section 5.3.5). To minimise any bias concerning representativeness created by using the snowballing technique (for example see Szolnoki & Hoffmann, 2013), individual invitations were sent to over 150 contacts in the Whangarei area, both social and professional, via email (by way of the local district council, chamber of commerce, and polytechnic), Facebook local group pages, and LinkedIn.

A $150 meal voucher was donated by a local restaurant and offered as a prize, to help ensure a broad range of respondents, and to minimise as much as possible the limitation of voluntary response samples, where often "those with a strong interest in the topic are more likely to participate" (Triola, 2014, p. 8). At the conclusion of the data collection, those that indicated they wanted to be in the meal voucher draw were sorted in a spreadsheet and a google based random number picker tool was used to choose the prize winner. Respondents provided email addresses to enter the draw, or to request a copy of the results. These email addresses were not shared with any other party and remain confidentially filed with the raw data in the authors two-step password protected google cloud account.

[32] Convenience sampling is a non-probability sampling method where data is collected from 'group' members who are conveniently available to participate in the study. I.e. "getting participants wherever you can find them" (Dudovskiy, 2018, para. 2).

In order to achieve a 2% margin of error (see Section 5.3.5) a sample size of 2225 respondents (7.4% of the target population of 30,204 households) was required (SurveyMonkey, 2018b). The survey remained open from 9 March 2018 to 13 April 2018 to allow adequate time to achieve this goal, with 'nudges' along the way in the form of reminder emails, printed posters, and social media posts. When the survey closed, a sample size of 248 individual respondents (0.82% of the target population) was achieved. This meant that the margin of error on the reported data was at 6% (SurveyMonkey, 2018a) (see Section 5.3.5 for further explanation).

### 5.3.2 Participants

In total, 248 individual Whangarei householders participated in the online survey, excluding six responses during the pre-testing phase of development (see Section 5.3.4). The respondents represented a cross section of the district, determined by demographic data gleaned from the survey (see Chapter 6). This was important to ascertain, to ensure the population was [approximately] proportionally represented (Triola, 2014).

### 5.3.3 Online Survey

The research tool utilised for this thesis was a voluntary online survey of Whangarei householders using Google Forms as the data collection (survey software) platform (see Appendix 5.1 for a copy of the survey). Surveys are a "widely used and acknowledged research tool", particularly in developed countries, and it is accepted that "information derived from a relatively small number of people [can] be an accurate representation" of the opinions, preferences and attitudes of a "significantly larger number of people" (Rea & Parker, 2005, p. 3). A large amount of the international research investigating household consumer e-waste behaviours utilised survey as a research tool (see for example: Barr, Ford, & Gilg, 2003; Darby & Obara, 2005; Dwivedy & Mittal, 2013; Nixon, Saphores, Ogunseitan, & Shapiro, 2008; Saphores, Nixon, Ogunseitan, & Shapiro, 2009). However, of the examples listed only Dwivedy and Mittal (2013) and Saphores et al. (2009) utilised online surveys, with other researchers using door-to-door and postal questionnaires, and face-to-face interviews.

The survey was divided into four parts: Part One, Demographic Profile; Part Two, General Recycling Behaviours, and Environmental Values; Part Three, Household E-waste Behaviours; and Part Four, E-waste Management, which included opinions on current options available for e-waste, and how e-waste is currently being managed in the district and in NZ as a whole. Targeted question framing[33], utilising quantitative questioning methods such as multi-choice and Likert-type scale; and qualitative methods, such as open-ended questions and space for comments, was guided by the literature (see Table 5.1 and previous chapters), and, in part, by a previously unpublished NZ based online survey conducted in 2012 by Jonathon Hannon (2014) (see Appendix 5.2), used with permission.

Google Forms was chosen as the survey software platform due to the ease of use by respondents anywhere (e.g. at home, work, school, or anywhere else via mobile data), on any device (e.g. PC, smartphone, tablet, MacBook, etc.). To ensure that questions were as easy as possible to read, regardless of the device used, some of the larger questions, such as questions 11 and 12, were broken up into parts to enable the respondents to see what each selection box represented as they scrolled down or across the screen. While this made the overall survey longer, it ensured that the respondents were not guessing what the indicator represented. This is a common issue with survey software platforms, and one that was easily managed by adopting this technique.

Another benefit of Google Forms is that it provides real time response information and automated charts, and the data can be easily exported into Microsoft Excel at the survey's conclusion. Understanding how many responses are coming in allowed further promotion of the survey to be undertaken, such as posting on social media, reminder emails, and poster distribution which included a QR code with a link to the survey.

As discussed in Section 5.3.1, the survey link was initially released via email and social media. Included in the research information was an email address that respondents could contact if they

[33] Targeted question framing is where questions are created to get answers to specific questions relative to the topic of research. For example, wanting to understand how various e-waste categories are disposed of you would ask a question directly related to specific e-waste category (e.g. small household appliances) disposal (see Question 12 of the survey in Appendix 5.1).

had any questions relating to the survey. This email was not utilised by respondents. However, one respondent did make contact via Facebook to ask a question on how best they should answer a question relating to where they lived, as their suburb was not listed in question one. This was one of the benefits of using social media as a distribution method, and confidentiality was maintained as the 'conversation'[34] was deleted from the authors Facebook Messenger account once completed.

### 5.3.4 Pre-Testing / Pilot Survey

To minimise the need for respondents to ask questions, and to ensure the research tool was robust, rigorous pretesting was undertaken before the survey was released. There were three main components of this pre-testing: supervisor critique; a pilot survey to respondents with educated insights; and finally, a pilot survey to respondents with no educated insight. Supervisor feedback was given at all stages of the survey design and development. Input on question structure, number of questions, and how the research questions related to the literature, were all aspects covered during this critique. For example, the lead supervisor questioned why question 12 was broken in to parts a - k, rather than a single question (see Appendix 5.1). While the argument for one solid table to indicate the answer to this question rather than being broken into 11 parts, was valid, unfortunately the use of an online platform did not allow for this (see Section 5.3.3). Furthermore, conducting a paper-based survey was not a method that could be easily adopted in order to seek the desired response rate (see Section 5.3.1), and therefore was not 'convenient' (Triola, 2014).

Once the first stage of supervisor critique was complete, the survey was distributed to members of the Whangarei Waste Minimisation Action Group for pretesting. At the time of writing, this group had 10 members including Whangarei District Councillors, environmental educators, waste engineers, and members of various interest groups. It was decided that this would be an ideal space to test the tool as the group members all have an interest and educated insight into the topic so were likely to give constructive feedback. Furthermore, the group were also of

[34] Facebook Messenger refers to dialogue using its Messenger service as an online 'conversation'.

varying levels of computer and technology literacy, so the tool itself could be critiqued. Out of the 10 members the survey was distributed to, four responses were received, however these responses provided considerable meaningful feedback. Amendments to the survey from this round of feedback included adding some simple questions relating to localised transfer stations, and the removal of a section of questions relating to the NEP scale (see Chapter 4) due to the survey taking over 20 minutes to complete. It was felt that the general environmental views of the respondents could be ascertained by answers to other questions in the survey (questions 8 and 10), and that the relationship between environmental values and e-waste behaviour was only one small part of the overall picture.

When the focus group feedback had been applied, the survey was conducted via Facebook video chat with two Whangarei District household residents who did not have any real knowledge on the subject of e-waste or waste management as a whole. These residents were emailed the survey link and asked to complete it while online with the researcher. This component of the pretesting was very beneficial as any of the respondent's questions could be answered in real time, and comments that respondents were making to themselves as they completed the survey were also noted. From this, three minor and one significant amendment were made, including removing two questions which were considered "long and confusing and hard to understand". Furthermore, one respondent commented that they "got carried away trying to finish and didn't really think about the answers to the last few questions". It was decided that information gained in these two questions, in more general terms, could be found elsewhere. Therefore, the decision was made to remove these questions, and further reduce the survey length and time. This was prudent as concerns could be raised about the robustness of any results to later questions if respondents were rushing to finish. To further overcome this, the introduction to Part Four included the comment "Nearly there! Only 5 questions to go!".

### 5.3.5 Research Validity

Validity is a key facet of research to ensure quality outcomes and outputs. In quantitative research, one way to ensure valid results is to collect a large enough sample in order to estimate

a population parameter[35] or make an inference about the population (Triola, 2014). While this research aimed to achieve a 2% margin of error, the number of responses actually collected allowed for a margin of error of 6% with a 95% confidence factor. This means that the data reflected in the research is 95% likely to contain the true value of the population proportion within 6% either side of the reported figure (Triola, 2014). For example, where the data indicates that 68% of householders throw away batteries with their household rubbish (see Chapter 6), we can be 95% confident that the interval from 62% to 74% actually does reflect the battery disposal behaviour of Whangarei District household consumers.

Qualitative factors were also included in this research, with a number of open-ended questions, and space for the respondents to comment. To ensure a rich description of the data, quotations were utilised in parts to illustrate the opinions of the respondents (see Chapter 6). This enabled the author to give further depth into the meaning of data being presented, therefore increasing the perceived validity by the reader (Creswell & Miller, 2000). Qualitative responses were also used to triangulate the data where possible, further increasing validity.

### 5.3.6 Research Limitations

The most significant limitation of this research is self-reported data. Darby and Obara (2005, p. 27) found that "respondents tend to exaggerate their waste management behaviours especially when these are perceived to be ethically sound". Farrelly and Tucker concurred, finding that self-reporting, while often used in environmental compliance contexts, produces "over-estimates of positive environmental behaviour" (2014, p. 15). Farrelly and Tucker recommend that "integrated methodologies" be applied to environmental behaviour research. These include a blend of qualitative and quantitative research tools to provide "greater depth, context, and nuance" to responses (2014, p. 15). Integrated methodologies were not applied to this research project, however to attempt to reduce this limitation as much as possible, a varied group of

[35] A population parameter is a number that describes that population (or 'group'). For example, where the question aims to identify what percentage of Whangarei householders dispose of batteries with their household waste, and 68% of Whangarei householders dispose of batteries in landfill; therefore **68%** disposal in landfill of batteries is the population parameter.

respondents were surveyed, room for comments was allowed, and some qualitative open-ended questions were included in the content. Future research into the e-waste management behaviours of household consumers in NZ may adopt a more integrated method approach.

The second limitation of the research was that the survey was only conducted online, and therefore only respondents with access to the internet could respond to the survey. However, the 2013 NZ Census data shows that 71.5% of Whangarei households have access to the internet and 83.7% have access to a cellphone (StatsNZ, n.d., p. 19). The software platform utilised to conduct the survey (Google Forms) was chosen due to its ease of use on handheld devices to reduce this limitation as much as possible.

Another feature of Google Forms is the ability to track respondents via their Google email address. However, the decision was made to not utilise this tool, as it could prove a barrier to engagement, as participants who did not have a Google account, would need to create this first before starting the survey. A limitation of this decision was that respondents could participate in the survey more than once. A request on the information sheet (first page of the survey) asking respondents not to complete more than one entry was included, to limit repetition. Furthermore, by adding a competition, any duplicated email addresses submitted for entry could be located with reasonable ease, and the duplicated responses could be deleted from the data set. This was found on only one occasion with four duplicate data sets, therefore three were deleted. This reduction in responses did not impact the validity of the data (i.e. margin of error, see Section 5.3.5).

Bias is a common limitation of any research, and the causes and impacts can vary depending on the research tool utilised (Rea & Parker, 2005). Bias was minimised in this research project by asking well-worded survey questions that were not in any way leading. To ensure this, the survey faced rigorous pre-testing (see Section 5.3.3), and all aspects of the final thesis were reviewed by the two research supervisors to ensure that the findings and discussion remained objective.

A final significant limitation of the research was the fact that due to external commitments, the researcher relocated away from the Whangarei District, during the study period. This limitation was most consequential when it came time to release the survey, as it meant that reliance was put on personal contacts in the area to promote the survey link via hard copy posters. It also meant that local media was not engaged in the promotion process as had been first hoped, in order to gain more responses. This was, in part, overcome by offering a prize for completion of the survey, donated by a local restaurant.

### 5.3.7 Ethics

An important part of conducting research is ensuring that ethical considerations are undertaken. This includes informing respondents of the content and purpose of the research tool, what will happen with the information they have provided, and seeking their consent to participate. Furthermore, respondents must be confident that the information that is provided will be treated with confidentially and that any personal information remains private. To fulfil these requirements the first page of the survey provided crucial information for the participants (see Appendix 5.1) and a low-risk ethics application was made to the Massey University Ethics Committee. Approval for this low-risk application was granted in October 2017, prior to commencement of the survey (Notification Number: 4000018572).

The framing of questions 17, 19, 20, and 21 of the survey, and data utilised in the findings when discussing the outcome of these questions, was provided from a 2012 previously unpublished online survey conducted by Hannon (2014), used with written permission. The 2012 survey questions mapped closely with questions already crafted for this research, and it was felt that by adding this data set, a deeper analysis of e-waste behaviours in the NZ context could be undertaken. The 2012 survey had its own low-risk ethics approval granted by the Massey University Ethics Committee before the survey was released. Communication with the Massey University Ethics Committee found no ethical issues with the comparison of these data sets.

Lastly, some themes of the research have been guided by informal phone discussions and emails with various actors (WDC, WasteMINZ, NZ Product Stewardship Council, EcoSolutions, etc.)

conducted during the scoping phase, and two interviews with e-waste recyclers conducted for a previous research project (see Blake, 2016). In all cases permission was sought and granted to use the information provided to guide this research. Further to this, e-waste recycling volume data (see Chapter 3) was provided by WDC and written permission was given to publish this data.

## 5.4 Data Analysis

Data analysis for this research was reasonably straightforward as there was only one research tool utilised therefore only one set of data to be analysed. However, due to the quantitative and qualitative nature of the data set, differing analysis methods needed to be applied. As Google Forms (the survey software platform) initially collates data into various formats, including graphs, this can allow a quick snapshot of any obvious emerging themes, and significant statistics. Therefore, reviewing this overview was the first step of the data analysis. After this first look, the data was downloaded from Google Forms into a Microsoft Excel spreadsheet so that a deeper analysis could take place. It was at this point that any duplicate responses were removed.

Each set of quantitative questions were analysed to find trends. Responses were grouped together as appropriate (for example, questions 11 and 12) and put into graphs making the data easier to interpret. Correlation equations, utilising Microsoft Excel data analysis tools, were also conducted to ascertain correlations between demographic factors and general recycling behaviours, and environmental value statement responses. Demographic factors (age, household makeup, income) and general recycling behaviours were also compared with e-waste recycling behaviours across the categories of e-waste. Line graphs were utilised to review groupings or anomalies in order for further analysis to be undertaken. The author sought assistance from a research consultant in relation to these specific data analysis techniques, however did not engage the services of a statistician for the data analysis conducted for this research due to both financial and time constraints. In addition to correlation and relationship investigations, the

responses to questions 17, 19, 20 and 21 were compared with the 2012 data set (see Appendix 5.2).

Qualitative responses were read carefully noting key themes, determined by the repetition of key words, phrases and themes. These key words/concepts were analysed, and themes that were derived from the literature review before the survey process had begun were also highlighted. Possible bias and personal opinion was also noted to ensure that this may be made clear during any findings. The answers given to qualitative question 16 were compared with the quantitative results of question 12 to see if the qualitative responses supported the quantitative findings or contradicted them. Manual mind mapping techniques were utilised from early on in the data analysis stage, to investigate overarching themes and subthemes and how they were connected to each other. This was then mapped to literature findings, in particular international literature (see Table 5.1).

As this study is designed for the purpose of a 90 credit Master's thesis (including resource constraints and wordcount) the data analysis remained at the level of broad patterns. Microsoft Excel data analysis tools and line graphs were utilised to illustrate any correlations, particularly when investigating relationships between demographic factors and e-waste behaviours. Future research projects could delve deeper into the data set.

## 5.5 Conclusion

A voluntary online survey, utilising snowballing techniques, that had undergone rigorous pre-testing, was conducted to meet the research aim and three specific objectives of this thesis, between 9 March 2018 and 13 April 2018, in the Whangarei District, Northland, NZ. This survey used predominately quantitative questioning methods but included qualitative aspects for a full rich picture to be ascertained, as while quantitative questions alone may have allowed for a comprehensive data set, qualitative responses provided context and gave the data real value by allowing the voices of the respondents to support the quantitative data.

In total 248 responses were collected from Whangarei District household consumers over the age of 16, and a margin of error on the quantitative aspects of the data of 6% was achieved. The utilisation of previously used survey questions allowed for some comparisons to be made, and it is hoped that the structure of the survey utilised for this research project could be utilised in other areas within NZ to allow future comparisons to be made. The analysis of the data primarily remained at the level of broad patterns, due to the constraints of the project parameters, however it is expected that future research projects will delve deeper into the data set. The following chapters present the findings of the survey results and compare the findings with international literature.

# Chapter 6 – Results

This chapter presents the results of the 2018 online survey of Whangarei District residents. The chapter is broken up into five sections. Section 6.1 discusses the demographic representation achieved and how well it aligned to the demographic profile of the district. These demographic factors are investigated in later sections to ascertain if the various demographic groups have any impact on household waste behaviours.

Section 6.2 shows the results of the survey questions relating to how households recycle various waste categories that can be recycled kerbside in Whangarei (i.e. glass, paper, cardboard, aluminium, metal, and plastic), and discusses interpretations, values, and understanding that householders' may have in relation to recycling practices. The recycling behaviour data is then collated in order to investigate whether general recycling behaviours impact on e-waste disposal behaviours.

Sections 6.3, 6.4 and 6.5 focus solely on e-waste: reasons for its creation, how it is being disposed of, and management options available both in Whangarei District, and NZ as a whole. Section 6.3 investigates reasons why and how e-waste is disposed of by households; Section 6.4 presents results related to the survey questions that focused on household storage of e-waste; and Section 6.5 discusses e-waste management options, including current services and options available locally and nationally. Section 6.5.1 focuses on e-waste recycling services that are available to respondents in the Whangarei District, and Section 6.5.2 discusses wider NZ e-waste management systems. Section 6.5.3 includes discussion on willingness to pay, and Section 6.5.4 presents the opinions of respondents regarding what needs to change with the way that e-waste is managed in NZ.

This chapter presents primarily quantitative results, however, due to the mixed method structure of the survey, a number of these results are further supported by qualitative responses. The mixed method approach undertaken in the survey has allowed for a rich set of data and findings which are discussed as a full set in Chapter 7.

## 6.1 Demographic Profile of Survey Respondents

As discussed in Chapter 5, 248 Whangarei District residents completed an online survey. Demographic data were collected through survey questions for two purposes; firstly, to allow a representative sample of the Whangarei District to be ascertained, which this section will discuss, and secondly, to allow investigation into whether demographic factors influenced any of the findings (see Sections 6.2.2, 6.3.1, 6.3.2, and 6.3.3).

Given the voluntary nature of the survey, it was encouraging that 35 of the 42 suburbs in the Whangarei District (Whangarei District Council (WDC), 2013) were represented in the sample. Onerahi (19.9%) and Parua Bay (13.9%) had the highest response rate, with other Whangarei District suburbs generally ranged between 1% and 2% representation, not including the further exceptions of Bream Bay (3%), Kamo East (4%), Kamo West (5%) Kensington (4%), Maungatapere (5%), Maunu (3%), Raumanga West (3%) and Tikipunga West (5%). The suburbs not represented were Mairtown, Port – Limeburners, Te Hihi, Western Hills, and Wharekohe – Oakleigh.

Significantly more women than men completed the survey (82% female and 18% male), with no respondents identifying as "Other". Women often have a higher response rate to surveys, as Smith (2008) illustrated in his research into online survey participation. However, Smith's results were not as pronounced as those presented here, comparing a 36% female response rate with 24% male.

Further to gender, seven age groups, from 16 – 65+, were represented (see Table 6.1). Over 90% of responses came from household consumers over the age of 25, with 25 – 34-year olds (25%) and 35 – 44-year olds (26.2%) being the groups with the highest representation. The age groups over 25 are represented higher than the 2013 Census data[36], but this may be because this survey was not open to participants under the age of 16 due to ethical considerations. However, as illustrated in Table 6.2, ethnic group identification closely matched those found in the 2013

[36] The 2013 Census data was the most recent data available at the time of data analysis.

Whangarei District Demographic Profile (WDC, 2013) (see Table 6.2) with 24.4% of survey respondents identifying as Māori and 83.6% identifying as NZ (78.4%) or Other (5.2%) European. 12.9% of respondents identified themselves in more than one ethnic category.

*Table 6.1 Participant age groups compared with 2013 NZ Census data (StatsNZ, n.d.)*

| Age Group | Number of Responses | % | 2013 Census % of Whangarei District Population |
|---|---|---|---|
| 16 – 18 | 2 | 0.8 | 28% (Under 19)<br>27% (20 – 39) |
| 19 – 24 | 23 | 9.0 | |
| 25 – 34 | 64 | 25.0 | |
| 35 – 44 | 67 | 26.2 | 27% (40 – 65) |
| 45 – 54 | 39 | 15.2 | |
| 55 – 64 | 39 | 15.2 | |
| 65 and over | 19 | 7.4 | 18% (Over 65) |

*Table 6.2 Participant ethnic groups compared with 2013 Whangarei District demographic profile data (Whangarei District Council, 2013)*

| Ethnic Group | Number of Responses | % | 2013 Whangarei District Demographic Profile | Variance |
|---|---|---|---|---|
| Maori | 61 | 24.4 | 27.6% | -3.2 |
| NZ European and Other European | 193 + 13 | 78.4 + 5.2 (83.6) | 81.1% | +2.5 |
| Pacific Islander | 7 | 2.8 | 3.2% | -0.4 |
| Asian | 2 | 0.8 | 3.9% | -3.1 |
| Other | 9 | 3.6 | No Data | N/A |

Households with children made up 56.5% of responses. This was lower than the 2013 NZ Census data which showed 63.8% one family households in the District (NZ Stats, 2013). Further to this, over 70% of respondents had completed some form of tertiary education close to the District representation of 74.9% (NZ Stats, 2013). However, 47.3% of the survey respondents reported having completed a Bachelor's degree or higher, a much higher representation that the 2013 NZ Census data (13.9%). This over-representation is likely due to the fact that "highly educated people are more inclined to respond to … surveys"[37] (Mohr & Webb, 2005, p. 131). The survey also found that household income was represented higher than

[37] While the referenced research was conducted using a mail survey, the same can be assumed for online survey methods.

2013 census information with 63.3% reporting household incomes of over $50,000 compared with a census total of 22.6% (NZ Stats, 2013).

The final demographic question that the survey asked related to which political party the respondent supported. This was relevant to this study as political affiliation can indicate pro-environmental values. When compared with the 2017 NZ general election results, 30% less National Party supporters responded to the survey than supported National in the election ("Final Results … ", n.d.), with Labour and Green Party supporters representing a combined 16.3% higher than the election result (see Table 6.3). Another reason for inclusion of this question was to establish any political bias. A 2011 NZ Election Study (as cited by Easton, 2014) found Labour and Green Party voters to be very similar, especially when compared to National voters. Green Party voters are known to hold high environmental values, illustrated by recent debate between supporters relating to the social policy discussion spurred during the run up to the 2017 NZ general election (for example see Neal, 2017). Further to this, both the Labour and Green Party are considered left-wing political parties.

*Table 6.3 Participant supported political party compared with 2017 general election results for Whangarei Electorate (Election results source: "Final Results …," n.d.)*

| Political Party | Number of Responses | % | Whangarei 2017 Election Result | Variance |
|---|---|---|---|---|
| Green Party | 31 | 12.7 | 5.7 | +7.0 |
| Labour | 100 | 40.8 | 31.5 | +9.3 |
| National | 38 | 15.5 | 45.1 | -29.6 |
| New Zealand First | 14 | 5.7 | 14.1 | -8.4 |
| Other | 5 | 2.0 | 3.6 | -1.6 |

In order to make assumptions on the e-waste recycling behaviours and beliefs of Whangarei District households, it was important to ensure that the demographic profile of the district was represented in the survey respondents. While findings of this research show that the results are not a complete representation of the district, due to the increased levels of income, education, and left-wing political views, they do provide a reasonably accurate picture of the demographic profile of the district, as was practicable within the scope of this thesis. This enables the general discussion to be conducted on e-waste in Whangarei and NZ (see Chapter 7). Furthermore,

international research has shown that there is a relationship between demographic factors and both general recycling, and e-waste recycling behaviours, hence it was important to collect this data to investigate if this is also true for NZ.

## 6.2 General Recycling Behaviours and Values

International research suggests that household general recycling behaviours and values impact household e-waste recycling (see Chapter 4). For this reason, the survey of Whangarei District households asked respondents questions relating to their general recycling behaviours and values. This section presents the results of these survey questions and investigates whether demographic factors affect general recycling behaviours and/or beliefs.

### 6.2.1 General Recycling Behaviours

Part Two of the survey asked respondents questions relating to their general recycling behaviours. On a five-point scale from "Always" to "Never" recycle, respondents were asked how often their household recycled commonly recycled household waste. Respondents were expected to use their own judgement regarding their frequency of recycling and were not given definitions for these five scale points. The materials they were asked to rate were broken into glass, plastic, metal, aluminium, paper and cardboard, all of which are collected at kerbside for all households in the Whangarei District (see Chapter 3). However, some rural households may need to travel to their closest intersection for kerbside collection (WDC, n.d.). For all six categories, at least 50% of respondents reported that they "Always" recycle, with plastic and cardboard both scoring over 70%, and glass reaching almost 90% (see Figure 6.1). Metal recorded lowest at 51%. It is likely that metal is the lowest ranked category here due to the often-large size of metal waste items, and the types of metals collected kerbside. Kerbside collected recyclable waste must fit into the standard 55 litre recycling bin (WDC, n.d.).

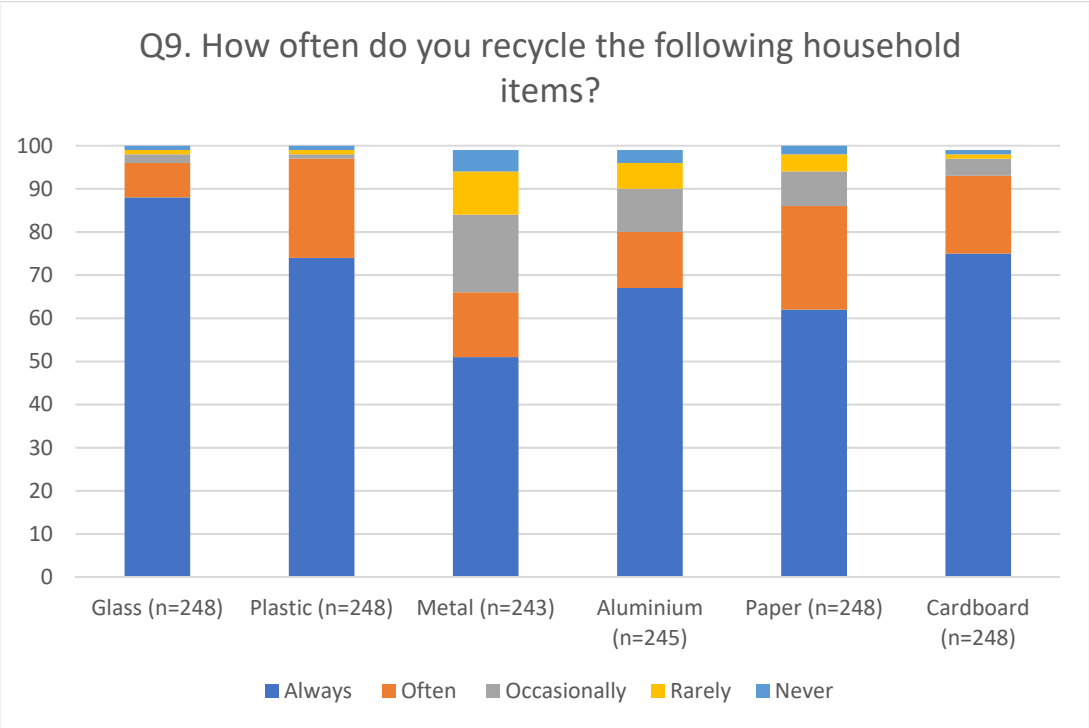



*Figure 6.1 General recycling behaviour results by percentage*

### 6.2.2 Impacts of Demographics on General Recycling Behaviours

Utilising the data analysis tools in Microsoft Excel to analyse two separate sets of data to ascertain association between these data sets, correlation equations were conducted between the demographic data and the reported general recycling behaviours, specifically age, ethnicity, gender, income, and household makeup. No correlation could be found on any occasion between the recycling behaviours results, both looking at the household items individually, nor by investigating the behaviours by considering the number of times a respondent selected that they "Always" recycled across the six categories. This could imply that demographic factors have no significance when related to recycling behaviours in the Whangarei District. However, these findings could be affected by the higher respondent representation of income and education (see Section 6.1).

### 6.2.3 Recycling Values

Participants' knowledge and values in relation to recycling causes and impacts were also questioned in Part Two of the survey. Respondents were asked to rate whether they agreed or disagreed with a range of statements, some of which were factually correct, and some which

were factually incorrect[38]. This helped to determine whether participants had in-depth knowledge of the impacts of general household recycling, and, to a lesser extent, to allow for an introduction to the main survey topic, e-waste recycling. The responses represented in Figure 6.2 indicated that householders seemed to have some in-depth knowledge in relation to general household recycling, particularly relating to resource conservation and the reduction of landfill use. However, they were less certain about whether recycling created jobs, or whether recycling made a difference to the environment. Further to this, while householders seemed reasonably confident that e-waste created significant environmental and social problems, they were less certain about the environmental impact of storing e-waste (Figure 6.3). The implications of these results are discussed in Chapter 7.

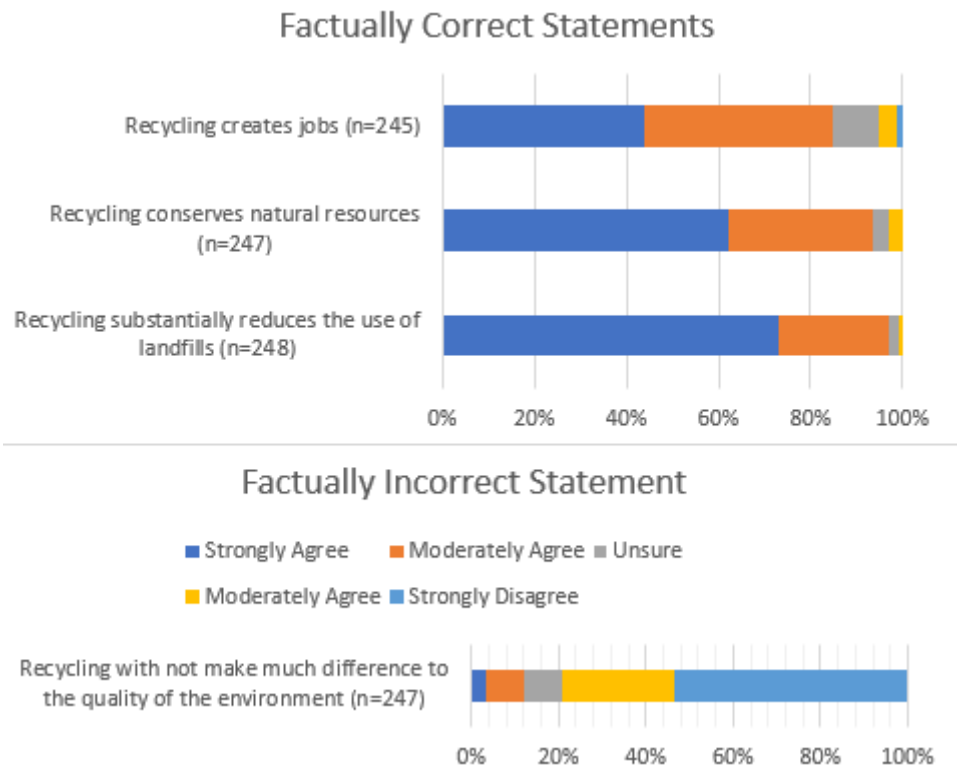



*Figure 6.2 Response distribution to general recycling statements*

[38]The factually incorrect statement claims that recycling will not make much difference to the quality of the environment. It could be argued that recycling does not actually make much difference to the environment due to the low levels of materials that are actually being recycled globally, and that reduction and reuse make a more significant impact. However, for the argument of this thesis, assuming recycling processes are in place and are fully utilised, recycling (particularly of e-waste) would make a difference to the quality of the environment.

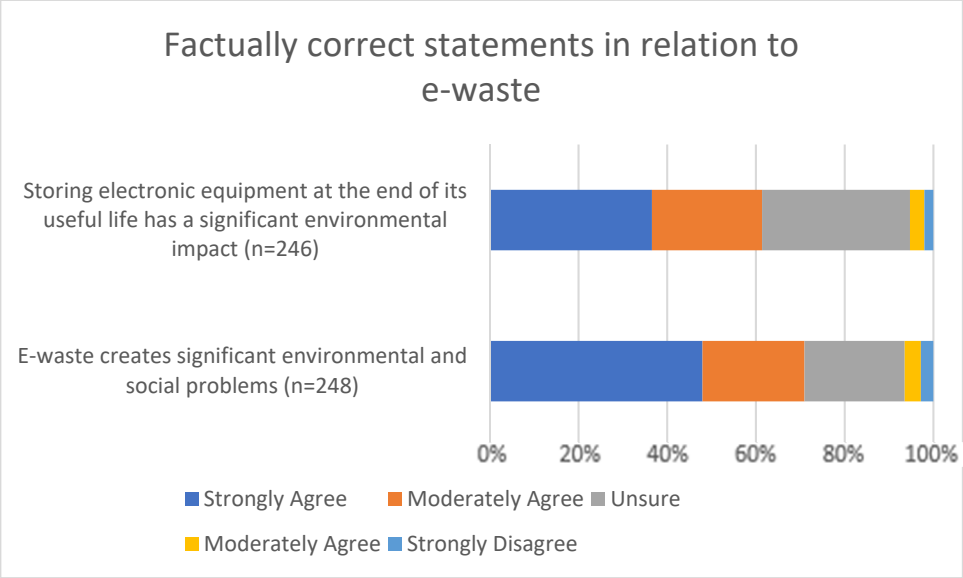



*Figure 6.3 Response distribution to e-waste statements*

The final two questions in Part Two of the survey aimed to gain an indication of the environmental leanings of the participants (i.e. whether they exhibited pro-environmental values). Over 90% of respondents either "moderately" or "strongly" agreed that they felt a moral obligation to recycle. However, when asked if households like their own should be blamed for environmental problems caused by excessive waste generation, over 40% either "moderately" or "strongly" disagreed with the statement, with a further 19% being "unsure". The results for this particular statement were reasonably well spread between the five options (see Figure 6.4).

As in Section 6.2.2, correlation equations were conducted to investigate relationships between environmental value statement responses and age, ethnicity, gender, income, household makeup, and political support. Similar to the findings of Section 6.2.2, no correlation could be found.

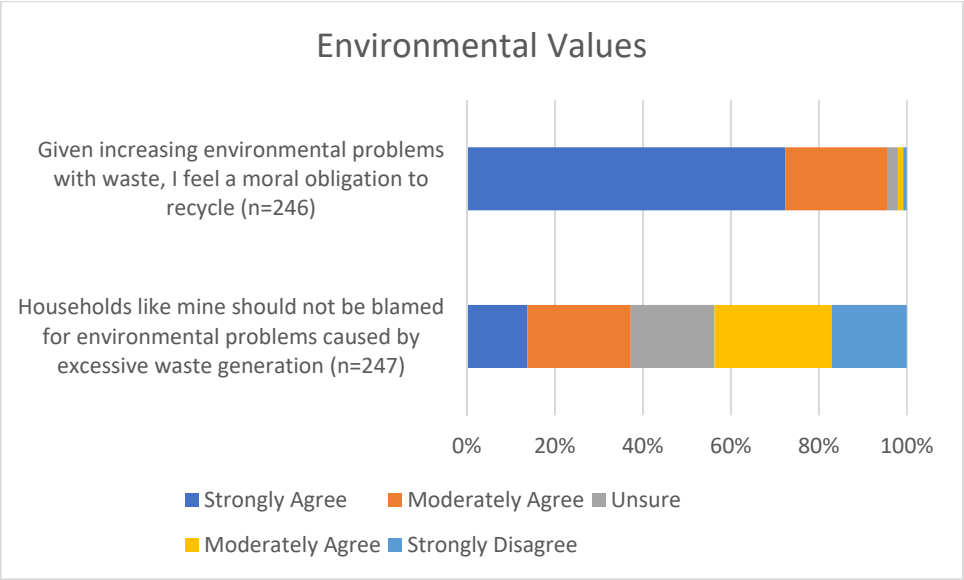



*Figure 6.4 Response distribution to environmental values statements*

## 6.3 E-waste Disposal Behaviours

The main topic of this thesis is household e-waste disposal behaviours in the Whangarei District. The majority of the survey questions focused on e-waste, both household behaviours and values, and opinions on local and national options and services available. This section presents the results of questions of Part Three of the survey that focused specifically on reasons for e-waste disposal, how e-waste is disposed of, and what changes to options and/or services may motivate households to change their current behaviours.

### 6.3.1 Reasons for Disposal

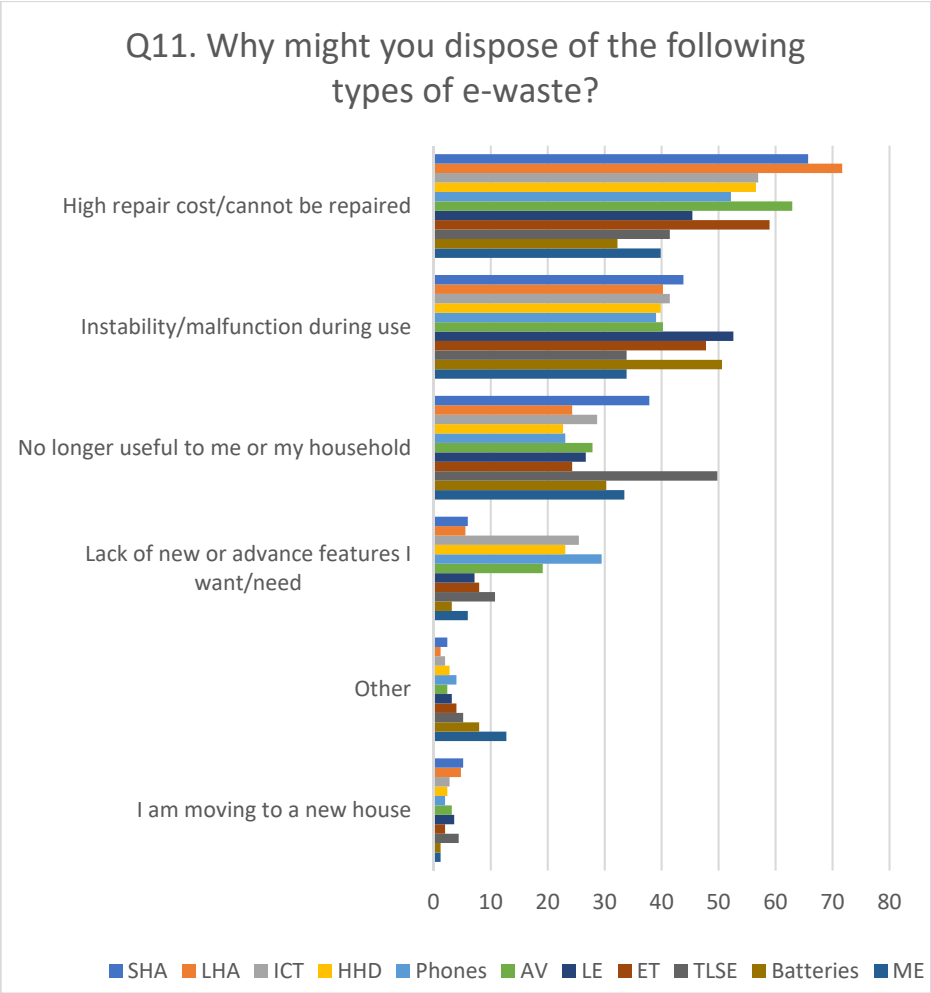
The first set of questions in Part Three asked respondents to indicate why they might dispose of e-waste across the e-waste categories: small household appliances (SHA), large household appliances (LHA), ICT equipment (ICT), handheld devices (HHD), cellphones/smartphones (phones),

audio visual equipment (AV), lighting equipment (LE), electrical tools (ET), toys, leisure and sports equipment (TLSE), batteries, and medical equipment (ME) (for definitions of each category see Table 2.1). As indicated in Figure 6.5, high repair costs or the inability for an item to be repaired showed to be the most common reason for disposal, particularly for SHA (66%), LHA (72%), AV (63%), and ET (59%). Instability and malfunction during use closely followed,

with LE (53%), ET (48%), and batteries (51%) scoring highest in this category. The TLSE category was found to be the most commonly disposed of when it was no longer of use to the household (50%), and ICT (25%), HHD (23%), and phones (29%), rated highest when items are disposed of due to lack of new or advanced features. Very few respondents selected “moving to a new house” as a reason for disposing of e-waste.

Further to the above categories, respondents were asked to elaborate if they selected “Other” as a reason for disposal (i.e. an option that differed from the list available). Most respondents who commented here stated that they did not have e-waste in certain categories (e.g. ME), as there was no “not applicable” option in this question, however some statements relating to other reasons for disposal were made, many of which related to design factors, such as:

> “I have to upgrade electronics almost solely on the fact that they no longer function with current products, e.g. memory is no longer large enough to run current programs.”
>
> “Power consumption too high / poor energy star rating.”
>
> “Most probably broken as we can't afford the stuff that "doesn't break".”
>
> “Bought new ones because outdated so can’t buy replacement parts or don’t make them anymore.”




**Key**

| | |
|---|---|
| SHA | Small Household Appliances |
| LHA | Large Household Appliances |
| ICT | Information and Communication Technology |
| HHD | Handheld Devices |
| AV | Audio Visual Equipment |
| LE | Lighting Equipment |
| ET | Electrical Tools |
| TLSE | Toys, Leisure and Sporting Equipment |
| ME | Medical Equipment |

*Figure 6.5 Participant responses to influences on e-waste disposal by percentage*

### 6.3.2 Reported Disposal Behaviours – Quantitative Results

Part Three asked how households currently dispose of e-waste by giving them a selection of possible disposal methods and asking them to select all that applied. As shown in Figure 6.6, using the mean (average; $\bar{x}$) of responses to calculate across the e-waste categories, "throw away with household rubbish" was the most common method of

disposal ($\overline{x}$ = 29.6%). However, this figure is affected by two categories, specifically LE and batteries. 70.4% of households reported disposing of LE with household rubbish, while 68% of households reported disposing of batteries with the household rubbish. Disposal at a waste transfer station for recycling ($\overline{x}$ = 26.9%) was the second most common disposal method and was found to be most common for LHA (48.2%), ICT (44.4%) and AV (43.5%) as shown in Table 6.4. Donations to charity were also a significant disposal method ($\overline{x}$ = 26.7%) for most e-waste categories (excluding batteries [0.4%] and ME [5.3%]) with TLSE (50.6%) and SHA (52.6%) most commonly disposed of this way.

Of the remaining three categories, ET was spread reasonably evenly between storage (19.9%), selling (19.9%), donation to charity (21.1%), household waste (22.8%), and recycling (21.1%), with giving away to friends/whānau rating the highest at 24.8%. Phones and HHD were most commonly stored (37.3% and 32.4% respectively), however most categories were stored in households to some extent.

The disposal options are broken down into three categories for discussion in Chapter 7. These categories include: landfill, recycle/re-use, and an 'other' category. The landfill category includes throw away with household rubbish, dispose of at waste transfer station mixed with general waste, and fly-tipping/illegal disposal. The recycle/reuse category includes: dispose of at waste transfer station for recycling, give away to friends/whanau, sell it, and return to supplier/retailer. "Other" as an option chosen by respondents can also be included in this category, as most of comments in this field related to other recycling or reuse activities. The final category includes: "donate to charity", "store it", and "don't know". This 'other' category requires further explanation (see Chapter 7) but includes options where householders may not be aware of the negative environmental impact of these choices. Overall, the majority of the disposal methods chosen fall within the recycle/reuse category, followed by the 'other' category, with landfill options being the less likely to be chosen overall.

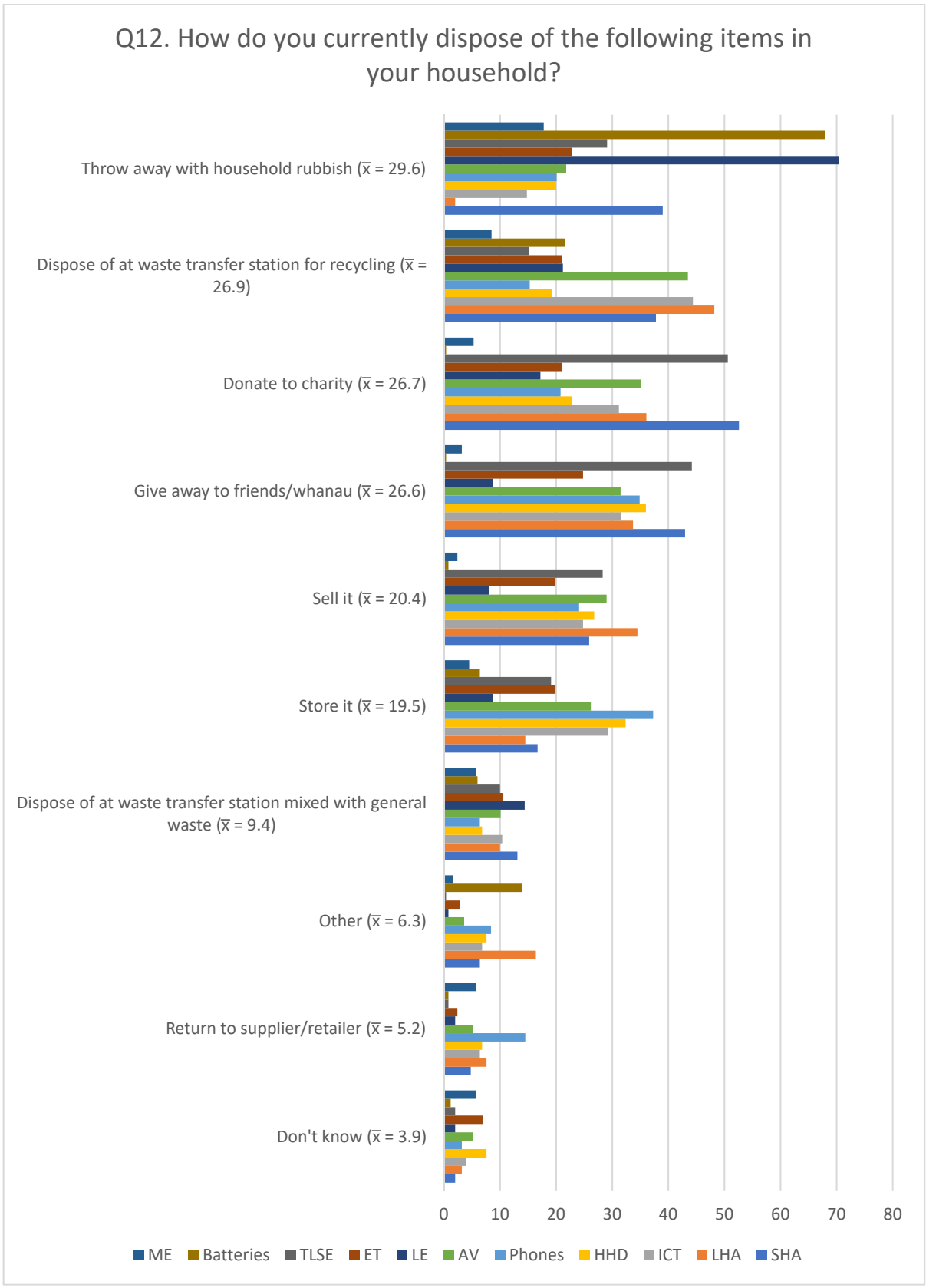



*Figure 6.6 Participant responses to method of e-waste disposal by percentage*

*Table 6.4 Participant responses to method of e-waste disposal by percentage with most common method of disposal by e-waste category and disposal method, and least common disposal method highlighted.*

| Disposal Method / Category | Don't know | Return to supplier/retailer | Other | Waste transfer station mixed with general | Store it | Sell it | Give away to friends/whanau | Donate to charity | Waste transfer station for recycling | Throw away with household rubbish |
|---|---|---|---|---|---|---|---|---|---|---|
| Small Household Appliances | 2 | 4.8 | 6.4 | 13.1 | 16.7 | 25.9 | 43 | 52.6 | 37.8 | 39 |
| Large Household Appliances | 3.2 | 7.6 | 16.4 | 10 | 14.5 | 34.5 | 33.7 | 36.1 | 48.2 | 2 |
| ICT | 4 | 6.4 | 6.8 | 10.4 | 29.2 | 24.8 | 31.6 | 31.2 | 44.4 | 14.8 |
| Handheld Devices | 7.6 | 6.8 | 7.6 | 6.8 | 32.4 | 26.8 | 36 | 22.8 | 19.2 | 20 |
| Phones | 3.2 | 14.5 | 8.4 | 6.4 | 37.3 | 24.1 | 34.9 | 20.8 | 15.3 | 20.1 |
| AV Equipment | 5.2 | 5.2 | 3.6 | 10.1 | 26.2 | 29 | 31.5 | 35.1 | 43.5 | 21.8 |
| Lighting Equipment | 2 | 2 | 0.8 | 14.4 | 8.8 | 8 | 8.8 | 17.2 | 21.2 | 70.4 |
| Electrical Tools | 6.9 | 2.4 | 2.8 | 10.6 | 19.9 | 19.9 | 24.8 | 21.1 | 21.1 | 22.8 |
| Toys, Leisure & Sports Equipment | 2 | 0.8 | 0.4 | 10 | 19.1 | 28.3 | 44.2 | 50.6 | 15.1 | 29.1 |
| Batteries | 1.2 | 0.8 | 14 | 6 | 6.4 | 0.8 | 0.4 | 0.4 | 21.6 | 68 |
| Medical Equipment | 5.7 | 5.7 | 1.6 | 5.7 | 4.5 | 2.4 | 3.2 | 5.3 | 8.5 | 17.8 |

| Key | Highest for Category | Highest in Disposal Method | Lowest in Disposal Method |
|---|---|---|---|

As in Section 6.3.1, respondents were asked to elaborate if they selected "Other" as a method of disposal (i.e. an option that differed from the list available). As previously indicated, most respondents that commented here discussed other forms of recycling that they undertook, including local metal recyclers, local e-waste recyclers such as the "Brain Injury Trust", or other recycling initiatives like the "Starship" phone recycling scheme, which respondents may not realise has now been replaced (see Chapter 3).

Not included in Figure 6.6 or Table 6.4 were the results for the fly-tipping option. Respondents were given the opportunity to select "Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property". This option was only selected on one occasion under the LE category.

Utilising line graphs to see patterns and groupings, relationships were investigated between age, household makeup, income, recycling behaviours and e-waste disposal methods (see Appendix 6.1). While some spread could be seen in age and income for various WEEE categories, this may have been due to low numbers of respondents in the associated categories (e.g. only 2 respondents in the 16 – 18-year-old category). As stated in Section 6.1, international research indicates that there is a relationship between demographic factors and e-waste recycling behaviours. It was important to investigate if this is also true for NZ. However, no clear significant relationships could be found for any of the e-waste categories on this occasion, indicating that demographic factors do not influence e-waste disposal in the Whangarei District.

### 6.3.3 Reported Disposal Behaviours – Qualitative Results

Question 16 of the survey was an open-ended question that asked respondents when the last time was that they disposed of e-waste and how they did it. Utilising quantitative metrics to analysis this qualitative data, Figure 6.7 shows landfill disposal (household rubbish and waste transfer landfill) was the most common disposal method equalling 37%. This was followed by recycling methods (return to retailer and waste transfer station recycling) at 33%, and reuse methods (sell, give away) at 11%. When compared with the solely quantitative question results of question 12 (see Section 6.3.2), Figure 6.8 shows that disposal method differs significantly. For example, while landfill rates were similar between both questions, recycling rates were much higher in the quantitative results illustrated in the previous section than the qualitative responses. Further to this, while respondents may have good intentions of reuse (illustrated in the quantitative results), such as giving away to friends and whānau, or selling, the qualitative results showed these categories greatly reduced.

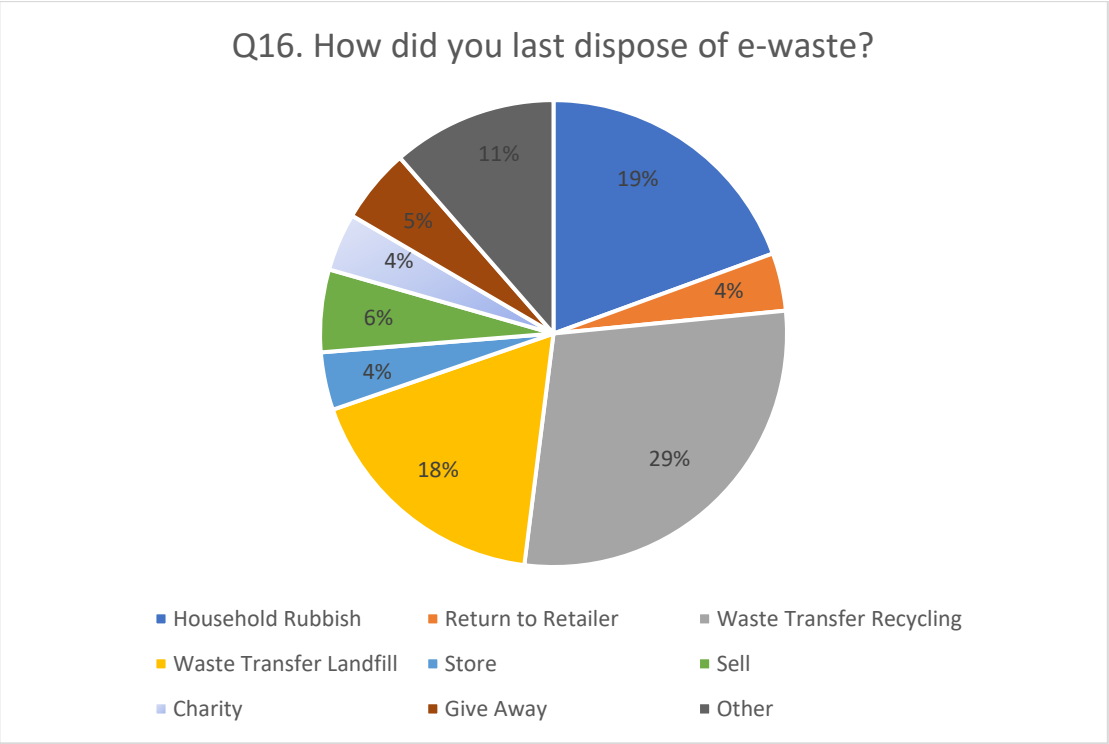



*Figure 6.7 Self-reported disposal method by percentage (n=175)*

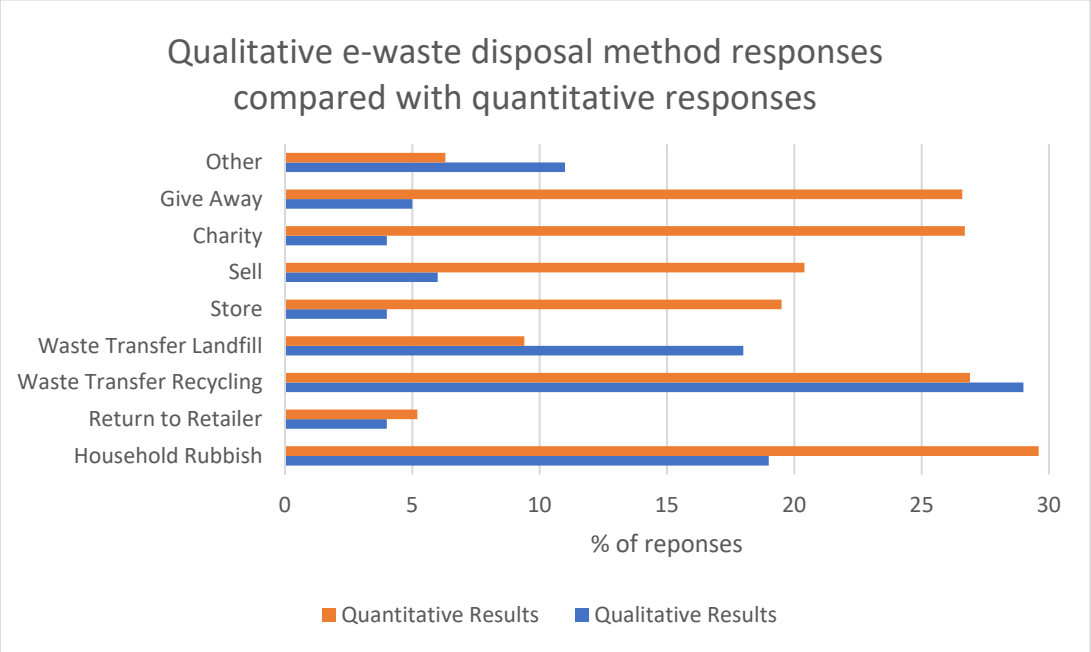



*Figure 6.8 Question 16 qualitative disposal method responses by percentage compared with question 12 quantitative disposal mean results (see Fig. 6.6)*

If the qualitative responses to how householders had disposed of their e-waste in the past were broken down into the three categories described in Section 6.3.2, landfill, reuse/recycle, and 'other'; again reuse/recycle is the most common method of disposal (a total of 55%). This is

followed by landfill (37%), and finally 'other' options (8%). However, as this question asked participants how and when they last disposed of e-waste, participants who were currently storing e-waste, and had not disposed of it in the past, may not have responded to this question.

Again, utilising quantitative metrics to analyse the qualitative data, of the 85 respondents who indicated a timeframe of when they last disposed of e-waste, 24.7% reported having disposed of e-waste within the last month, 45.9% within the last year, and 11.8% between one and two years. This means that of the 85 respondents who indicated a timeframe, 70 had disposed of some form of e-waste within the past two years. This could indicate that significant amounts of e-waste are being disposed of in the Whangarei District.

A number of significant comments emerged from this open-ended question which require further investigation, such as e-waste being buried "in the paddock", and issues relating to attempts to recycle e-waste at the local transfer station:

> "Paid $30 at the tip and the guy chucked it straight into ordinary landfill. That wanker lost all my motivation to pay to recycle."
>
> "Took old heaters to [E]cosolutions who told us they could now be recycled at the dump. Then took them to Whangarei refuse centre where we were told by workers that it was pointless and would just end up in the landfill anyway...."
>
> "2 weeks ago. I took them to the local recycle/rubbish place and they told me to put them where the general rubbish goes. So I did".

Correlation equations were conducted between age, household makeup, income, general recycling behaviours and the qualitative e-waste disposal method results. No correlation could be found in any case. This could again indicate that demographic factors do not impact on disposal methods.

### 6.3.4 Changes to Household E-waste Management

To ascertain what might change the way a household managed (disposed of) their e-waste, respondents were asked to rate a number of statements as to whether certain aspects of the current services/options available were changed, it would change their household e-waste management behaviours (Figure 6.9). Most respondents indicated that for each of the

suggestions they would “definitely” or “probably” change their e-waste management behaviours. However, of these statements, those that made recycling easier (i.e. recycling being included in kerbside pick-up and retailers providing a place to dispose of e-waste), and aspects associated with cost (i.e. no cost associated with recycling and receiving a rebate at disposal) all figured significantly in householders "definitely" changing their current behaviours.

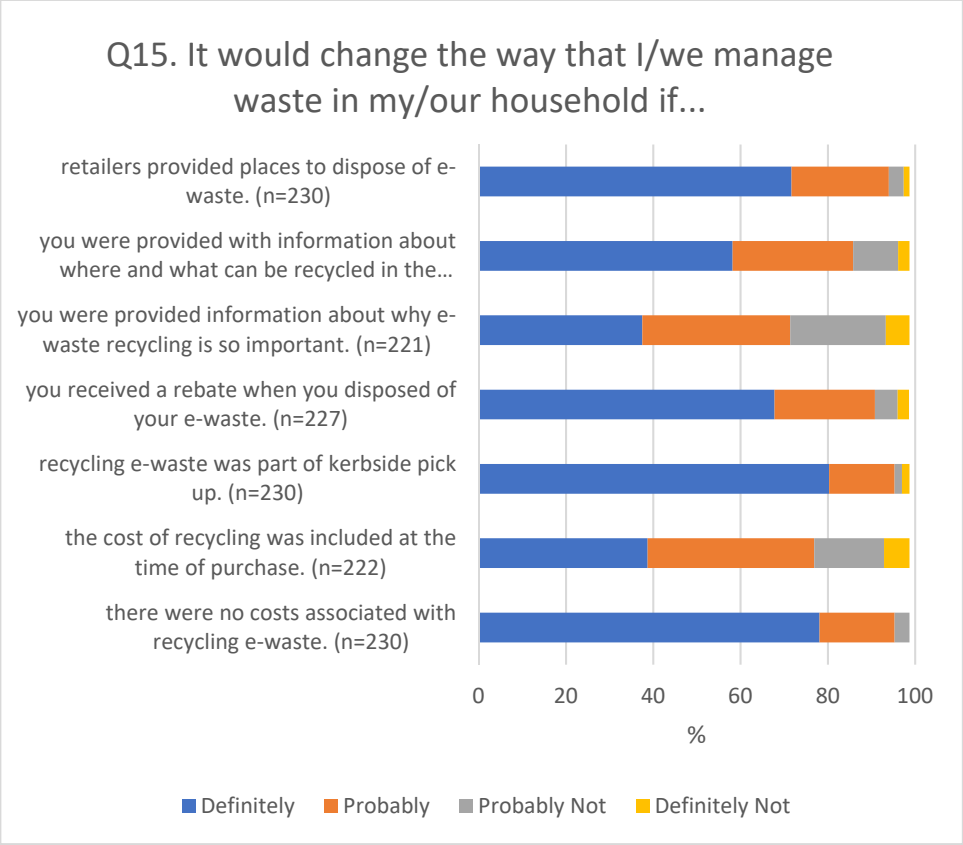



*Figure 6.9 Response distribution to possible e-waste behaviour impact statements*

## 6.4 E-waste Storage

International literature (see Chapter 4) has indicated that the levels of e-waste being stored could have an impact on the availability of e-waste services, and furthermore that householders may not be aware of the environmental impacts of storing e-waste. This section discusses the results of questions in the online survey that directly related to household storage of e-waste. Section 6.4.1 investigates how much e-waste is in storage in households in the Whangarei District, and Section 6.4.2 looks at the reasons why e-waste is being stored.

### 6.4.1 Number of E-waste Items in Storage

Question 12 (see Section 6.3.2) asked respondents if they stored the various types of e-waste in their household. To elaborate on these results two more questions were included. The first of these questions asked those respondents who indicated that they stored e-waste how many items in each WEEE category they had in storage, and introduced a new category of "power cables, cords etc." The result of this question is presented in Table 6.5, where the number of responses for each of the categories is recorded as *n* in the table. Of these response numbers, 124 respondents reported storing phones, followed by 94 reporting storage of SHA, and 93 reporting storage power cables/cords etc. ME had the lowest number of responses recorded at 15. The response rates are further highlighted in Figure 6.10, which shows that 50% of all respondents to the survey reported storing phones and between 35 – 40% of all respondents reported storing SHA, ICT and power cables, cords etc. Table 6.5 highlights that the majority of those that responded to this question stored one e-waste item for eight of the listed e-waste categories. Of the remaining three categories, the majority of those who responded stored two phones, with TLSE and batteries at the other end of the spectrum with the majority of respondents reporting that they had five or more items in storage. This was the same for power cables, cords etc.

*Table 6.5 Number of items participants held in storage by percentage with most common option highlighted*

| Number of items / E-waste type | 1 item | 2 items | 3 items | 4 items | 5 or more items |
|---|---|---|---|---|---|
| SHA (n=99) | 38.4 | 32.3 | 15.2 | 2.0 | 12.1 |
| LHA (n=62) | 46.8 | 30.6 | 11.3 | 8.1 | 3.2 |
| ICT (n=94) | 30.9 | 26.6 | 17.0 | 12.8 | 12.8 |
| HHD (n=71) | 43.7 | 35.2 | 8.5 | 8.5 | 4.2 |
| Phones (n=124) | 25.8 | 31.5 | 18.5 | 10.5 | 13.7 |
| AV (n=65) | 38.5 | 32.3 | 12.3 | 3.1 | 13.8 |
| LE (n=47) | 48.9 | 31.9 | 12.8 | 4.3 | 2.1 |
| ET (n=53) | 45.3 | 24.5 | 11.3 | 7.5 | 11.3 |
| TLSE (n=64) | 28.1 | 20.3 | 14.1 | 6.3 | 31.3 |
| Batteries (n=47) | 12.8 | 25.5 | 10.6 | 10.6 | 40.4 |
| ME (n=15) | 73.3 | 13.3 | 6.7 | 0.0 | 6.7 |
| Power cables, cords etc. (n=93) | 17.2 | 21.5 | 14.0 | 4.3 | 43.0 |

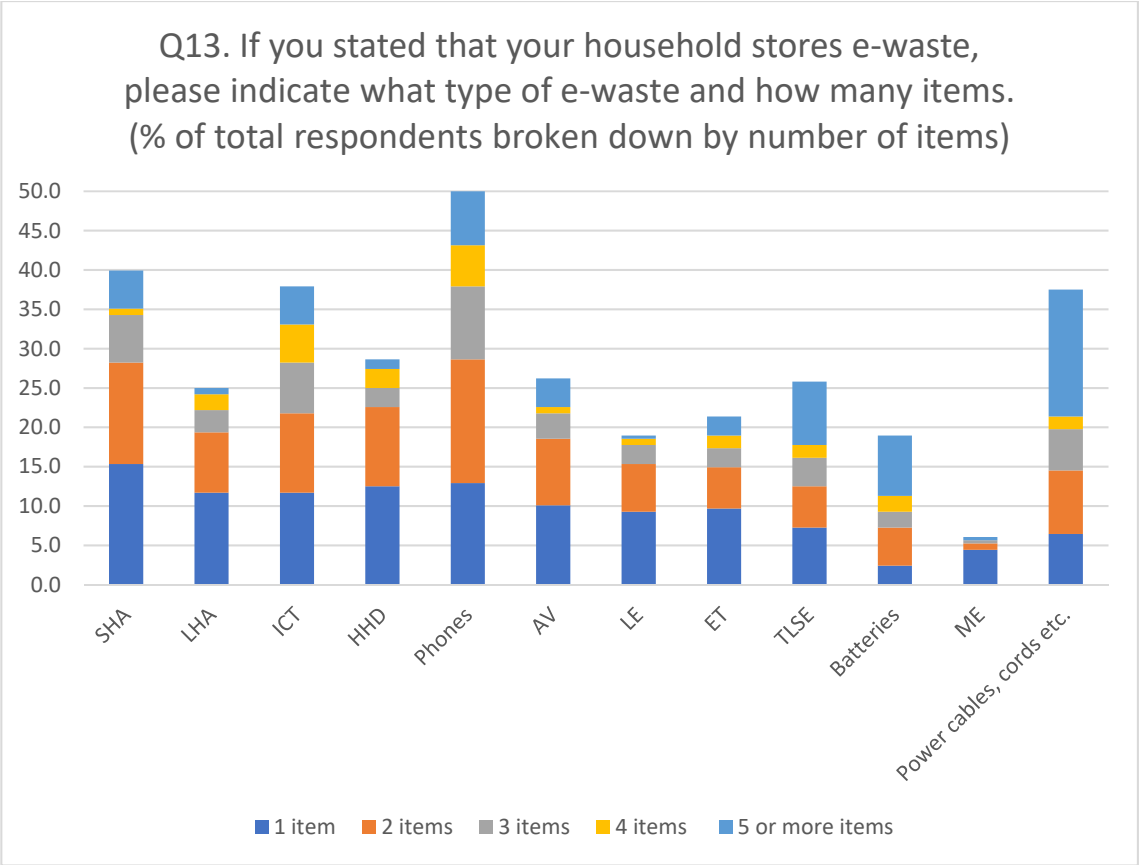



*Figure 6.10 Percentage of total respondents that indicated storing e-waste, further broken down by number of items*

### 6.4.2 Reasons for Storing E-waste

To further elaborate on some of the reasons why households might store e-waste, question 14 asked respondents to rate a series of statements on a scale from "true" to "not true". Figure 6.11 illustrates the distribution of these responses. The results indicated that data security concerns were not a significant reason for e-waste storage with less than 40% of respondents rating this as true or slightly true. However, the high cost of local recycling options, and household consumers being unsure about what to do with their e-waste, rated above 60% “true” or “slightly true” for both options. Around 50% of respondents stated it was “true” or “slightly true” that they stored e-waste to keep a spare/backup, and just under 50% stored e-waste due to perceived monetary value.

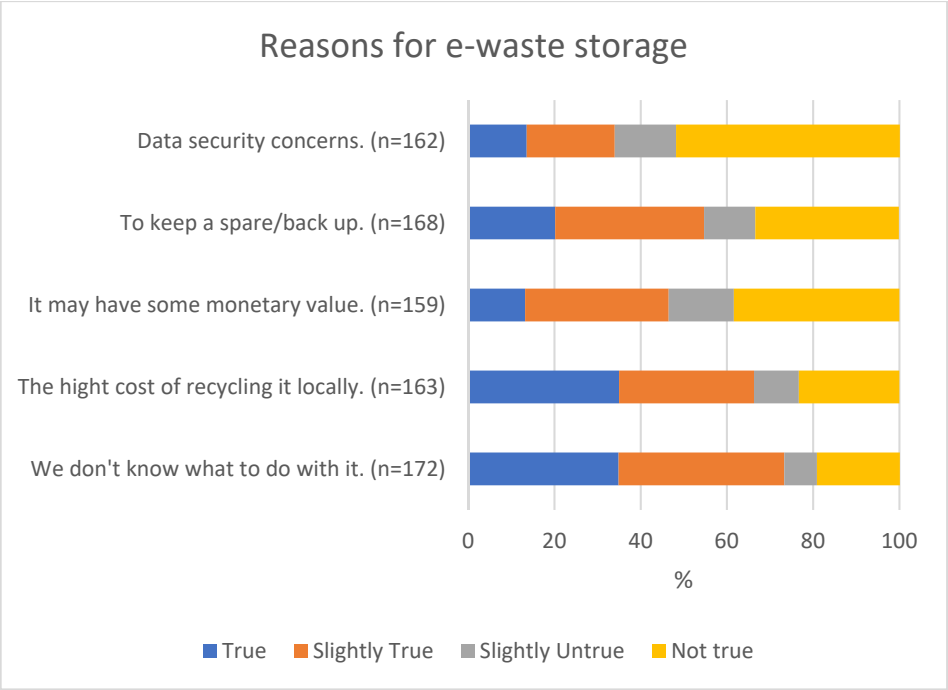



*Figure 6.11 Response distribution to reasons for e-waste storage statements*

Question 14 had a second part which asked respondents to elaborate in an open-ended response if there were other reasons, other than those listed in the aforementioned statements, that their household stored e-waste. A number of themes were taken from these qualitative responses. These included householders commenting that they had not yet got around to it, that they were saving it up to make a full load to the local refuse station, that they were "too lazy to go to town", and that they thought that they, or their husbands, might be hoarders.

Other responses included concerns with the services available, including cost,

> "Expensive to dump"

> "I moved into a rental property that has a TV and monitor dumped in the back yard. I will not do anything about it as it is too expensive."

lack of faith in services,

> "No assurance that it was recycled or disposed of responsibly"

and several respondents were unaware that recycling/disposal services were available or were unsure what to do with their e-waste.

Finally, some respondents stored e-waste for sentimental reasons, or because it may have some future uses.

## 6.5 E-waste Management

Part Four of the survey asked household consumers questions relating to local and national e-waste management. The questions were broken into local and national, and a number of the results were compared to an unpublished 2012 NZ-wide e-waste survey. Section 6.5.1 focuses on local e-waste management in the Whangarei District with Section 6.5.2 discussing results of questions relating to national e-waste management. Householders willingness to pay for e-waste recycling services is discussed on its own in Section 6.5.3, and finally, Section 6.5.4 discusses the qualitative results of an open forum for discussion on both local and national e-waste management that concluded the survey.

### 6.5.1 Local E-waste Management

The first of the questions in Part Four asked participants about their satisfaction with available e-waste recycling services. As illustrated in Figure 6.12, 45% of respondents stated that they were unsatisfied with the services available, while 10% were not aware of any local services. Only 4% of respondents were satisfied with the available services. To further elaborate on household consumer awareness of services available to them locally, respondents were asked if they knew where the nearest waste transfer station was to their home, and if they had used it to dispose of e-waste. 16% of respondents were unaware of their nearest transfer station, however, 84% were aware of their nearest transfer station, and 44% had used it to dispose of e-waste (Figure 6.13).

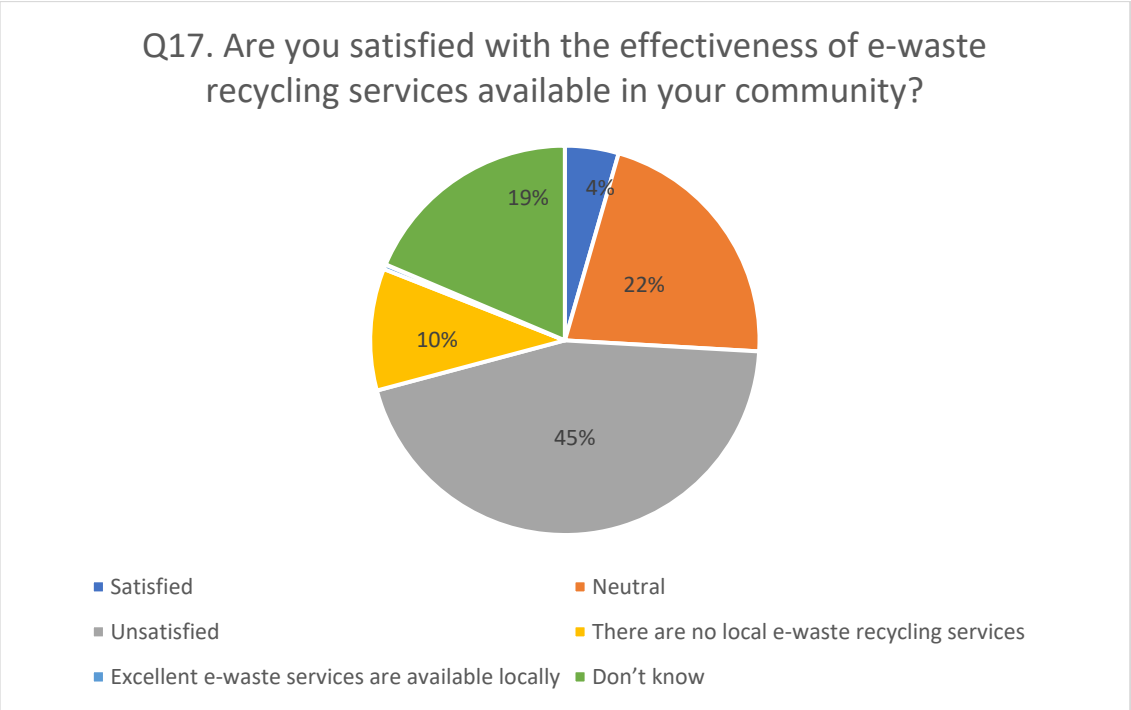



*Figure 6.12 E-waste services satisfaction by percentage (n=247)*

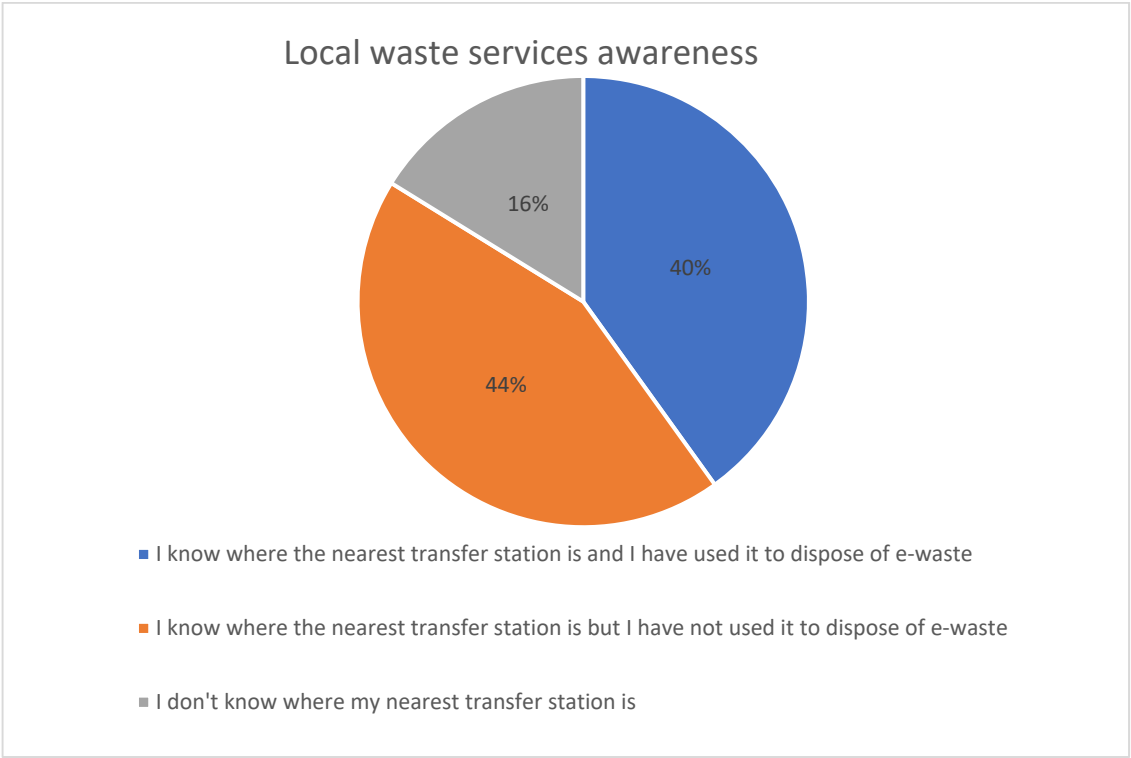



*Figure 6.13 Local waste services awareness by percentage (n=247)*

To review possible changes in the e-waste scape in NZ in the past five years, the results of question 17 (Figure 6.12) were compared with results from Hannon's unpublished 2012 NZ-wide survey (2014), that asked the same question. This comparison indicated a decrease in

satisfaction of local services, however Table 6.6 shows an increase in awareness of local recycling services available.

*Table 6.6 E-waste services satisfaction 2018/2012 results comparison (2012 results source: Hannon, 2014)*

| | 2018 Whangarei Result | 2012 NZ Wide Result | Variance |
|---|---|---|---|
| Satisfied | 4.4 | 12.6 | -8.2 |
| Neutral | 21.2 | 15.3 | +5.9 |
| Unsatisfied | 44.4 | 34.6 | +15.7 |
| There are no local e-waste recycling services | 10 | 16.5 | -6.5 |
| Excellent e-waste services are available locally | 0.4 | 4.1 | -3.7 |
| Don't know | 18.4 | 16.9 | +1.5 |

### 6.5.2 National E-waste Management

The second set of questions in Part Four of the survey asked respondents questions about e-waste management nationally. The first of these asked respondents to rate the 'overall effectiveness' of the current approach to dealing with e-waste in NZ as a whole. As illustrated in Figure 6.14, 57.2% of respondents rated the current approach as "poor" or "very bad" with a further 26.4% rating the current approach as "average". Only 4.8% rated the current approach as "good" or "excellent" with a further 10.4% indicating they were unsure.

Like question 17, these results were compared with Hannon's NZ-wide survey (2014), which asked the same question (see Table 6.7). 2.7% more Whangarei District respondents felt that the current approach is "good" or "excellent" than the nationwide responses in 2012, however, responses of "poor" and "very bad" also rate higher by 6%. It is also interesting to note the 16% decrease in the "don't know" response, implying that Whangarei District households are better informed than New Zealanders were as a whole in 2012.

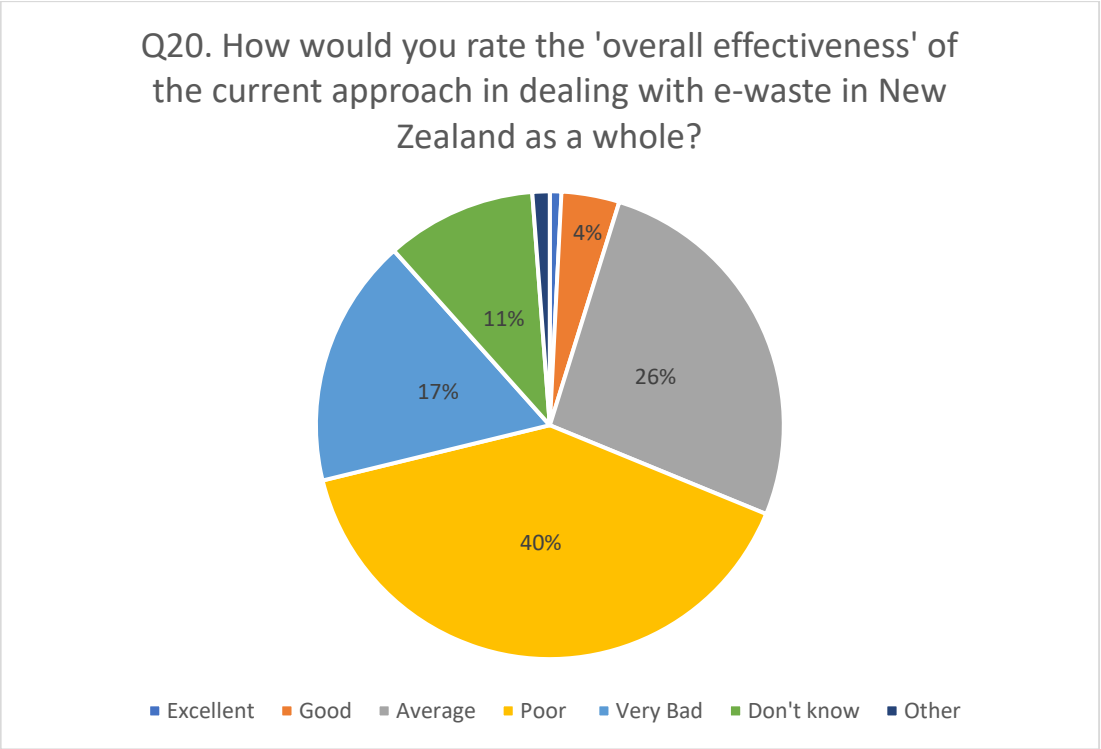



*Figure 6.14 NZ e-waste approach effectiveness by percentage (n=247)*

*Table 6.7 NZ e-waste approach effectiveness 2018/2012 results comparison (2012 results source: Hannon, 2014)*

| | Whangarei Result (2018) | NZ Wide Result (2012) | Variance |
|---|---|---|---|
| Excellent | 0.8 | 0.1 | +0.7 |
| Good | 4.0 | 2.0 | +2.0 |
| Average | 26.4 | 20.9 | +5.5 |
| Poor | 40.0 | 42.0 | -2.0 |
| Very Bad | 17.2 | 8.6 | +8.6 |
| Don't know | 10.4 | 26.4 | -16.0 |
| Other | 1.2 | N/A | N/A |

Question 21 asked respondents what, in their opinion, is the best approach for NZ to take when dealing with e-waste issues. These results were directly compared with Hannon's (2014) nationwide survey. Figure 6.15 shows that the results to this particular question are reasonably similar across both surveys. Free public drop off was the approach preferred overall in both surveys (70.8% in 2018, 76.8% in 2012), followed by the adoption of national e-waste recycling standards (52.4% in 2018, 66.5% in 2012). Some differences were seen in the other suggested options. However, options that required some government intervention (e.g. adopting national e-waste recycling standards, banning e-waste from landfill, government intervention being required selected specifically, and compulsory registration and licensing of e-waste recyclers)

rated highly in both sets of results, and keeping the status quo (e.g. user pays at drop-off, leaving e-waste recycling up to the free market, "status quo", and maintaining a voluntary only approach) rated poorly.

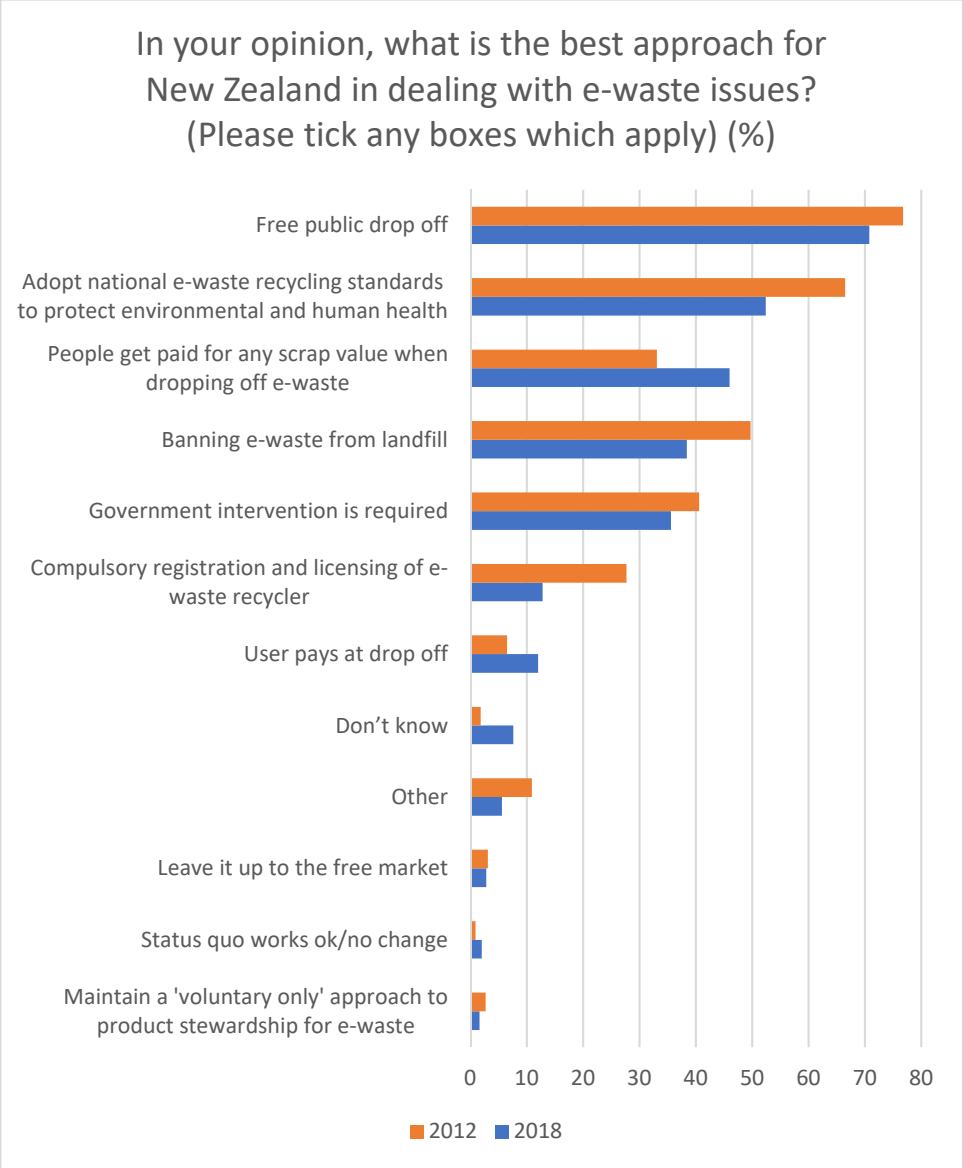



*Figure 6.15 Best e-waste approach for NZ 2018/2012 survey results comparison (2012 results source: Hannon, 2014)*

When responding to the question relating to the best approach for e-waste management in NZ, the 2018 survey respondents were asked to elaborate if they selected "Other" as an option. Many inferred that compulsory product stewardship or extended producer responsibility was necessary for NZ:

> "Compulsory product stewardship."

> "Mandatory product stewardship not voluntary."

> "People that make it should have to take it back for recycling."

> "Stores who sell products should be responsible for their collection and recycling and this cost should be built into the product."

> "Commercial premises should be bound to recycle their e-waste."

> "Add the recycling fee to the cost of the product in the first place."

Some suggested other options for disposal:

> "Make it part of rubbish pick up (curbside) [sic] or once a month so people can drive around and help themselves."

> "Drop off points plus collection options - at a higher charge though."

> "Have regional e-waste stations and curb [sic] side pick up."

> "Reward eco disposers with rates rebates or other rewards."

> "time taken to drop off is sometimes a barrier to recycling, kerbside pickup even once a month would remove this."

And others thought that education was important:

> "If people understood how much of a hazard it is to our health I think we would take more responsibility. The truth of the matter is that we are selfish beings, so telling the masses that e-waste affects the environment doesn't have much impact. Tell them how irresponsible disposal of e-waste affects our bodies... then we might have more interest and action."

> "I would be surprised if most people knew what to do. Educate."

> "To be educated about e-waste and the effects it has on our health and well-being as well as the environment. Maybe statistics of how it affects us?"

Overall, the responses to this question indicated the respondents' desire for change, and that this should be led by local and central government, with producers taking further responsibility.

### 6.5.3 Willingness to Pay

Question 19 asked householders how much they would be willing to pay for user friendly, quality assured, environmentally sound, healthy and safe e-waste recycling. As shown in Figure

6.16, 60.5% of respondents indicated that they would be willing to pay a fee of $1 to $10, with only 21.4% being unwilling to pay anything, and 19% wanting to be paid for the 'scrap' value of their e-waste.

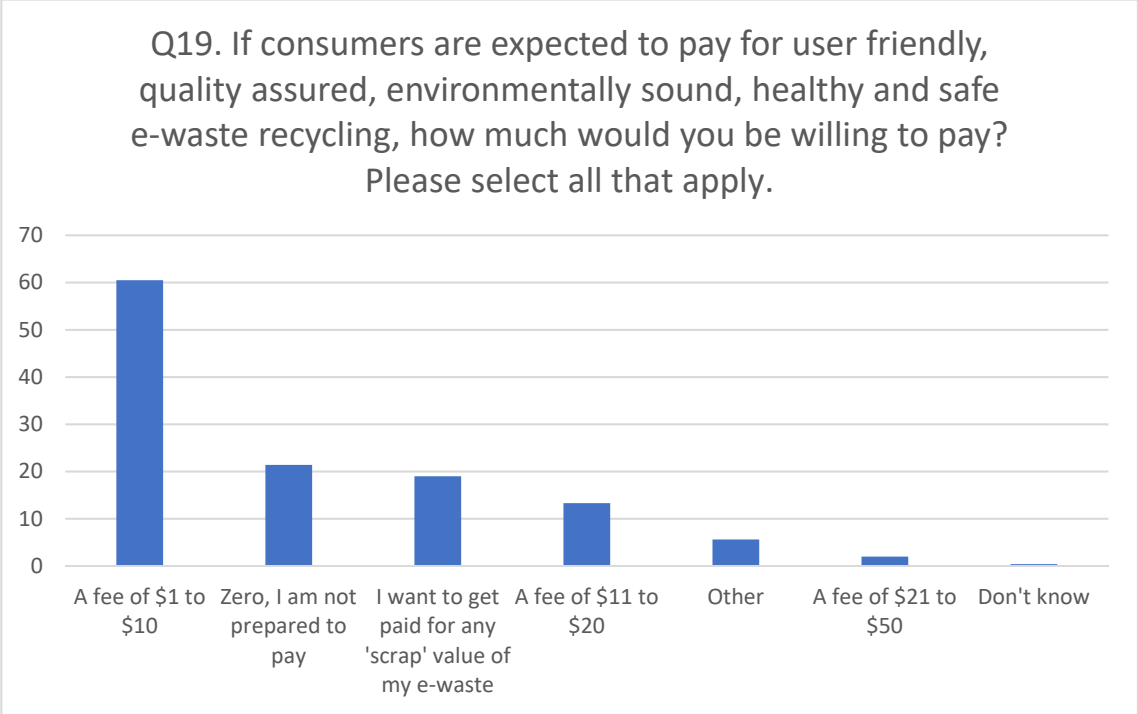
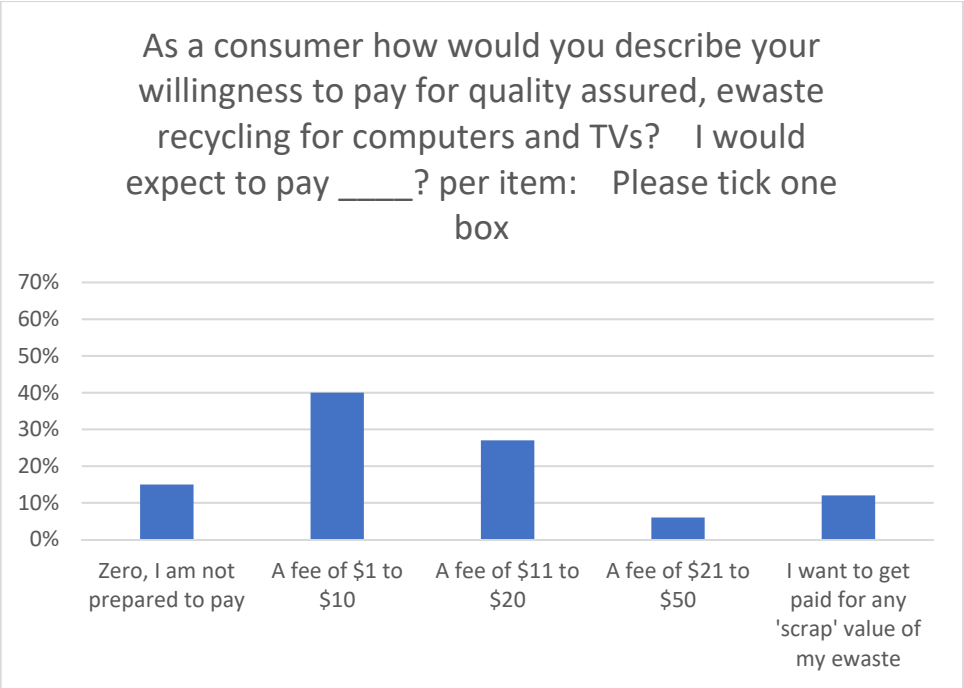



*Figure 6.16 Percentage of respondents willing to pay for e-waste recycling*

While the responses to this question could not be directly compared to Hannon's survey, as the questions slightly differed, Hannon's nationwide 2012 results also showed that the majority of respondents would be willing to pay a fee of $1 to $10 (see Figure 6.17), and overall in both examples, far more respondents would pay for user friendly, quality assured, environmentally sound, healthy and safe e-waste recycling, than refuse to pay.



[39]

*Figure 6.17 2012 e-waste survey results for willingness to pay (Adapted from: Hannon, 2014)*

Further to the options given regarding willingness to pay, Whangarei respondents that selected "Other" as an option, were asked to elaborate. Some respondents felt payment for e-waste management was, or should be, part of the rates programme, and others felt that the charges or rebates should depend on the item being recycled.

Some respondents elaborated on why they thought there should be no cost to recycle e-waste:

> "I pay as no other option however the cost should be applied when purchased and free to drop off."
>
> "Waste recycling is a business opportunty [sic] therefore should be self funding and no charges should apply."
>
> "I'd like it to be free because many people can't afford it and it would possibly prevent them from fly tipping."

And others felt they did not have enough knowledge to make a decision on the question:

> "I don't know much about e waste so I can't make any decision. All I know is I have a stack of old tvs [sic] which some don't work taking up space in my shed because it's too expensive I feel to dispose of them."

[39] "Quality assured" relates to quality recycling practices utilising recycling standards.

Finally, one respondent felt ethical recycling was especially important, "as [e-waste] is normally recycled in the poorer, third world."

### 6.5.4 Final Comments

The final question of the survey asked respondents if they had any other comments they would like to make on e-waste management either in the Whangarei District, or in NZ as a whole. Sixty-seven respondents took up the opportunity. Several themes came through during this forum, as illustrated in Table 6.8.

*Table 6.8 General themes from open forum question*

| | |
|---|---|
| More educational resources required | 17 |
| User pays systems needed | 2 |
| Free drop off/costs are too high | 10 |
| Need for action | 7 |
| Charge at purchase point | 3 |
| Government intervention required | 7 |
| Extended producer responsibility themes | 7 |
| Consume less | 1 |
| Rebates/incentives to recycle required | 3 |
| Issues with current management in Whangarei District | 7 |
| Illegal dumping/flytipping | 5 |
| Off topic | 3 |
| TOTAL RESPONSES OVERALL | 67 |

As illustrated in Table 6.8 some respondents discussed the need for education:

> "I don't know a lot about e waste management and I'm sure a lot of other people are the same. I think it would be good if there was a focus on getting more information about it out to people so that there is more awareness about the subject."

> "Educate our young people. The legacy our parents and grandparents are leaving us is pretty grim, we need to teach our young people what to do with e-waste in a world where everything is disposable…Talk to young leaders in the community to see if they are interested in spreading the word."

> "First time hearing about e-waste. I would like to know more about how it affects our health and well-being. If it does affect us when we do not have any use for us, it must have even more of an affect [sic] on us when we ARE using it."

and action:

> "We need to get organised with solving this problem soon."

> “our clean green image is in danger - and our planet is still warming up: it is urgent to get into stronger action with this!”

Respondents also gave opinions on how e-waste could be better managed, including the requirement for government intervention and extended producer responsibility:

> “There should be a charge levied on all electronic goods at the time of purchase which covers the cost of recycling is that people don’t have to pay at the end of life of the product.”

> “Mandatory product stewardship should be implemented to cover the cost of collections.”

> “Manufacturers need to work alongside retailers to provide drop off places.”

> “Retailers should need to take back all waste free of charge.”

> “So much waste across the board, those making and selling the products and packaging are the ones that need a second look as consumers choices are limited and putting the problem on individuals won't stop the flow of products and waste from coming in no matter how much we recycle at the ground level. It makes a difference but won't deal with the problem long term.”

> “They need to wake up.  Technology is ever evolving, and we need to keep up with the rates of people discarding what no longer serves them.”

And some commented on the high cost of e-waste recycling:

> “I can’t afford the transfer stations charges.”

> “Too expensive to do.”

The illegal dumping of e-waste and its possible causes was also a topic discussed:

> “If you put a price on recycling a majority will not bother and keep illegally dumping their waste.”

> “Convenient and cheap e waste disposal could help with illegal dumping.”

> “badly needs fixing what we have, no wonder so much fly-tipping.”

As was found in question 21 of the survey (see Section 6.5.2), the common theme in the respondents’ comments was that change is required.

## 6.6 Conclusion

248 Whangarei District householders engaged in the e-waste survey, a reasonable response rate which allowed for a 6% margin of error (see Chapter 5). Some demographic factors of these respondents were representative of the District, such as ethnicity, where others were over-represented, such as higher income and education levels, and a higher representation of left-wing political supporters. Female respondents also greatly outnumbered male. When behaviour, both relating to general recycling, and e-waste recycling, were compared against demographic factors, no statistically significant relationships were found, which implies that these factors do not impact general household or e-waste recycling behaviours in the Whangarei District.

General household recycling habits were well-adopted by Whangarei District residents, and overall recycle/reuse options were the preferred and most engaged in disposal options undertaken by households for most e-waste categories. However, landfill options were still high, with some e-waste categories most commonly disposed of in household waste, including batteries and lighting equipment. Further to this, 29.6% of e-waste was reported as being donated to charity, and 19.5% was reported as being stored.

The survey results indicated that at least 50% of household consumers store e-waste in their homes, and most e-waste categories have items being stored, especially phones, toys, leisure and sports electrical equipment, batteries, and cables, cords etc. The reasons household consumers are storing e-waste vary, but the high cost of recycling locally, and being unsure of what to do with e-waste, rated highly among these reasons.

Overall, Whangarei District householders appear to want to see change to the current e-waste management options and services both locally and nationally, with a large number being willing to pay up to $10 per item to have e-waste disposed of in a safe and appropriate manner. Further to this, the need for government intervention into national e-waste management practices was a theme that came through not only survey question responses, but also through comments made by the survey respondents.

The results of this survey showed some factors that were expected, such as rates of e-waste disposal, and the fact that some e-waste is being landfilled, but also some unexpected results, for example that a high percentage of e-waste is donated to charity. The fact that demographics did not play a significant role in waste disposal behaviours was also unexpected, however disappointment in the current management services and options, and the perceived requirement of government intervention were not. These and other key findings of the survey are investigated further in the following chapter, with the final chapter (Chapter 8) making overall conclusions and recommendations for both current policy makers and future research opportunities.

# Chapter 7 – Discussion

The Whangarei District is located in NZ northern most Northland region and has an estimated population of 86,754[40] people. It was chosen as a case study to investigate household e-waste options, knowledge and behaviours in order to inform discussion around e-waste management policy, resources and services which could be specifically designed for the district. Whilst the Whangarei District (Whangarei) is unique, this study may bear some resemblance to other districts in NZ and will therefore have a degree of relevance in providing national decision makers with current data and contextualised information relating to the broad issues of e-waste in NZ. The research design was informed by a review of literature and was implemented via an online survey of Whangarei District residents, with its primary focus investigating the way e-waste is managed from a household perspective, in order to explore what factors may impact on these behaviours.

Demographics and general recycling habits were investigated as international research suggests that these factors may impact e-waste disposal behaviours (Section 7.1). The e-waste disposal behaviours of Whangarei households were considered (Section 7.2), including the storage of e-waste (Section 7.3), and aspects influencing these disposal methods (Section 7.1), including pro-environmental values and the value-action gap, and the impacts specific disposal methods may have were also discussed. The reasons why households disposed of e-waste were investigated and the causes considered (Section 7.2.1). Finally, e-waste management resources and services currently available in Whangarei, and in NZ as a whole, particularly relating to how the resources, services, and management frameworks overall, may impact on the e-waste problem both in the district, and nationally (Sections 7.1 .3 and 7.4), were discussed. Some discussion is had here in relation the Moser, Ekstrom, and Kasperson (2010) adaptation framework, a problem-solving model Moser, Ekstrom, and Kasperson applied to climate change adaptation which has been adjusted to provide a framework for adaptation to appropriate e-

[40] A 2017 estimation based on 2013 census figures and WDC Demographic Profile grow rates (WDC, 2013a)

waste management. Section 7.5 reflects on where both Whangarei, and NZ as a whole, currently sit in relation to the appropriate management of the e-waste problem.

When reviewing the findings of this thesis, it should be understood that the research undertaken specifically investigated the e-waste disposal 'intention' of Whangarei households, and not the 'actual' behaviours exhibited (for example via action research). Therefore, the value-action gap, and the fact that respondents may exaggerate pro-environmental behaviours through self-reported survey (see: Chapter 4; Farrelly & Tucker, 2014), need to be considered. The differences found between quantitative and qualitative survey results (see Figure 6.8) imply this limitation may also true for this research.

## 7.1 Influences on Household E-waste Disposal Methods

International research suggests there are several factors that may influence e-waste disposal methods (see Chapter 4), including socio-demographics, general recycling behaviours, pro-environmental values, and the e-waste disposal services available. This research found that socio-demographic, general recycling behaviours, and pro-environmental values did not have a significant impact on Whangarei household e-waste recycling behaviours per se (Sections 7.1.1 and 7.1.2), however the structure of the services available, including provision and cost, did have an impact (Section 7.1.3). However, it should be noted that the respondents of the survey exhibited predominantly left-wing political views which are often linked with pro-environmental behaviours, and exhibited higher levels of both education and income, which may have impacted these findings.

### 7.1.1 The Influence of Socio-demographics and General Recycling Behaviours on E-waste Disposal Methods

International literature reviewed in Chapter 4 indicated that various socio-demographic factors had an impact on household waste management, including both general recycling behaviours and e-waste disposal methods. When these aspects were investigated in the Whangarei District, socio-demographic factors were not found to impact general recycling or e-waste recycling

behaviours, however, research participants presented increased levels of income, education, and left-wing political views (see Section 6.1). This over-representation of both income and education level may have skewed the research findings as international research showed that these two demographic attributes can have an effect on both e-waste disposal methods and reasons for e-waste disposal. Example of these impacts include higher income households being more likely to generate higher volumes of e-waste than lower income households, and respondents with pro-environmental behaviours more likely to engage in waste practices higher up the waste hierarchy (Figure 2.3) (see for example: Martin, Williams & Clark, 2006; Schultz et al., 1995; Rice, 2014). International literature also suggests that age and household makeup can affect disposal methods (see for example: Martin, Williams & Clark, 2006). These aspects were more closely represented in the survey sample and yet showed no significant impact on disposal method. The findings of this case study suggest that socio-demographic factors do not have a significant influence on household e-waste management disposal behaviours in the Whangarei District.

Further to socio-demographic factors, it is argued that general recycling behaviours impact e-waste recycling behaviours, with households that engage in general recycling behaviours more likely to engage in e-waste recycling behaviour (Saphores, Ogunstein, & Shapiro, 2012). General household waste recycling could be considered normative behaviour[41] in the Whangarei District, likely due to the kerbside municipal recycling services that have been available on a weekly basis in the district since 2003 (WDC, personal communication, October 8, 2018). Over 50% of households stated that they "always" recycle all of the six waste types that are recycled in the district (glass, metal, plastic, paper, cardboard, aluminium), with over 70% recycling plastic and cardboard, and almost 90% of households recycling glass (see Figure 6.1). The significant improvements in general household recycling infrastructure over the past 20 years in NZ (see Figure 7.1), influencing the acceptance of recycling as normative behaviour (Barr et al.,

[41] Normative behaviours are societal behaviours that are agreed upon by society as correct (i.e. social norms).

2003), could explain the reason there are no significant relationships found between socio-demographic factors and general recycling in this research, nor between general recycling and e-waste recycling for that matter. Furthermore, most of the literature reviewed for Chapter 4 that indicated connections between these factors was conducted over 10 years ago. If this research was repeated today, different findings may ensue as significant changes in both waste management, and awareness of the environmental issues surrounding waste, have occurred in this time, and more significant changes are likely to occur in the near future (see for example: Moorby & Huffadine, 2018; Woolf, 2018).

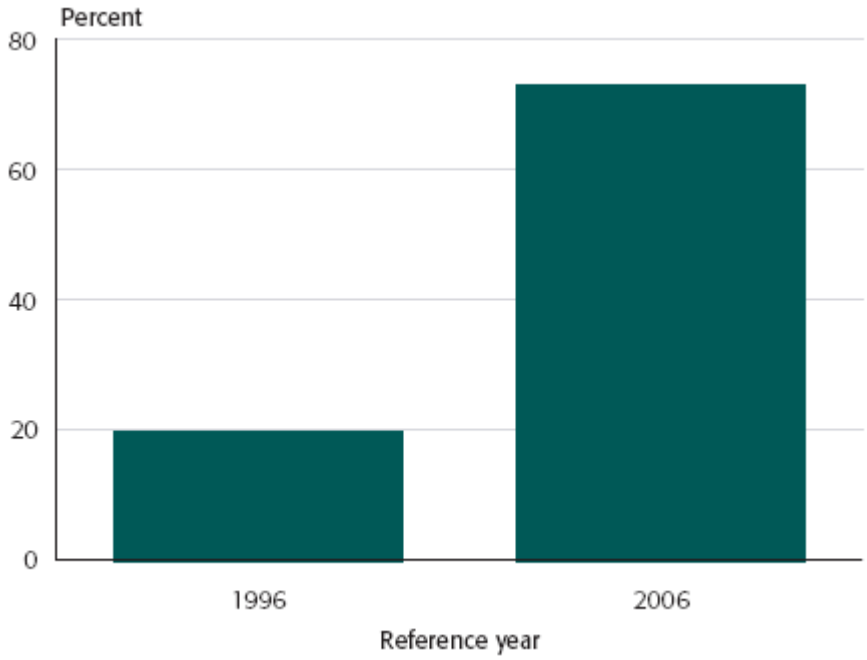



*Figure 7.1 Proportion of New Zealand population with access to kerbside recycling in 1996 compared with 2006. (Source: Stats NZ, 2008)*

### 7.1.2 The Influence of Environmental Knowledge and Pro-Environmental Values on E-waste Disposal Methods

The Whangarei case study found that over 70% of survey respondents recognised that e-waste creates significant environmental and social problems, with the same number understanding the role of recycling in environmental protection. These figures indicate that Whangarei residents have high levels of environmental knowledge and understand the impacts of waste, however this could have been influenced by the higher education level and left-wing political views reflected in the sample (see Chapter 6).

The survey of Whangarei households also aimed to ascertain the pro-environmental values of the respondents, in order to ascertain any influence these may have on e-waste disposal. Two questions, where respondents were asked to rate statements on a five point sliding scale from 'strongly agree' to 'strongly disagree', were asked to investigate this. This first of these showed clear pro-environmental values with over 90% of respondents either strongly or moderately agreeing that they felt a 'moral obligation' to recycle due to the detrimental impacts of waste on the environment. This moral obligation is partly exhibited in the high general household recycling rates discussed above (Section 7.1.1). However, when respondents were asked if households like theirs should be blamed for the environmental problems caused by e-waste, they were not so sure.

When asked if households like their own should be blamed for environmental problems caused by excessive waste generation, over 40% either "moderately" or "strongly" disagreed with the statement, with a further 19% being "unsure". The results for this particular statement were reasonably well spread between the five options given (see Figure 7.2). These results indicate that there appears to be confusion as to who is to blame for waste creation: producers or consumers. One side of this argument is that producers are responsible for excessive waste generation for reasons of planned obsolescence and excessive packaging, among other things. Others argue that consumers are responsible as they are the ones purchasing the (often cheap) goods that are creating the waste, supporting producers to keep producing them (for further discussion on this debate see for example Braungart & McDonough, 2008; Slade, 2006). Some argue that this confusion could be resolved by extending producer responsibility (see Chapter 2).

This study did not investigate reasons for purchasing EEE products, however addressing this question could also shed light on what factors drive the generation of e-waste NZ, as could further targeted questioning as to the responsibility of waste creation. While the uncertainty around who is responsible for waste generation may not have an influence on e-waste disposal behaviours necessarily, it may influence purchasing choices and how policies could be framed.

For example, where householders' feel the responsibilities lie for the creation of waste could impact where they feel the costs of these services should lie, and, as shown in Section 7.1.3, cost can be a significant barrier to engagement in e-waste recycling services.

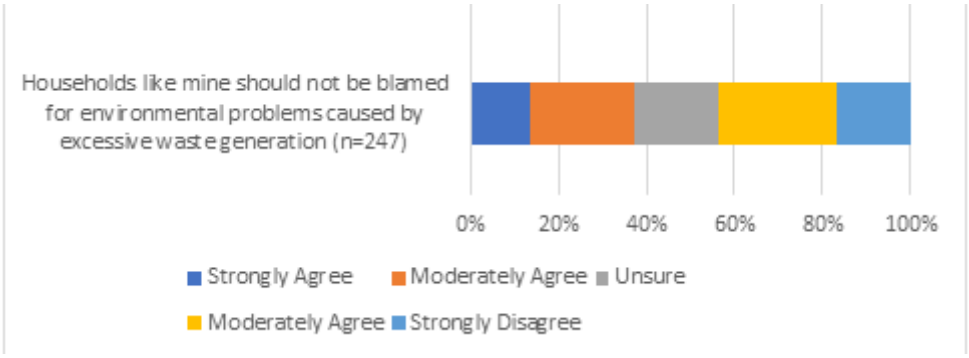



*Figure 7.2 Survey responses to question asking who is to blame for environmental problems stemming from waste generation (for full results see Chapter 6).*

### 7.1.3 The Influence of E-waste Disposal Services on E-waste Disposal Methods

The provision of services is vital to the success of any waste programme (Barr et al., 2002). Awareness of these services, and the costs related, are considered to have a significant influence on appropriate e-waste disposal methods (Barr et al., 2002; Tonglet, Phillips, & Bates, 2004). Awareness of the waste services available to households did not seem to be an in issue in the Whangarei District, with only 10% of respondents unaware of local services, however, of those that were aware of the services available, only 44% reported having used the services to dispose of e-waste. Respondents did, however, raise concerns about the quality of these services provided with only 4% satisfied with the services available. This was illustrated through respondent comments relating to the way e-waste was managed at the Re:Sort transfer station (the main transfer station in Whangarei). For example, some respondents indicated that when they intended to recycle their e-waste they were either told that it was going to end up in landfill, or they actually saw e-waste being disposed of this way. This is a significant concern for engagement in these services.

Because of the cost to dispose of e-waste appropriately (i.e. for end of life disassembly and recycling, particularly CRT computer monitors and TVs which have a $26 drop-off recycling cost in the district), if residents are not confident that e-waste is recycled of appropriately, they

could choose to dispose of it inappropriately, either because they lack confidence in the system and/or simply in order to avoid the costs associated, or store these items in their homes (Section 7.3). The cost is already a barrier to engagement to appropriate e-waste management, as indicated by 95.3% of respondents stating it would change the way they manage e-waste if there was not cost associated, and 76.9% stating they would change their behaviours if the cost was included at the time of purchase. One survey respondent spoke of how when they moved into their new home they found that two CRT TVs has been illegally dumped in their hedgerow. Due to the cost to recycle these TVs ($52) this single parent was going to have to store the e-waste, as her pro-environmental values would not allow her to dispose of the TVs inappropriately. While there were no statistics collected during this study to ascertain the specific impact of cost on recycling rates, it is known that cost can impact flytipping rates (see Martin, Williams, & Clark, 2006; Webb et al., 2006), and both the qualitative responses, and the literature reviewed (see for example Fahy & Davies, 2007; Kollmuss & Agyeman, 2002; Rice, 2014), imply that cost has a significant influence on the decision to recycle.

Many of the qualitative responses received via the survey indicated the main cause of dissatisfaction with the services available in Whangarei was the cost to recycle e-waste. Various suggestions were made as to how this could be rectified, including providing e-waste recycling coupons to householders via rates payment receipts, as many felt the cost of recycling was already covered in their council rates. Several respondents felt that the cost to recycle e-waste (and waste disposal generally) was a primary cause of illegal dumping, an opinion supported by this research, which found that between 60 to 80 instances of fly-tipping are recorded in the district each month (see Chapter 3), likely influenced by waste disposal costs. However, in a separate question which investigated respondents' willingness to pay for appropriate recycling services, 60.5% of respondents suggested they would be happy to pay a fee of between $1 and $10, and only 21.4% were unwilling to pay anything at all. This may suggest that it is the cost, and not the requirement to pay for recycling, that is of concern, and that these costs could vary depending on the product being disposed of, with some producers perhaps even providing a

rebate, depending on the e-waste management model adopted. For example, the timing of the cost being applied could be a factor to engagement in recycling services. Some qualitative responses suggested that cost should not be applied at the disposal end of the product lifecycle, but at the time of purchase, a common component of an EPR scheme. This component, known as advanced disposal fees (ADF), can also be set up to provide rebates on disposal (see ADF, Chapter 4), which may create further engagement in services. EPR is further discussed in Section 7.4.

## 7.2 Household E-waste Disposal Methods and Reasons for Disposal

According to WDC figures Whangarei households are recycling 31.72 tonnes of e-waste through municipal services each year (see Chapter 3). However, this study predicts that this is barely 1.8%[42] of the e-waste generated in the district each year[43]. When asked to indicate how their household disposed of e-waste, 44 – 74% of residents reported recycling and reuse methods, which contradicts the low figure presented by WDC. Section 7.2.1 describes the results of the self-reported e-waste disposal intentions of the survey respondents, and Section 7.2.2 investigates some of the reasons for this disposal, finding obsolescence (including both planned and technological) a key factor in e-waste disposal in the Whangarei District.

### 7.2.1 Methods of Household E-waste Disposal

When Whangarei households were asked to select how, out of a list of options, they would dispose of e-waste, the highest single category disposal method was to throw away with household rubbish with an average of 29.6% of e-waste disposed of this way across the e-waste categories. However, when individual options were grouped together in recycle/reuse options, landfill options, and 'other' options (see Chapter 6), the majority of respondents selected recycle/reuse options such as recycling at the local waste transfer station, giving away to friends and whānau, selling, or returning to the supplier.

[42] 31.72 tonnes recycled annually / 1743 tonnes possibly created
[43] 1743 tonnes based on a 2017 estimated population of 86,754 (WDC, 2013a) and using the estimated annual e-waste rate of 20.1kg/person (Baldé et al., 2017).

When the average across the e-waste categories for the quantitative questions were calculated, and the qualitative results were considered, between 44 - 74% of e-waste was reportedly disposed of via recycle/reuse methods. However, the volume of e-waste processed via WDC contradicts this finding, as only 31.72 tonnes of e-waste is reported by WDC as being recycled in the last year (only 1.8% of the estimated e-waste generated each year), where these findings predict it should be between 766 and 1289 tonnes[44]. While some e-waste may be being recycled or reused in other ways (i.e. returned to suppliers, given away to friends and whānau, sold, etc.), it is unlikely that the entire volume of the remaining tonnage is being recycled/reused this way. This is illustrated in the discrepancy between the 77% recycle/reuse figure from the quantitative questioning methods, compared with only 44% from the qualitative questioning methods, where the utilisation of other recycle/reuse options were greatly decreased.

This may also highlight the value-action gap where 77% of respondents may have intended to recycle their e-waste in the quantitative *intention* question framing, but only 44% had *acted* that way in the past when asked as a self-reported historic activity question. It is also important to note here that reported disposal (recycling) rates during the quantitative questioning varied depending on the e-waste category. For example, the results of this research supported international findings that small e-waste is commonly disposed of with household rubbish (Darby & Obara, 2005), with batteries (68%) and lighting equipment (70.4%) reported as being predominately disposed of this way, and small household appliances following behind (39%). Whangarei does not have any specific recycling initiatives for lighting equipment or small household appliances, other than those available at the transfer stations (see Chapter 3). However, a free battery recycling collection initiative was launched in mid-2017 by EcoSolutions, who work in partnership with WDC (see Chapter 3). While it is yet to be seen if this initiative will make an impact on battery disposal methods, at the time the survey was conducted, 10% of residents reported using the scheme.

[44] 44 – 74% of a possible 1743 tonnes possibly created in the district annually.

Landfill options (disposal with household rubbish, or with general waste at a transfer station) were the second most common disposal options selected overall, with more e-waste being disposed of with household rubbish than with general waste at the local transfer stations. Considering the average across the e-waste categories for the quantitative question results, and the qualitative questions results, between 37 - 39% of e-waste was reportedly disposed via landfill. Using the estimated e-waste generation rate of 1743 tonnes per year in Whangarei (based on Baldé et al., 2017), these figures imply that over 600 tonnes of e-waste is landfilled in the district each year. This estimate aligns with the national estimation of 88,100 tonnes of e-waste landfilled in NZ each year (see Chapter 3).

Almost all respondents knew how they were disposing of (or intended to dispose of) their e-waste with very few reporting they did not know. However, 19. 5% ($\bar{x}$) of e-waste was stored across the e-waste categories, and some respondents suggested that this was an option if they were not sure what to do with it. Many respondents indicated that they donated e-waste to charity, with more choosing this option than those who chose to recycle or give away to friends and whānau. However, charity donations are not considered a recycling/reuse option, due to the negative impacts of a large number of these donations both nationally and internationally. In NZ, donations of e-waste, and other inappropriate materials, is becoming an increasing concern for charities (see, for example: “Dumped goods…”, 2018). While some NZ charities collect e-waste to raise money by recycling e-waste appropriately (for example Re:Mobile), scoping conversations, and interviews conducted for previous research on this topic by the author (Blake, 2016), suggest some charities/recyclers who collect e-waste strip the parts of value and landfill the rest (see Chapter 3). More targeted research into this is assertion is required in order to fully explore this. Further to this, many charity organisations, such as the Salvation Army, who have charity shops that sell second-hand goods (also known as Opportunity Shops or ‘Op Shops’), are increasingly concerned about receiving inappropriate donations, and some no longer accept electronic goods (see Figure 7.3).This refusal of electronic goods is mostly due to the volumes being donated, and the costs incurred to both professionally test the products and to

dispose of them if they are not fit for sale. In other cases, charities already have too many of the same item which links to obsolescence where things are replaced for fashion reasons (for example) and not because they are no longer working (see Chapter 1 for discussion).

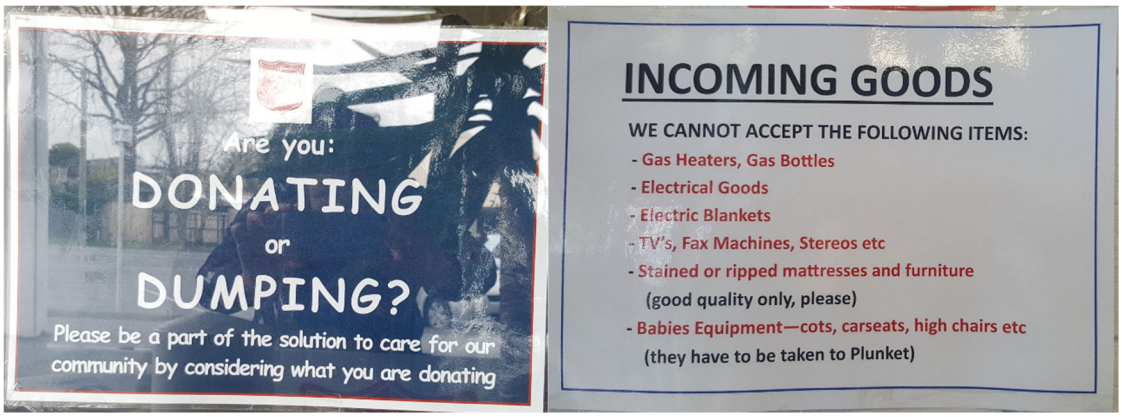



*Figure 7.3 Signs in a Salvation Army op-shop illustrating the donation issue, and advising that electronic goods will no longer be accepted for donation (Source: Blake, 2018. Photographed with permission).*

When respondents were asked to report, in their own words, how and when they had most recently disposed of e-waste, the resulting data painted a different picture from the previously discussed quantitative findings, with only 4% of e-waste reported as being sent to charity. Recycling and landfill rates were similar to those found in the quantitative results, however, reuse options, such as giving away to friends and whānau or selling, were greatly reduced with only 10% of respondents reporting these activities as historic methods of e-waste disposal, compared with 47% ($\overline{x}$) in the quantitative responses. Discrepancies of this nature are common between qualitative and quantitative survey responses ("Why use mixed methods", 2015), and why a mixed method approach was chosen, as it allowed for a deeper analysis and triangulation of the data presented. These discrepancies also illustrate the value-action gap where respondents may intend to dispose of their e-waste appropriately, for example, but actual behaviour, in this case historic reported behaviour, contradicts this intention (Barr et al., 2003). The findings of this research support the findings of Barr et al. (2003), as the survey results indicated pro-environmental beliefs, and the knowledge and understand that e-waste recycling is a good for the environment, did not necessarily translate into actual recycling behaviour.

The survey results indicated that e-waste could be being disposed of by up to 82.4% of households over a two year period in the district. WDC reports formally recycling only 31.72 tonnes of e-waste in the last year, 1.8% of a possible 1743 tonnes of e-waste estimated as being generated in the district each year (see Chapter 3). Even if the total e-waste generated in the district was calculated for only 82.4% of the population over a two-year period, this still equates to approximately 718 tonnes of e-waste[45] being disposed of in the district each year. Considering WDC data relating to e-waste recycling volume (see Chapter 3), these figures suggest that only 4.4% of this is appropriately recycled, almost 6% shy of Hoeveler's (2008) estimation that 10% of e-waste is being recycled in New Zealand each year. Regardless of whether the forecast of 1743 or 718 tonnes of e-waste generated in the district each year is used, the WDC provided e-waste recycling data suggests that there is a significant amount of e-waste being inappropriately managed in Whangarei, which could have detrimental environmental and health impacts if the issue is not rectified.

### 7.2.2 Reasons for Household E-waste Disposal

There were three main themes prevalent when investigating reasons for e-waste disposal, all of which related to poor product design, and lack of repair-ability, functionality, and usability. However, the reasons for household disposal of EEE varied relating to the type of product. Storage of e-waste, was influenced by different factors, and are discussed separately in Section 7.3.1.

When Whangarei householders were asked why they might dispose of e-waste, the three top reasons across the e-waste categories was "high repair cost/cannot be repaired". This was followed by "instability/malfunction during use", and "no longer useful to me or my household" respectively. The first of these two reasons directly relate to product design and cost. As shown in Chapter 2, product design is a significant contributor to e-waste volumes, specifically where products are designed to break (Ubeda, Barrat, & Dannoritzer, 2010), and it is cheaper to buy a

[45] 20.1(kg generation rate per year) x (86,754 x 0.824) (population) / 2 (years) / 1000 (to get to tonnes)

new item than to repair a broken one. One respondent specifically commented that they "couldn't afford the stuff that doesn't break", indicating that a 'disposable' culture is significantly impacting e-waste volumes. Qualitative survey responses depicted consumers purchasing cheap EEE which they expect will have a short lifespan, rather than spending more money on better quality products, or paying for products to be repaired, findings supported in international research (for example see: Chapter 1; Martin, Williams & Clark, 2006). Issues relating to the e-waste repair-ability and repair cost specifically affected small household appliances, which was to be expected. However, this also affected large household appliances, audio visual equipment and lighting equipment. While this was expected for audio visual and lighting equipment, it was not as expected for large household appliances, particularly due to cost to replace these items.

Instability and malfunction during use was the second highest reason overall for households to dispose of e-waste. This response is closely linked to the first response as the instability/malfunction experienced could likely not be repaired. There are various reasons for instability or malfunction, including design factors, the end of a component's life, such as internal motors, batteries that cannot be removed/replaced, etc. (Gurauskienė, 2008; Slade, 2006), along with single use items such as batteries and lightbulbs. Batteries and lighting equipment featured highly in this response by householders, with electronic tools also rating high here.

"No longer useful to my household" was a response that was found to be most common for toys, leisure, and sport equipment (TLSE) more so than any other category, however information and communication technology (ICT) equipment, cellphones, and handheld devices also rated highly as being no longer useful. While the question did not elaborate on why an item may no longer be of use to a household, the TLSE category may be high in this category due to aging children where toys are no longer played with, unused sport and leisure equipment where households no longer participate in specific activities, and possible impulse purchases of these

types of goods. To further clarify why EEE items are no longer useful to a household, targeted research would need to be conducted.

Cellphones, handheld devices and ICT equipment were commonly no longer useful to households for two reasons, they had upgraded to a newer version for fashion / trend reasons, new features, and the like, or, as one respondent stated, "I have to upgrade electronics almost solely on the fact that they no longer function with current products, e.g. memory is no longer large enough to run current programs". These memory issues directly relate to Moore's Law[46], which refers to the ever-increasing capabilities of technological advances. These technological advances, and a lack of compatibility between devices and/or components, as discussed in Chapter 2, make products obsolete and therefore, no longer of any use (E.g. analogue only TVs became obsolete when digital transmission replaced analogue in NZ in 2011/2012, initiating the TV TakeBack Scheme discussed in Chapter 3). Whangarei households also indicated that a lack of new or advanced features were a reason for the disposal of cellphones, ICT equipment, and handheld devices, at roughly the same rate as malfunction/instability. AV equipment was also featured in this group, however not as prominently as the first three reasons already discussed.

Overall, aspects of obsolescence, such as those caused by design (for example: built-in obsolescence), marketing and fashion trends, or the speed of technology advancement, was the main contributing factor to the disposal of e-waste in Whangarei District.

## 7.3 E-waste in Storage

Baxter et al. (2016) found that e-waste storage impacts recycling services, suggesting that a lack of resources entering the 'resource cycle' impacts directly on the services that could be made available (see Chapter 3). Of the Whangarei householders who completed the survey, 50% reported storing e-waste, with 124 respondents reporting that they were storing at least one

[46] Moore's Law is based on Gordon Moore's 1965 paper which estimated that the number of components on an integrated circuit chip would double each year. This was revisited in 1975 where Moore re-estimated these changes would occur every two years. This has been proven to be true with under 10,000 'on-chip transistor counts' in the early 1970s to over 10,000,000,000 by 2015. For more information on Moore's Law see: Schaller, 1997.

mobile phone, which supports Ongondo and Williams' finding that up to 60% of EOL cell phones were sitting in cupboards and drawers in the UK often due to their "(perceived) in-build obsolescence" (2011, p. 1307). This link was not explicitly investigated in this study. Other items with high storage quantities included small household appliances and power cords and cables. Respondents generally reported one item in storage, however batteries, power cords and cables, and toys, leisure and sports equipment were reported with the majority of respondents having more than five of these items in storage. A question that was not asked of households was how many electronic items were owned in each household, and how many e-waste items were stored in total over all of the WEEE categories, which could be considered a weakness of this study. Arguably, these questions are better suited to an action research methodology and further research adopting this methodology could help to better understand the motives and reasons for e-waste disposal or storage. However, the reasons householders stored e-waste was investigated during the survey and is explored further below.

### 7.3.1 Reasons for Storing E-waste

As shown above, 50% of survey respondents reported storing at least one item of e-waste in their homes. When asked to rate a list of reasons for e-waste storage, the main reason respondents indicated storing e-waste was that they did not know what to do with it. This contradicts the findings of Section 7.1.3, which found only 10% were not aware of local services, but may indicate they are not aware that e-waste can be 'dropped-off' to local transfer stations, and perhaps more information may need to become available to Whangarei residents on how to appropriately manage their e-waste.

The second most common reason for e-waste storage was the cost to recycle it locally, which supports the findings of Section 7.1.3, and international research findings that showed cost can be a significant barrier to engagement in e-waste recycling practices (Dwivedy & Mittal, 2013; Chapter 3). However, contrary to Baxter et al.'s (2016) findings relating to households storing e-waste due to data security concerns, very few Whangarei residents reported this as a reason

for e-waste storage, and less than half reported storing e-waste due to any monetary value it may contain.

Overall, it was not unexpected to find that Whangarei residents stored e-waste due to lack of e-waste disposal knowledge and the high costs of services as this aligned with international research (for example see Baxter et al., 2016; Baxter & Gram-Hanssen, 2016). Household e-waste storage is more common where only voluntary e-waste management services exist and is a situation that could be rectified if more information relating to waste management and its negative environmental impacts if not engaged in appropriately was provided to households (Martin, Williams & Clark, 2006). Without clear information provided to residents on the 'how' of e-waste management in the Whangarei District (i.e. the services available and how to access them), as much as 56%[47] of households could be prevented from engaging in recycling, therefore storing their e-waste at best, or landfilling or fly-tipping at worst, as indicated in Section 7.2.

## 7.4 E-waste Management and Policy

The most common successful e-waste management tool that is used internationally is extended producer responsibility (EPR). The EU has had EPR schemes in place for e-waste since 2003, and today has some of the highest e-waste recycling rates in the world (see Chapter 2). EPR schemes have many benefits, not only impacting end-of-life phases of the product lifecycle, but also on the design phase. The responsibility EPR puts on producers influences the reduction of both built-in obsolescence and the production of poor-quality goods, as producers move toward a circular economy (Braungart & McDonough, 2008). Global EPR for all consumer products would ensure that low standard recycling was no longer a concern for waste streams such as e-waste, and the habitual recycling of many more waste streams would become the social norm, as producers become more reliant on recycled goods (re-)entering the resource stream and do more to ensure waste material is entering this resource cycle. The NZ central government does

[47] 44% of respondents indicated they had used WDC recycling services in the past, therefore indicating they are aware of e-waste recycling services available.

not currently support mandatory product stewardship, the first step on the way to full EPR (see Chapter 2), however it is possible within its policy framework.

Research has shown that in NZ, a lack of appropriate and usable data is impeding the classification of e-waste as a priority product, and therefore the possibilities for more robust e-waste management tools, such as mandatory product stewardship, being enforced under the Waste Minimisation Act 2008 (WMA). This lack of data is also preventing the local government bodies from understanding consumer behaviours and whether the current resources and services are sufficient to effectively manage the waste stream. An example of appropriate and usable data is illustrated through the recording of fly-tipped waste in the Whangarei District. WDC currently records how many fly-tipping events are witnessed in the district, but this data is not specific. If, for example, WDC was to record the specific waste streams that are included in each of these fly-tipping events, this data could indicate patterns of appearance of e-waste, among other waste streams, which may begin to contribute to the understanding of why this activity may be occurring so frequently. By asking specific questions, recording appropriate and usable data, and making this data publicly available, the evidence required to enforce the mandatory product stewardship of e-waste in NZ, for example, would become available. Data collection and monitoring is also crucial to ensure EPR schemes are effective once they have been introduced (Gottberg, Morris, Pollard, Mark-Herbert, & Cook, 2006; Khetriwal, Kraeuchi, & Widmer, 2009; Tanskanen, 2013). Currently in NZ, more work is required in this space to enable any policy change or enforcement to take place.

As discussed in Chapter 3, Part 6 of the WMA has requirements for the collection of data relating to waste creation and disposal and for this information to be provided to the MFE Secretary (WMA, 2008, s86). However, this research found no evidence of this requirement being enforced, nor is any information that is collected for reporting purposes transparent, often due to cited "commercial sensitivity". The recent *Global E-Waste Monitor* is an example of the lack of transparency of this information. In 2017, Baldé et al. published the official e-waste recycling rate of NZ at 0%, a figure that this research has proven inaccurate with its, albeit

small, Whangarei-based figure. This is unlikely to be the only data that exists in the country that records volumes of e-waste recycling.

Of the e-waste that is generated in the Whangarei District each year, this study estimates that only 1.8% of the possible e-waste generated in the district is recycled via the municipal e-waste recycling services. While there may be other e-waste recycling opportunities available in the district that the data is unavailable for, it is unlikely that these are high quality services that follow any environmental guidelines (see Chapter 3 for further discussion). Low levels of recycled material affect economies of scale, which in turn can affect the recycling services that are made available. For example, if even 50% of e-waste went through the recycling cycle, this could increase demand for high quality processes, and may also improve the benefits for producers of using recycled materials (e.g. metals/plastics) over virgin materials[48] due to their increased availability.

When respondents were asked their opinion on how e-waste is managed in NZ currently, only 4.8% of respondents felt that the current national approach to e-waste management was either 'good' or 'excellent', only a slight improvement on a NZ wide survey conducted in 2012 that asked the same question, and over 57% rated current approaches as 'poor' or 'very bad'. While these results do not elaborate on what respondents are not satisfied with, respondents indicated that the status quo was not acceptable and government intervention, including EPR, was required. However, EPR intervention can only occur on a national level and cannot be implemented by district, therefore local management practices are intrinsically dependant on national incentives, initiatives, and policies (see Figure 2.6; EPR Canada, 2017). The current, voluntary approach, appears to be an insufficient management practice, as indicated by the 1.8% recycling rate in the Whangarei District. Countries that have embraced EPR principles see much higher rates of appropriate e-waste management (see Figure 2.9). Of the 38 nations identified as

[48] Some processes may still require the use of virgin materials, but this could be supplemented with recycled materials therefore supporting a more circular economic system.

having official e-waste takeback systems in 2014 (Baldé et al., 2015), only eight[49] collected less than 20% of the e-waste generated annually, and only one reported collecting less than 10%[50].

## 7.5 E-waste Management Adaptation

Chapter 4 introduced Moser, Ekstrom, and Kasperson's (2010) model for adaptation to climate change. For the purpose of this research, this model has been modified to a framework for adaptation to appropriate e-waste management. It was chosen as a model to review the Whangarei and NZ-wide e-waste scape due to the similar barriers in both the adaptation to appropriate e-waste management and the adaptation to climate change. Chapter 4 introduced the three phases of adaptation: understanding, planning, and managing. Currently in NZ, it seems that policy makers are stuck in the first phase of the model (Figure 7.4), as they cite there is inadequate information (data) to understand what the problem looks like in NZ and argue that the scale of the e-waste issue is not yet completely understood (see Chapter 3; SLR Consulting, 2015). This lack of data is preventing movement into the planning stage, and therefore the management stage. Because of this, this research places itself in the understanding phase, as indicated in Figure 7.4, and it is hoped that the findings within can help policy makers progress to the stage of (re)defining the problem.

[49] 19% of the countries identified as having official takeback systems reported collecting less than 20% of the e-waste generated.
[50] Australia was reported as only collecting 8.76% of generated e-waste according to the 2014 Global E-Waste Monitor (Baldé et al., 2015)

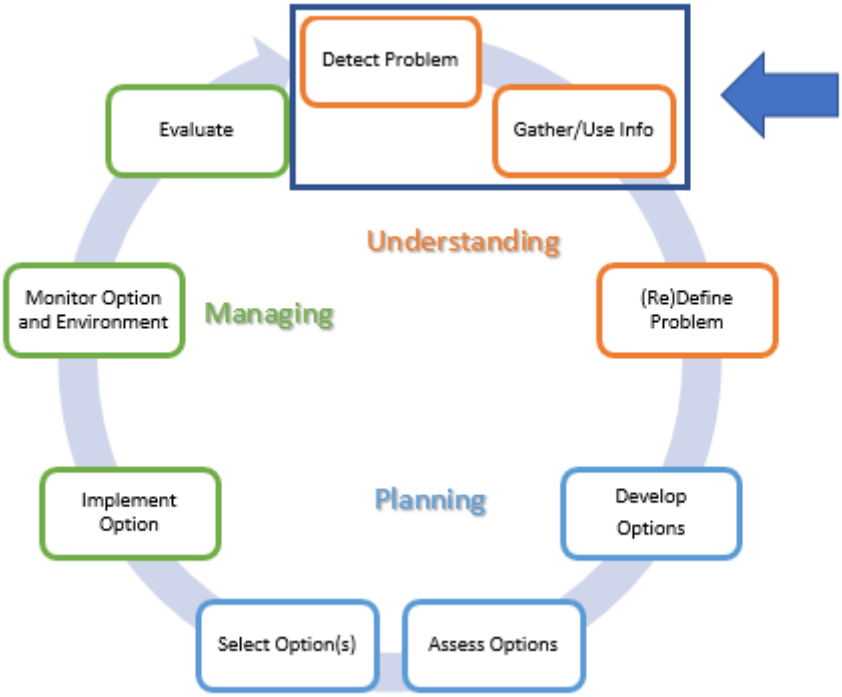



*Figure 7.4 Moser, Ekstrom and Kasperson's phases and subprocesses throughout the adaptation process, with an arrow indicating where this research is placed. (Source: Adapted from Moser, Ekstrom, & Kasperson, 2010, p. 22027)*

Moser, Ekstrom, and Kasperson (2010) illustrates the scope and scale of adaptation to climate change by mapping short and long-term goals and the time and effort typically required to achieve them, from short-term coping measures to long-term system transformation, including a paradigm shift. The EPR aspects that the EU have adopted, such as the WEEE Directive which provides guideline for the significant responsibilities for e-waste producers (Directive 2012/19/EU), are allowing for more long-term goals to be achieved. In the time since its inception, substantial adjustments have been made, and systems are transforming, including the effects of EPR systems on product design. Meanwhile, in NZ, while there are some coping measures in place for e-waste in NZ, such as voluntary e-waste recycling schemes and municipalities offering e-waste recycling services (like as those available in the Whangarei District), no specific goals have been set by government relating to e-waste recycling rates, nor has the Whangarei District Council set any specific e-waste management goals. Therefore, while Figure 7.5 indicates that the Whangarei District, and arguably NZ as a whole, is sitting at the short-term goal end of the spectrum due to these coping measures, in truth goals are not being achieved as none are being set. To achieve this change, or adaptation, it must be

understood what needs to change, why it needs to change, what the problem currently looks like, and what needs to happen in order for the change to occur. This is all part of (re-)defining the problem, the third part of the understanding phase, and a desired output of this research for the Whangarei District.

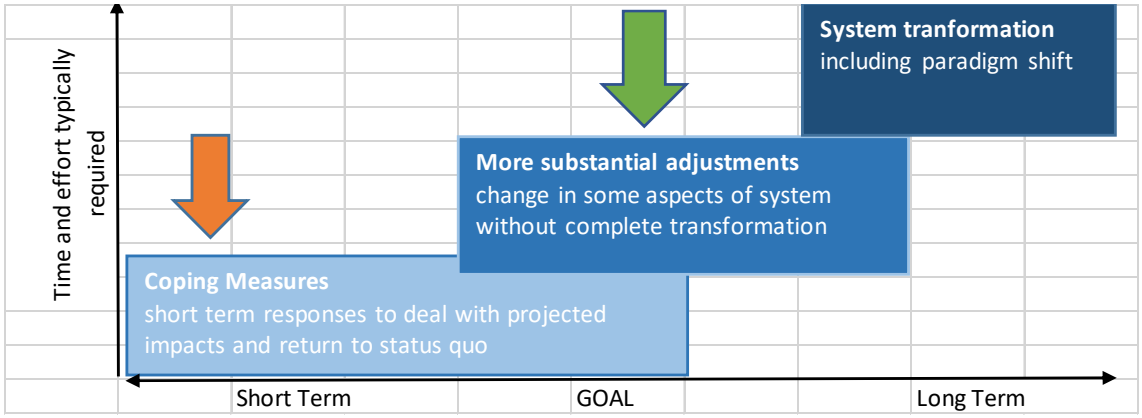



*Figure 7.5 Scope and scale of adaptation to appropriate e-waste management – orange arrow indicates where the author proposes Whangarei District sits currently, and the green arrow indicating where the EU EPR approach could sit (adapted from Moser, Ekstrom, & Kasperson, 2010, p. 22027)*

Figure 7.5 also indicates where the adoption of full EPR programmes may currently sit, using the EU as an example due to their significant legislation and practice (see Chapter 2). In the EU, for example, EPR is now affecting product design as well as distribution and EOL management (Gottberg et al., 2006; Lindhqvist & Lifset, 2003). However, in order for a full system transformation to occur, a move away from the current economic growth model and the consumer society would be required. The waste hierarchy (Figure 2.3) argues that reduction is the most appropriate waste management solution, and this would require consumers to stop purchasing EEE, something that may affect their sense of self (Hamilton, 2010).

In order to move from 'coping measures' to 'more substantial adjustments' significant improvement of the EOL management of e-waste is required in NZ (see Chapter 3). The reasons why this change is required in NZ varies, but is aligned with international literature that finds e-waste management must improve (see Chapter 2). The current state of the problem is difficult to define in NZ, due to the lack of available data, but the Whangarei District case study implies significantly low levels of recycled e-waste materials, when compared with the estimated e-

waste generated per person in the district (only 1.8% of e-waste generated in the Whangarei District being recycled via municipal e-waste recycling services), and that large amounts of e-waste are being landfilled (at least 37% across all e-waste categories, according to survey results). Requirements for changes to occur are currently unclear, however the findings of this research indicate that adopting EPR systems could influence both the rate of EOL e-waste recycling, and e-waste creation overall. As mentioned in Section 7.4, mandatory EPR can only be adopted on a national level. To see change for Whangarei District alone, WDC would need to set its own goals/targets to increase the level of e-waste recycled in the district. (Re)definition of the e-waste problem will allow for reasonable options to be developed. This must occur before Whangarei, or NZ as whole for that matter, can move into the next phase of the adaptation framework, and begin to plan the way to appropriate e-waste management.

Appropriate e-waste management adaptation must include mandatory EPR led by central government, as this study indicates that the voluntary approach to e-waste management is not effective in managing the waste stream in NZ. Enforcement of Part 6 of the WMA, will ensure robust data monitoring and evaluation which could inform regional and national e-waste recycling goals, and should prove the case that mandatory product stewardship is required for e-waste in NZ. Achieving any goals set would require the raising of public awareness of the issues relating to e-waste, and the importance of recycling, via environmental education programmes. Setting and achieving appropriate e-waste management targets will also ensure that NZ is meeting its obligations under the central government initiatives already in place, as well as the Basel Convention and other supranational directives that relate to hazardous waste of which the nation is a party to (see Figure 3.1).

## 7.6 Conclusion

Contrary to international research, Whangarei District household engagement in e-waste recycling does not appear to be influenced by sociodemographic factors. Most Whangarei households claim they engage in general household recycling, with over 50% recycling each of the six waste types recycled kerbside in the district and up to 90% recycling glass. Engagement

in e-waste recycling was not affected by these general recycling behaviours, also contradicting international research. Engagement in e-waste recycling services was, however, influenced by the lack of knowledge residents had about the services that were available to them, and the cost to recycle e-waste locally, particularly CRT TVs.

Many Whangarei residents reported the intention to recycle and/or reuse e-waste by selling or gifting to friends and whānau. However, the low level of e-waste materials recycled municipally in the district contradicted these claims, as did the qualitative responses of respondents when they were questioned as to how they had last disposed of e-waste. When respondents were asked when the last time was that they had disposed of e-waste, over 80% had disposed of e-waste within a two-year period, with almost 25% disposing of e-waste in the past month, however, 50% of respondents reported storing e-waste.

Municipal e-waste management services do exist in the Whangarei District, but only 1.8% of the possible e-waste generated in the district each year is being processed this way, indicating that the voluntary approach to e-waste management is unsuccessful in managing the waste stream. International literature suggests that EPR could rectify this issue (Gottberg et al., 2006; Lindhqvist & Lifset, 2003; Widmer et al., 2005). However, this would need to be applied on a national level, as EPR cannot be applied in isolation in NZ. Currently NZ is barely coping with the e-waste problem, and further work needs to be completed to move NZ from the understanding phase of adaptation to appropriate e-waste management to the planning stage, both of which must occur before the management stage can begin.

# Chapter 8 – Conclusions and Recommendations

This research aimed to generate first-time data on Whangarei household e-waste options, knowledge and behaviours, in order to inform e-waste management policy, resources and services which could be specifically designed for the district. The intention of this study was to work towards filling the data gap recently identified by the consulting firm engaged by MFE to investigate whether e-waste should be considered a priority product therefore enforcing product stewardship (SLR Consulting, 2015). To achieve this aim, five objectives were set. The first of these objectives included identifying the possible environmental, social, and economic impacts of e-waste. Chapter 2 aimed to meet this objective by giving an overview of the impacts of e-waste on an international level. The findings of this chapter suggest NZ is not immune to the detrimental impacts of inappropriate e-waste management, despite its population of just over four million people, due to the fluxes of contaminants associated with e-waste (Section 2.1.2), and the increasing generation rates of e-waste both in NZ and internationally (Section 2.1.1).

The second objective of this study related to identifying the options (resources and services) available to Whangarei households for the disposal of e-waste. Chapter 3 investigated the e-waste scape of both the Whangarei District and NZ as whole. It found that while there were services available in Whangarei, mandatory product stewardship was not enforced in NZ, therefore all e-waste recycling that is available is of a voluntary nature. Whangarei has municipal drop-off services available, at a cost, to its residents for the appropriate management of e-waste, however only an estimated 1.8% of the e-waste generated in the district was managed this way (Section 3.2.1). The third and fourth objectives investigated the e-waste knowledge and behaviours of Whangarei household consumers, and factors influencing e-waste knowledge and behaviours, which could possibly shed a light on why this figure was so small.

The research tool utilised for this study aimed to identify the types and volumes of e-waste, currently being disposed of or stored by Whangarei households, and how; and the e-waste knowledge and behaviours of Whangarei household consumers, and factors influencing these e-waste knowledge and behaviours. The results of the study were laid out in Chapter 6 and

discussed in Chapter 7. The overall conclusions from these chapters can be found here in Section 8.1. Finally, this study aimed to make recommendations based on the research for changes to e-waste policy that may improve the e-waste behaviours of households in the Whangarei District. These recommendations are outlined in Section 8.2.

## 8.1 An Overview of E-waste Management in the Whangarei District

The research conducted for this study contradicted international findings that e-waste recycling is influenced by socio-demographic factors, as no clear relationships could be found between these factors and the intended e-waste disposal behaviours of Whangarei District households. However, these findings may have been impacted by the high levels of education that the respondents possessed, and the indication of pro-environmental values for many of the respondents both through political leanings, and survey responses. This research did however align to other international findings identifying the main barrier to e-waste recycling in the Whangarei District as the cost associated with disposing of e-waste appropriately, followed by the lack of knowledge of (or faith in) the services available to residents.

This study indicated that while many Whangarei households 'intend' to recycle their e-waste, as little as 1.8% of the possible e-waste generated in the Whangarei District is actually being recycled by municipal recycling services. The research found that as much as 600 tonnes of e-waste could be being landfilled in the district each year, a figure that could be reduced if mandatory product stewardship/extended producer responsibility schemes were introduced, and voluntary recycling was no longer relied upon, a recommendation of this research (see Section 8.2.3).

Most respondents wanted to see change in how e-waste is managed currently in NZ and were not happy with the status quo. Many commented on the requirements for more education around e-waste and the related environmental issues, extending producer responsibilities when it comes to both the prevention and management of e-waste, and having better recycling services available, that were guaranteed to recycle the e-waste, and not send it to landfill. Some respondents specifically commented on apprehensions with the WDC waste services that were

available and were not convinced that if they dropped their waste of for recycling, that it would actually be recycled. This is a serious concern and could be a significant barrier to engaging in appropriate e-waste management behaviours.

Small items of e-waste, including batteries, lighting equipment, and small household appliances are most commonly disposed of via household waste in Whangarei, which aligns to international findings, with almost 70% of both batteries and lighting equipment being disposed of this way in the district. Many households intended to reuse their e-waste by giving away to friends and whanau or selling, however, when questioned how they have actually disposed of e-waste in the past, less than 10% of e-waste was managed this way, indicating there is a value-action gap present between the intentions of disposal methods of e-waste in the district, and the actual disposal methods.

The reasons for e-waste generation identified in this research aligned with international research findings that product obsolescence (including both planned and technological obsolescence) is a main contributing factor to the creation of e-waste in households. Further to this, these research findings supported international findings on e-waste volume growth, with over 80% of Whangarei households reporting having disposed of e-waste within the last two years. This number did not include how many of the households currently had items in storage, however 50% of respondents reported this as the case, suggesting that more e-waste is being generated than is being disposed of.

When the current e-waste scape in both Whangarei and NZ was compared with the Moser, Ekstrom, and Kasperson adaptation framework, which illustrated the scope and scale of adaption process from coping mechanisms to more substantial adjustments and finally toward a system transformation, it was found that both Whangarei, and NZ as a whole, are barely coping with the e-waste problem with only voluntary responses to manage the waste stream in place. This was illustrated in only 1.8% of the total e-waste possibly generated in the Whangarei District currently being recycled via municipal systems. It can be concluded that the e-waste problem in Whangarei requires (re)definition so that planning can take place, and appropriate e-

waste management can begin. While WDC could create its own District E-waste Strategy (see Section 8.2.2) as a possible solution to the (re)defined problem, challenges will continue to exist until mandatory product stewardship is in place, and this can only occur at a national level via the ministerial declaration of e-waste as a 'priority product'.

## 8.2 Policy Recommendations for the Whangarei District

There are three main recommendations stemming from this research. The most significant relates to data collection and enabling the move to the next stage of the adaptation framework. Secondly a Whangarei District E-waste Strategy is recommended including setting targets and prioritising activities to overcome barriers to enable these targets to be met. Finally, the adoption of national mandatory product stewardship leading toward full EPR is recommended.

### 8.2.1 Data Collection

The Waste Minimisation Act 2008 (WMA) has requirements for the recording and reporting of waste data, however the investigation undertaken as part of this research could find no evidence that this was being enforced in relation to the recording and reporting of e-waste data[51]. It is recommended that in respect of e-waste the data requirements under Part 6 of the WMA are employed and enforced by the Ministry for the Environment in conjunction with local councils and other relevant stakeholders. There are many benefits that would occur with the enforced improvement of e-waste data collection in NZ. The benefits include; greater transparency as a foundation for improved collaboration amount all parties involved in waste management, the potential for national e-waste system optimisation, accountability, and better official information available for international reports such as the *Global E-Waste Monitor* (see Baldé et al., 2015; Baldé et al., 2017). Obtaining robust baseline data would enable the scope and scale of the e-waste problem to be better defined in NZ. Furthermore, ongoing monitoring and

[51] This is a true statement outside of reporting requirements for government funding/grants for recycling programmes, such as eDay and the TV TakeBack Scheme, and export permits completed under the Basel Convention.

reporting would enable relevant and realistic local/district and national targets to be set and achieved if management systems were enforced.

On a local level, WDC could benefit from recording more specific data relating to waste management in the district. For example, if waste audits were completed on fly-tipping occurrences, specifically those that include an element of e-waste, a greater understanding of what leads to these fly-tipping events could be developed, which could lead to more effective mitigation and management strategies being implemented. However, quantitative audits alone will not create the picture required to fully understand the e-waste problems in the district and a mixed method approach is required.

WDC could become a leader amongst NZ district councils in terms of e-waste management by improving the collection and analysis of local e-waste data, and integrating this information into future policy and practice decision making. It is understood that the new WMMP has objectives relating to waste data generation, however it would be good to see that these objectives are enforced, and that any waste data, specifically e-waste data, which is collected is made available to all of the stakeholders with an interest in the subject (i.e. the data is transparent).

Understanding the e-waste problem from collected data would support the three steps of planning phase identified in Moser, Ekstrom, and Kasperson's (2010) adaptation framework; detect the problem, gather/use info, (re)define the problem. Once the problem is (re)defined, progression can be made towards the planning phase; developing, assessing, selecting and implementing the option (solution). This will enable Whangarei to move towards appropriate e-waste management, the final phase. However, like all problem-solving models, Moser, Ekstrom, and Kasperson's model is a cyclic process and the problem may require redefinition a number of times until system transformation, the long-term goal, is achieved.

### 8.2.2 Whangarei District Council – District E-waste Strategy

The Moser, Ekstrom, and Kasperson adaptation framework, adopted in the research as a problem-solving tool, recommends that a problem needs to be fully understood before it can be

managed. This research has helped to develop a clearer picture of the local e-waste scape, and it is recommended that WDC establish a District E-waste Strategy that puts steps in place to significantly reduce the amount of e-waste going to landfill in the district. Now that the WDC are in a position to understand that potentially as little as 1.8% of the e-waste generated in their district is being recycled by the municipal services available, a strong argument can be made to set goals to increase this volume. For example, by setting a goal of recycling even 10% of the e-waste generated in the district, aligning to Hoeveler's 2008 estimation of how much e-waste is being recycled in NZ, significant improvements could be made on what is currently being recycled via WDC services. A 10% e-waste recycling goal could divert more than 174 tonnes of e-waste from landfill each year, over 140 tonnes more than is being processed currently.

Once targets are set, education schemes (with targeted message framing), and other initiatives on a local level supporting innovation, smart design, and solution focuses for example, could be implemented. Initiatives to reduce or even eliminate the value-action gap, ensuring that the intention householders have to recycle turns into recycling behaviour, should also be introduced. These could include reducing or even eliminating the costs associated with e-waste disposal, and making the disposal process more convenient, such as kerbside collections. Product stewardship could help support any infrastructure investments that are required to manage the waste stream appropriately, and could also work towards funding initiatives. For product stewardship to become mandatory, and not voluntary as it is currently considered in NZ, 'priority product' status would need to be enforced on a national level. WDC could lobby central government as part of their strategy to ensure e-waste is able to be appropriately managed in their district.

### 8.2.3 Mandatory Product Stewardship

Without the priority product designation of e-waste, or regulation around its management, it is unlikely that current e-waste management practices will change. The absence of change to current management practices has the potential to cause significant harm to the environment, and the physical and economic health of NZ citizens. While the SLR Consulting report (2015)

found that more data was required before mandatory product stewardship should be enforced under the WMA, the findings of this research suggest otherwise. The apparent low level of e-waste that is being recycled by municipal recycling services in the Whangarei District supports Hoeveler's (2008) earlier findings that less than 10% of e-waste generated is being recycled. If this was true 10 years ago, given the reported growth in e-waste volumes over this period (see for example Baldé et al., 2015; Baldé et al., 2017), it may be possible that each year over 88,000 tonnes of e-waste could be being landfilled in NZ[52], equating to over 800,000 tonnes since Hoeveler's estimation. It is more likely, however, that this figure is actually higher, if Whangarei's 1.8% rate of recorded recycled e-waste is considered. This would mean that a whole range of negative environmental, social, and economic impacts (see Chapter 2) stemming from the landfilling of e-waste will have been unnecessarily set in motion, rather than avoided or mitigated through more effective understanding and management of e-waste in NZ. This outcome appears to conflict directly with the aspiration and inference offered in the structure of the Waste Minimisation Act 2008 (WMA) and should, in itself, be enough to enforce the prioritisation of e-waste, under Section 9 of the WMA, for product stewardship in NZ.

This study shows that e-waste meets the requirements for ministerial declaration of product prioritisation for the following reasons:

- The product may cause significant environmental harm when it becomes waste (WMA, 2008, S9 2Ai) (see Section 2.1.2).
- There are significant benefits from reduction, reuse, recycling and recovery of the product (including reduced environmental impacts at both the EOL and product creation stages of the product lifecycle) (WMA, 2008, S9 2Aii) (see Chapters 1 & 2).

[52] 88,100 tonnes of estimated landfilled e-waste each year. Calculated as volume per resident 20.1kg (Baldé et al., 2017) x NZ population of 4,871,300 (NZ Stats estimate as at March 2018, 2018b) x 90% of e-waste likely landfilled (recycled e-waste max. 10%; Hoeveler, 2008).

- The product can be effectively managed under a product stewardship scheme, as illustrated by the extended producer responsibility policies in place in the European Union (WMA, 2008, S9 2B) (see Section 2.1.3).

Adopting mandatory product stewardship in NZ, and working towards full EPR, will not only support appropriate e-waste management, but will also ensure that NZ is meeting its obligations under the supranational agreements that it is a party to. By enforcing monitoring and control, as part of an EPR system, NZ's reputation as being "100% pure" (New Zealand Tourism, n.d.) will be protected as global reports on e-waste management in future years could represent the significant headway NZ has made in relation to e-waste management, an improvement on the official e-waste recycling rate NZ currently holds of 0% (Baldé et al, 2017).

## 8.3 Future Research Opportunities

There are a number of opportunities for future research on the topic of e-waste in NZ. Firstly, the research tool utilised for this thesis could be reviewed, revised (i.e. improved on the basis of practical learnings flowing from this research project), and then replicated in more districts in NZ of various population sizes, in order to build up a more accurate and complete picture of the e-waste scape throughout the country. However, this case study may represent other districts of a similar size, with similar (socio)demographics, and where similar services and resources available to residents exist.

Further to the adaption of this study for future research, more targeted research is required into how charities and/or recyclers who collect e-waste with a recycling intention are managing the recycling process. For example, questions on whether these organisations recycle only the parts of economic value, and landfill the rest, as Chapter 3 suggests, could be asked. Furthermore, municipal recyclers (or those contracted to provide these services) could also be investigated to see if they meet the requirements of the AS/NZS standard *5377:2013 collection, storage, transport and treatment of end-of-life electrical and electronic equipment*.

Finally, to better understand the impacts of household e-waste, and the motives and reasons for e-waste disposal in NZ, targeted research investigating specifically why electric and electronic equipment (EEE) may no longer be useful to a household, how many EEE items are owned in NZ households (both in use and not in use) and why they were purchased, and how many e-waste items households store in total across the WEEE categories, could be completed. This type of targeted research could confirm whether obsolescence is the main contributor to e-waste creation in NZ, which could provide meaningful data that could be translated into EPR regulation design and application (for example). Impacts on EEE purchasing behaviours, such as fashion, consumer buying patterns, and the like, and what proportion of e-waste (or EEE that is not in use) is being stored in households, and therefore not entering the resource cycle, could also be investigated further. This research could also provide deeper learnings on the value-action gap in relation to e-waste disposal methods, and the impact (or lack thereof) of pro-environmental values on e-waste disposal behaviours.

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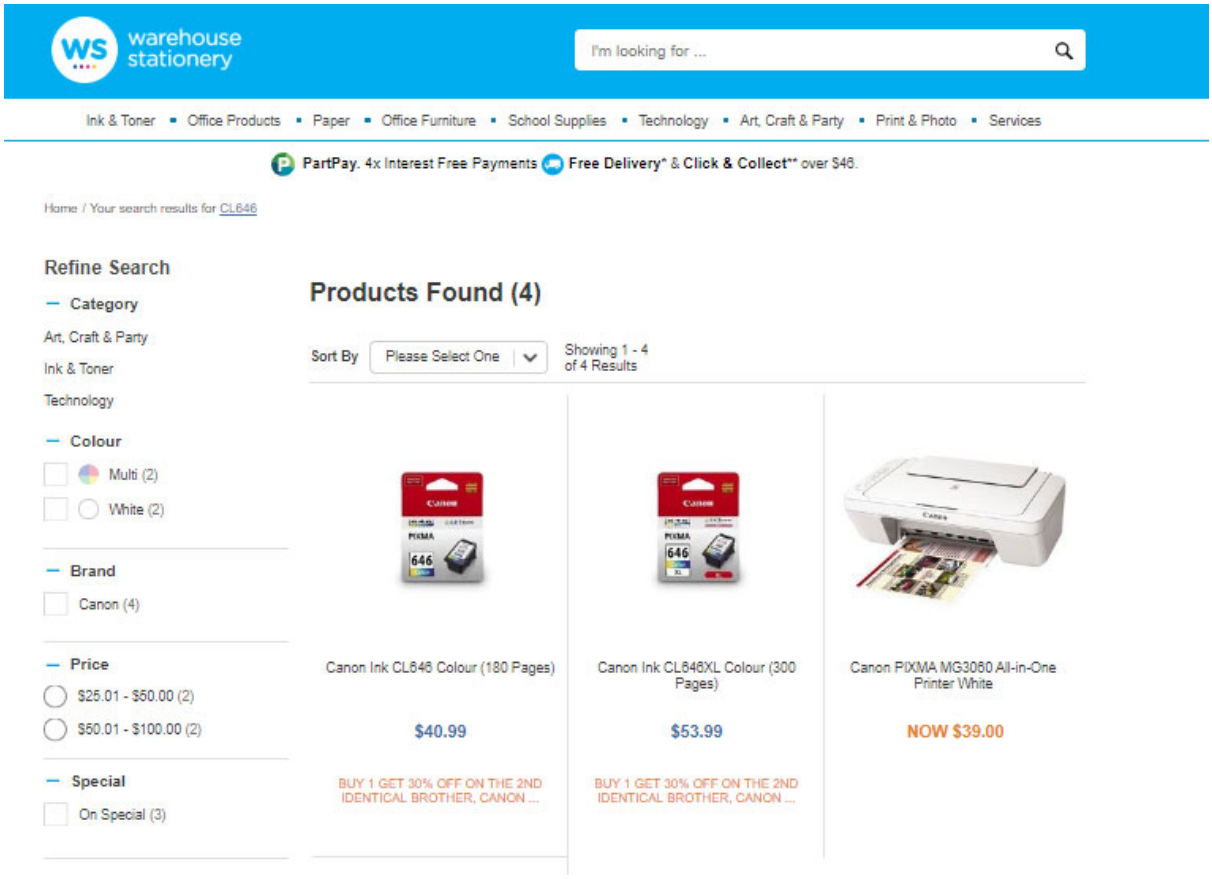
# Appendices

## Appendix 1.1. WDC waste disposal rates

| RUBBISH SERVICE AT KERBSIDE: | ($) |
|---|---|
| Official rubbish bag (65-litre) or sticker | 2.80 |
| Small rubbish bag (35-litre) | 1.80 |
| **RUBBISH SERVICES AT ALL WDC TRANSFER STATIONS:** | |
| Standard rubbish bag (65 litre) - rubbish | 2.80 |
| Standard rubbish bag (65 litre) - vegetation | 1.60 |
| Small rubbish bag (35 litre) - rubbish | 1.80 |
| Car boot - rubbish | 20.00 |
| Car boot – vegetation | 12.00 |
| Station wagons, people movers – rubbish | 35.00 |
| Station wagons, people movers – vegetation | 17.00 |
| Utes, vans, 4 wheel drives - rubbish | 45.00 |
| Utes, vans, 4 wheel drives – vegetation | 22.50 |
| Trailers - rubbish | 45.00 |
| Trailers - vegetation | 22.50 |
| Loaded vehicle plus loaded trailer | Combine fee |
| Car tyre | 7.00 |
| Truck tyre | 22.00 |
| 4WD and light commercial tyre | 18.00 |
| Tractor tyre | 38.00 |
| Tyres on rim | As above + 2.50 |
| Earthmover tyres | Not accepted |
| CRT screens from computers and TVs | 26.00 |
| Whiteware / gas bottles (de-gassing) | 7.00 |

Source: WDC, 2017b, p.30

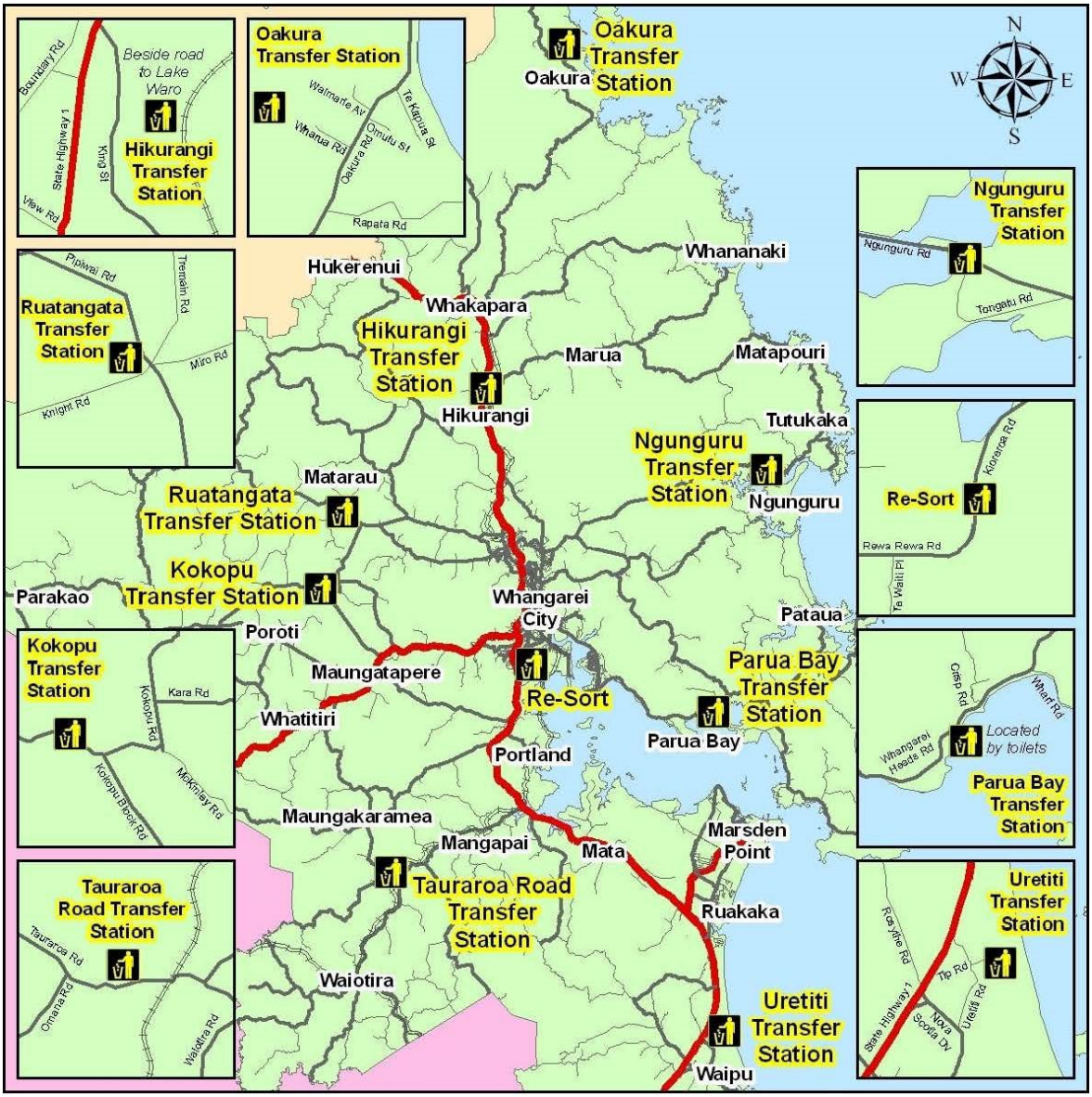
## Appendix 1.2 Desktop Printer and Replacement Ink Costs




Source: Warehouse Stationery website 14 July 2018

https://www.warehousestationery.co.nz/search?q=CL646

## Appendix 3.1. WDC Transfer Station Map




Source: Image retrieved from
http://www.wdc.govt.nz/WaterandWaste/Rubbish/Documents/refuse-transfer-station-map.pdf

**Appendix 3.2 WMMP Hearing Presentation Slides**



Vicktoria Blake
NorthTec Academic Staff Member
Massey Master of Environmental Management student
Completing thesis on household ewaste behaviours based on Whangarei District consumers
Whangarei resident for 10 years


Zero Waste Target
Continuing the status quo is not good enough.
We should be setting zero waste targets and following Auckland Councils lead.
How can we expect behaviour change if there is no incentive to do so?
We need to have better infrastructure to allow for more recycled products and better education programmes to enable residents to understands the impact of their waste production.

## Weekly Waste in Auckland District


- What do we look like?
- If we don't set reduction targets could this be us in the future?

## Need for Data

In order to make better decisions for the District we need better data, and this data should be available for public knowledge.

For example:

- The make up of fly-tipped rubbish may give some insight into why that waste stream is being illegally disposed of
- Data around volumes and types of eWaste disposed of in the District will help to understand how much is being disposed of appropriately, and if compulsory product stewardship is required.
- More specific data collection from household consumers on what products they would recycle if it was easier to do so etc.

## Need plans in place for hazardous waste streams

The plans in place regarding organic waste is commendable, but is not enough.

eWaste, for example, is a significant, and growing, waste stream that is not even mentioned in the WMMP

## Each year the Whangarei District disposes of approximately 1,666.3 tonnes of e-waste, and it is growing.

This is the same as weight as:

- 4,165,750 Smart Phones PLUS
- 13,885 CRT TVs PLUS
- 416,575 Toasters PLUS
- 11,902 Refrigerators

Obviously, the e-waste disposed of in the District is not solely of these products...but it is time that we start to think about the scale of this hazardous waste stream, and create better methods of responsible disposal.

## The current e-waste system is not working

- Very little advertising/lack of consumer knowledge
- High cost
- Small e-waste is being disposed of in general household waste
- No data to support changing model, however observation supports assumptions

The Medical Officer of Health recommended after the 2012 WMMP that central government be lobbied for compulsory product stewardship on e-waste. This did not happen. Product Stewardship would ensure that the funds existed to create appropriate recycling methods for e-waste.

But in the meantime...

## This is what is happening with e-waste in our district


What do we need?
Better waste targets - status quo is not sufficient
Working towards increasing consumer knowledge on the impact of waste
Better waste data to inform future plans
More robust e-waste management systems
Thank you

## Appendix 4.1: Barriers to phases of adaptation

Table 1: Common barriers of the Understanding Phase (Moser, Ekstrom, & Kasperson, 2010, p. 22028)

| Phase and process stages: Understanding | Barriers |
|---|---|
| Detect problem | Existence of a signal |
| | Detection (and perception) of a signal |
| | Threshold of concern (initial framing as problem) |
| | Threshold of response need and feasibility (Initial framing of response) |
| Gather/use of information | Interest and focus (and consensus, if needed) |
| | Availability |
| | Accessibility |
| | Salience/relevance |
| | Credibility and trust |
| | Legitimacy |
| | Receptivity to information |
| | Willingness and ability to use |
| (Re)define problem | Threshold of concern (reframing of the problem) |
| | Threshold of response need |
| | Threshold of response feasibility |
| | Level of agreement or consensus, if needed |

Table 2: Common barriers of planning phase (Moser, Ekstrom, & Kasperson, 2010, 22028)

| Phase and process stages: Planning | Barriers |
|---|---|
| Develop options | Leadership (authority and skill) in leading process |
| | Ability to identify and agree on goals |
| | Ability to identify and agree on a range of criteria |
| | Ability to develop and agree on a range of options that meet identified goals and criteria |
| | Control over process |
| | Control over options |
| Assess options | Availability of data/information to assess options |
| | Accessibility/usability of data |
| | Availability of methods to assess and compare options |
| | Perceived credibility, salience, and legitimacy of information and methods for option assessment |
| | Agreement on assessment approach, if needed |
| | Level of agreement on goals, criteria, and options |
| Select option(s) | Agreement on selecting option(s), if needed |
| | Sphere of responsibility/influence/control over option |
| | Threshold of concern over potential negative consequences |
| | Threshold of perceived option feasibility |
| | Clarity of authority and responsibility over selected option |

Table 3. Common barriers of managing phase (Moser, Ekstrom, & Kasperson, 2010, p. 22029)

| Phase and process stages: Managing | Barriers |
|---|---|
| Implement option(s) | Threshold of intent |
| | Authorization |
| | Sufficient resources (fiscal, technical, etc.) |
| | Accountability |
| | Clarity/specificity of option |
| | Legality and procedural feasibility |
| | Sufficient momentum to overcome institutional stickiness, path dependency, and behavioral obstacles |
| Monitor outcomes & environment | Existence of a monitoring plan |
| | Agreement, if needed, and clarity on monitoring targets and goals |
| | Availability and acceptability of established methods and variables |
| | Availability of technology |
| | Availability and sustainability of economic resources |
| | Availability and sustainability of human capital |
| | Ability to store, organize, analyze, and retrieve data |
| Evaluate effectiveness of option | Threshold of need and feasibility of evaluation |
| | Availability of needed expertise, data, and evaluation methodology |
| | Willingness to learn |
| | Willingness to revisit previous decisions |
| | Legal limitations on reopening prior decisions |
| | Social or political feasibility of revisiting previous decisions |

**Appendix 5.1. E-waste Survey**

# Whangarei District e-Waste Survey

Kia ora. My name is Vicktoria Blake. I am a Master of Environmental Management student at Massey University.

This survey aims to generate first-time data on Whangarei household e-waste options, knowledge and behaviours, in order to inform e-waste management policy, resources and services which could be specifically designed for the district.

All residents of the Whangarei District (over the age of 16) are invited to participate in this research by completing an online survey that should take no longer than 15 minutes.

Please feel free to share the link with your friends, whanau, and colleagues, so that we can get as many responses as possible

Completion of the online survey implies consent for the information to be used for research purposes.

You can skip questions if you want to, and remain anonymous, unless you would like to enter the draw to win a $150 meal voucher from The Quay Restaurant and Bar, or request information about the findings of the research.

Please only complete the survey once to ensure the robustness of the data.

If you have any questions about the survey, or the research, please contact the following people:

Researcher
Vicktoria Blake
Institute of Agriculture and Environment
Massey University
Private Bag 11-222
Palmerston North 4442
New Zealand
Email: ewastewhangarei@gmail.com

Lead Supervisor
Dr Trisia Farrelly
School of People, Environment and Planning
Massey University
Palmerston North
New Zealand
Email: t.farrelly@massey.ac.nz

## Demographic Information

**1. Which area of Whangarei do you live in?**
*Mark only one oval.*

- Abbey Caves
- Bream Bay
- Bream Head
- Hikurangi
- Horahora
- Kamo East
- Kamo West
- Kensington
- Mairtown
- Marsden Point - Ruakaka
- Maungatapere
- Maunu
- Morningside
- Ngunguru
- One Tree Point
- Onerahi
- Opouteke - Tanekaha
- Otaika - Portland
- Otangarei
- Parahaki
- Parua Bay
- Pataua - Whareora
- Port - Limeburners
- Punaruku - Kiripaka
- Raumanga East
- Raumanga West
- Regent
- Riverside
- Sherwood Rise
- Springs Flat
- Te Hihi
- Three Mile Bush
- Tikipunga East
- Tikipunga West
- Vinetown
- Waiotira - Springfield
- Waipu
- Western Hills
- Whangarei Central
- Wharekohe - Oakleigh
- Whau Valley

- ◯ Woodhill

**2. Which age group do you fit into?**
*Mark only one oval.*

- ◯ 16 - 18
- ◯ 19 - 24
- ◯ 25 - 34
- ◯ 35 - 44
- ◯ 45 - 54
- ◯ 55- 64
- ◯ 65 and over

**3. Are you:**
*Mark only one oval.*

- ◯ Female
- ◯ Male
- ◯ Other

**4. Which ethnic group(s) do you belong to?**
*Check all that apply.*

- ☐ Maori
- ☐ NZ European/Pakeha
- ☐ Pacific Islander
- ☐ Asian
- ☐ Other European
- ☐ Other: _____

**5. Who lives in your household?**
*Mark only one oval.*

- ◯ Single person, living with one or more children
- ◯ Single person, living alone
- ◯ Couple, living with one or more children
- ◯ Couple, living alone
- ◯ Unrelated adults, with one or more children
- ◯ Unrelated adults, without children
- ◯ Extended family, with one or more children
- ◯ Extended family, without children
- ◯ Friends or relatives, with one or more children
- ◯ Friends or relatives, without out children

**6. What is your highest completed qualification? (e.g. trade certificate, bachelor degree, etc.)**

_____

**7. What is your household income?**

*Mark only one oval.*

- ◯ Less than $20,000
- ◯ $20,000 to $34,999
- ◯ $35,000 to $49,999
- ◯ $50,000 to $74,999
- ◯ $75,000 to $99,999
- ◯ $100,000 to $149,999
- ◯ $150,000 to $199,999
- ◯ $200,000 or more
- ◯ Prefer not to say

**8. Which political party do you support?**

*Mark only one oval.*

- ◯ Green Party
- ◯ Labour
- ◯ NZ First
- ◯ National
- ◯ Other
- ◯ Don't know
- ◯ Prefer not to say

## Household Waste

**9. How often do you recycle the following household waste items?**

*Mark only one oval per row.*

| | Always | Often | Occasionally | Rarely | Never |
|---|---|---|---|---|---|
| Glass | ◯ | ◯ | ◯ | ◯ | ◯ |
| Plastic | ◯ | ◯ | ◯ | ◯ | ◯ |
| Metal | ◯ | ◯ | ◯ | ◯ | ◯ |
| Aluminium | ◯ | ◯ | ◯ | ◯ | ◯ |
| Paper | ◯ | ◯ | ◯ | ◯ | ◯ |
| Cardboard | ◯ | ◯ | ◯ | ◯ | ◯ |

**10. Please rate whether you agree with the following statements relating to household waste management**

*Mark only one oval per row.*

| | Strongly Agree | Moderately Agree | Unsure | Moderately Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Recycling substantially reduces the use of landfills | ◯ | ◯ | ◯ | ◯ | ◯ |
| Recycling conserves natural resources | ◯ | ◯ | ◯ | ◯ | ◯ |
| Recycling will not make much difference to the quality of the environment | ◯ | ◯ | ◯ | ◯ | ◯ |
| Recycling creates jobs | ◯ | ◯ | ◯ | ◯ | ◯ |
| Households like mine should not be blamed for environmental problems caused by excessive waste generation | ◯ | ◯ | ◯ | ◯ | ◯ |
| Given increasing environmental problems with waste, I feel a moral obligation to recycle. | ◯ | ◯ | ◯ | ◯ | ◯ |
| E-waste creates significant environmental and social problems. | ◯ | ◯ | ◯ | ◯ | ◯ |
| Storing electronic equipment at the end of its useful life has a significant environmental impact. | ◯ | ◯ | ◯ | ◯ | ◯ |

## Household e-Waste

Definition of e-waste: Any product with a plug or a battery that is no longer in use/wanted in your household.

**11. Why might you dispose of the following types of e-waste? Please tick all that apply.**

*Check all that apply.*

| | No longer useful to me or my household | Lack of new or advanced features I want/need | I am moving to a new house | High repair cost/cannot be repaired | Instability/malfunction during use | Other |
|---|---|---|---|---|---|---|
| Small household appliances (e.g. jugs, toasters, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Large household appliances (e.g. whiteware: fridge, freezer, washing machine, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| ICT equipment (e.g. computers, printers, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Handheld devices (e.g. tablets) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Cellphones / smartphones | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

*Check all that apply.*

| | No longer useful to me or my household | Lack of new or advanced features I want/need | I am moving to a new house | High repair cost/cannot be repaired | Instability/malfunction during use | Other |
|---|---|---|---|---|---|---|
| Audio visual equipment (including TVs) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Lighting equipment (e.g. lamps, lightbulbs) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Electrical tools | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Toys, leisure and sports equipment (e.g. video games, train sets, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Batteries | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Medical equipment (e.g. medical machines such as air purifiers, ventilators, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**If you selected "Other" to any of the above categories please describe**

_____

_____

_____

_____

_____

**12a. How do you currently dispose of Small Household Appliances (e.g. jugs, toasters, etc.) in your household? Please tick all that apply.**

*Check all that apply.*

- ☐ Throw away with household rubbish
- ☐ Return to supplier/retailer
- ☐ Dispose of at waste transfer station for recycling
- ☐ Dispose of at waste transfer station mixed in with general waste
- ☐ Store it
- ☐ Sell it (e.g. TradeMe)
- ☐ Donate to charity
- ☐ Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- ☐ Give away to friends/whanau
- ☐ Don't know
- ☐ Other: _____

**12b. How do you currently dispose of Large Household Appliances (e.g. whiteware: fridge, freezer, washing machine, etc.) in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] Don't know
- [ ] Other: _____

**12c. How do you currently dispose of ICT Equipment (e.g. computers, printers, etc.) in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] Don't know
- [ ] Other: _____

**12d. How do you currently dispose of Handheld Devices (e.g. tablets) in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] Don't know
- [ ] Other: _____

**12e. How do you currently dispose of Cellphones/Smartphones in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] Don't know
- [ ] Other: _____

**12f. How do you currently dispose of Audio Visual Equipment (e.g. stereos, TVs, headphones, etc.) in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] Don't know
- [ ] Other: _____

**12g. How do you currently dispose of Lighting Equipment (e.g. lamps, lightbulbs, etc.) in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] Don't know
- [ ] Other: _____

**12h. How do you currently dispose of Electrical Tools in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] Don't know
- [ ] Not Applicable
- [ ] Other: _____

**12i. How do you currently dispose of Toys, Leisure and Sports Equipment (Electrical) (e.g. video games, train sets, etc.) in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] Don't know
- [ ] Not applicable
- [ ] Other: _____

**12j. How do you currently dispose of Batteries in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] EcoSolutions Battery Recovery Initiative
- [ ] Don't know
- [ ] Other: _____

**12k. How do you currently dispose of Medical Equipment (e.g. medical machines such as air purifiers, ventilators, etc.) in your household? Please tick all that apply.**

*Check all that apply.*

- [ ] Throw away with household rubbish
- [ ] Return to supplier/retailer
- [ ] Dispose of at waste transfer station for recycling
- [ ] Dispose of at waste transfer station mixed in with general waste
- [ ] Store it
- [ ] Sell it (e.g. TradeMe)
- [ ] Donate to charity
- [ ] Fly-tip it (i.e. illegal, deliberate dumping of waste on public or private property)
- [ ] Give away to friends/whanau
- [ ] Don't know
- [ ] Not Applicable
- [ ] Other: _____

**13. If you stated that your household stores e-waste on the previous page, please indicate what type of e-waste you currently have in storage, and how many items.**

*Mark only one oval per row.*

| | 0 items | 1 item | 2 items | 3 items | 4 items | 5 or more items |
|---|---|---|---|---|---|---|
| Small household appliances | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Large household appliances | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| ICT equipment | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Handheld devices | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Cellphones / smartphones | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Audio visual equipment | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Lighting equipment | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Electrical tools | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Toys, leisure and sports equipment | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Batteries | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Medical equipment | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Power cables, cords, etc. | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

**14. If you stated that your household stores e-waste, please rate the following statements for your household.**

*Mark only one oval per row.*

| | Not true | Slightly untrue | Slightly true | True |
|---|---|---|---|---|
| Our household stores e-waste because we don't know what to do with it | ◯ | ◯ | ◯ | ◯ |
| Our household stores e-waste because of the high cost of recycling it locally | ◯ | ◯ | ◯ | ◯ |
| Our household stores e-waste because it may have some monetary value | ◯ | ◯ | ◯ | ◯ |
| Our household stores e-waste in order to keep a spare/back up | ◯ | ◯ | ◯ | ◯ |
| Our household stores e-waste due to data security concerns | ◯ | ◯ | ◯ | ◯ |

**There are other reasons that our household stores e-waste. Please describe.**

**15. I would change the way that I/we manage e-waste in my/our household if...**

*Mark only one oval per row.*

| | Definitely | Probably | Probably not | Definitely not |
|---|---|---|---|---|
| there were no costs associated with recycling e-waste. | ◯ | ◯ | ◯ | ◯ |
| the cost of recycling was included at the time of purchase. | ◯ | ◯ | ◯ | ◯ |
| recycling e-waste was part of kerbside pick up. | ◯ | ◯ | ◯ | ◯ |
| you received a rebate when you disposed of your e-waste. | ◯ | ◯ | ◯ | ◯ |
| you were provided with information about why e-waste recycling is so important. | ◯ | ◯ | ◯ | ◯ |
| you were provided with information about where and what can be recycled in the Whangarei District. | ◯ | ◯ | ◯ | ◯ |
| retailers provided places to dispose of e-waste | ◯ | ◯ | ◯ | ◯ |

**16. When was the last time you disposed of e-waste? And how did you do it?**

## E-waste Management

Nearly there! Only 5 questions to go!

**17. Are you satisfied with the effectiveness of e-waste recycling services available in your community?**

*Mark only one oval.*

- ◯ Satisfied
- ◯ Neutral
- ◯ Unsatisfied
- ◯ There are no local e-waste recycling services
- ◯ Excellent e-waste services are available locally
- ◯ Don't know

**18. Do you know where the nearest waste transfer station is to your home? And have you used it to dispose of e-waste?**

*Mark only one oval.*

- ◯ I know where the nearest transfer station is and I have used it to dispose of e-waste
- ◯ I know where the nearest transfer station is but I have not used it to dispose of e-waste
- ◯ I don't know where my nearest transfer station is

**19. If consumers are expected to pay for user friendly, quality assured, environmentally sound, healthy and safe e-waste recycling, how much would you be willing to pay? Please select all that apply.**

*Check all that apply.*

- [ ] Zero, I am not prepared to pay
- [ ] A fee of $1 to $10
- [ ] A fee of $11 to $20
- [ ] A fee of $21 to $50
- [ ] I want to get paid for any 'scrap' value of my e-waste
- [ ] Other: _____

**20. How would you rate the 'overall effectiveness' of the current approach in dealing with e-waste in New Zealand as a whole?**

*Mark only one oval.*

- ◯ Excellent
- ◯ Good
- ◯ Average
- ◯ Poor
- ◯ Very Bad
- ◯ Don't know
- ◯ Other: _____

**21. In your opinion, what is the best approach for New Zealand in dealing with e-waste issues? Please tick all that apply.**

*Check all that apply.*

- [ ] Status quo works ok /no change.
- [ ] Leave it up to the free market
- [ ] Maintain a 'voluntary only' approach to product stewardship for e-waste
- [ ] Government intervention is required
- [ ] User pays at drop-off
- [ ] Free public drop-off
- [ ] People get paid for any scrap value when dropping off e-waste
- [ ] Compulsory registration and licensing of e-waste recyclers
- [ ] Banning e-waste from landfill
- [ ] Adopt national e-waste recycling standards to protect environmental and human health
- [ ] Don't know
- [ ] Other: _____

**22. Are there any other comments you would like to make on e-waste management either in the Whangarei District, or in New Zealand as a whole?**

## Thank you!

Thank you for taking the time to complete this survey.

This project has been evaluated by peer review and judged to be low risk. If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher, please contact Dr Brian Finch, Director (Research Ethics), email humanethics@massey.ac.nz, citing reference 4000018572.

Please feel free to share this survey with your friends, whanau, and colleagues. The survey will close to the public on Friday 13 April at 5pm.

Don't forget to enter the prize draw to win a $150 meal voucher from The Quay Restaurant and Bar by entering your details below.

Thanks again for your time.

Nga mihi nui,

Vicktoria Blake
Researcher

36. **Want more information or to go into the prize draw? Please select one of the following:**

*Mark only one oval.*

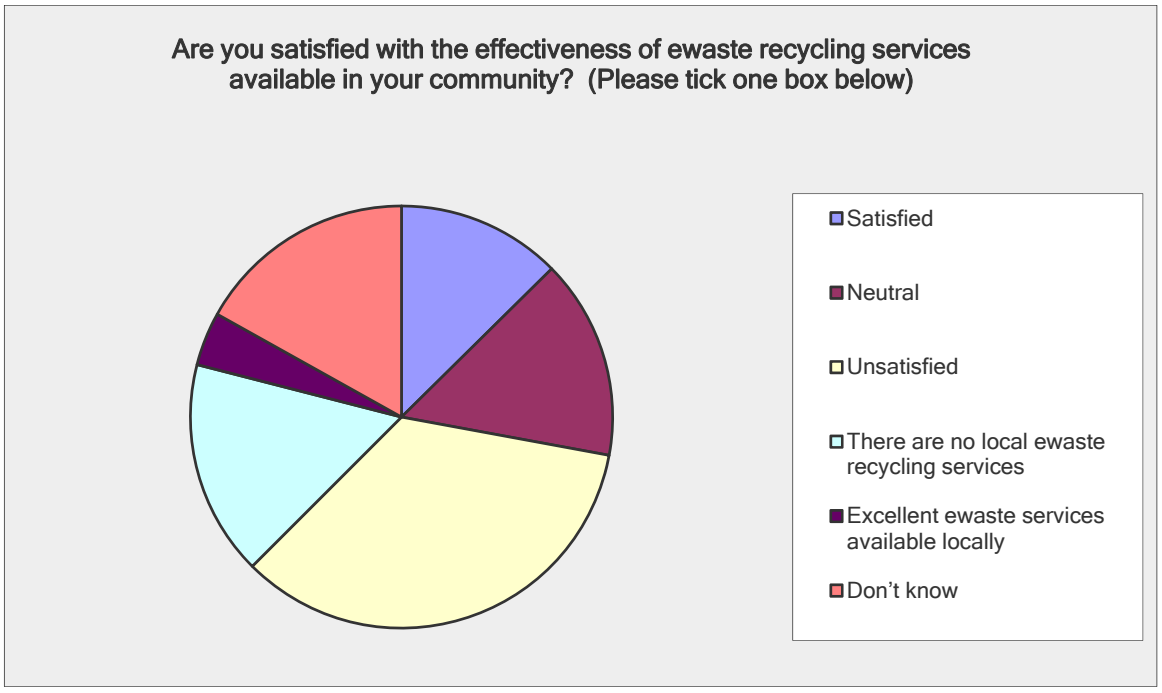
- A: I would like to receive further information, the final results of the survey, or a summary of the findings and go into the draw for the meal voucher.
- B: I would only like to receive further information, the final results of the survey, or a summary of the findings.
- C: I would only like to go into the draw for the meal voucher.
- D: None of the above.

37. **If you have selected from A - C above, please enter your email address below so we know how to contact you.**

## Appendix 5.2 2012 E-waste Survey Questions Utilised in Current Research

### Appendix 5.2.1 2012 Survey Question 11

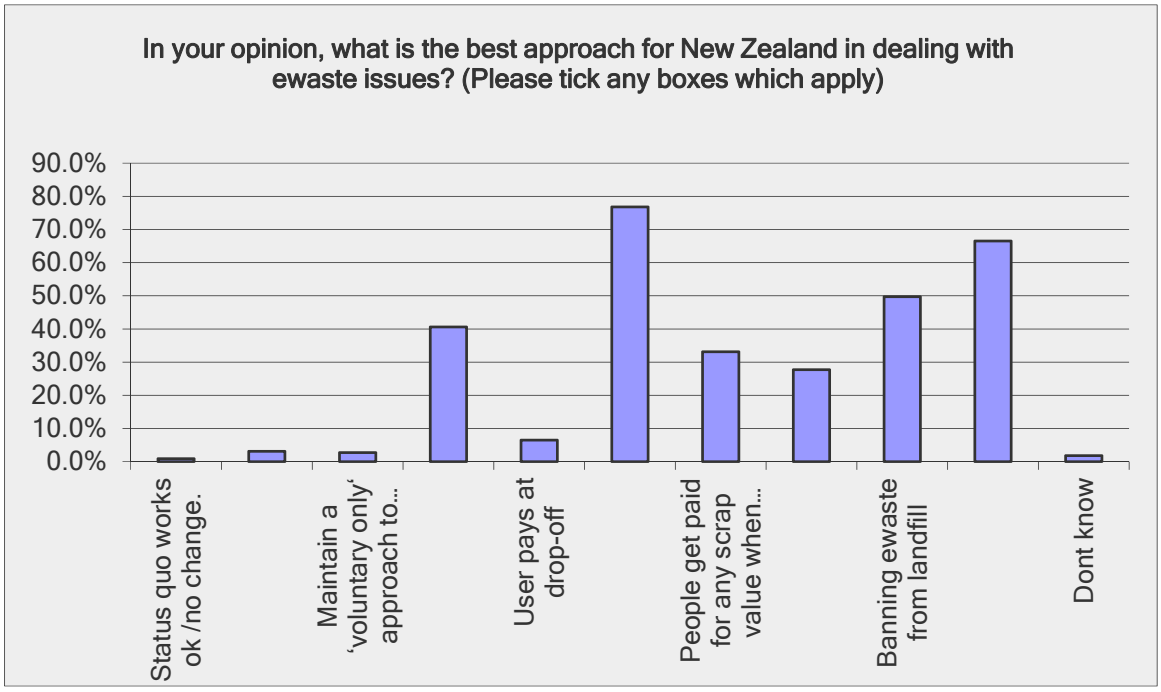
| Are you satisfied with the effectiveness of ewaste recycling services available in your community? (Please tick one box below) | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| Satisfied | 12.6% | 99 |
| Neutral | 15.3% | 120 |
| Unsatisfied | 34.6% | 271 |
| There are no local ewaste recycling services | 16.5% | 129 |
| Excellent ewaste services available locally | 4.1% | 32 |
| Don't know | 16.9% | 132 |
| Any comments? | | 183 |
| *answered question* | | 783 |
| *skipped question* | | 19 |




N.B. This question is found in the current research survey as question 17.

**Appendix 5.2.2 2012 Survey Question 15**

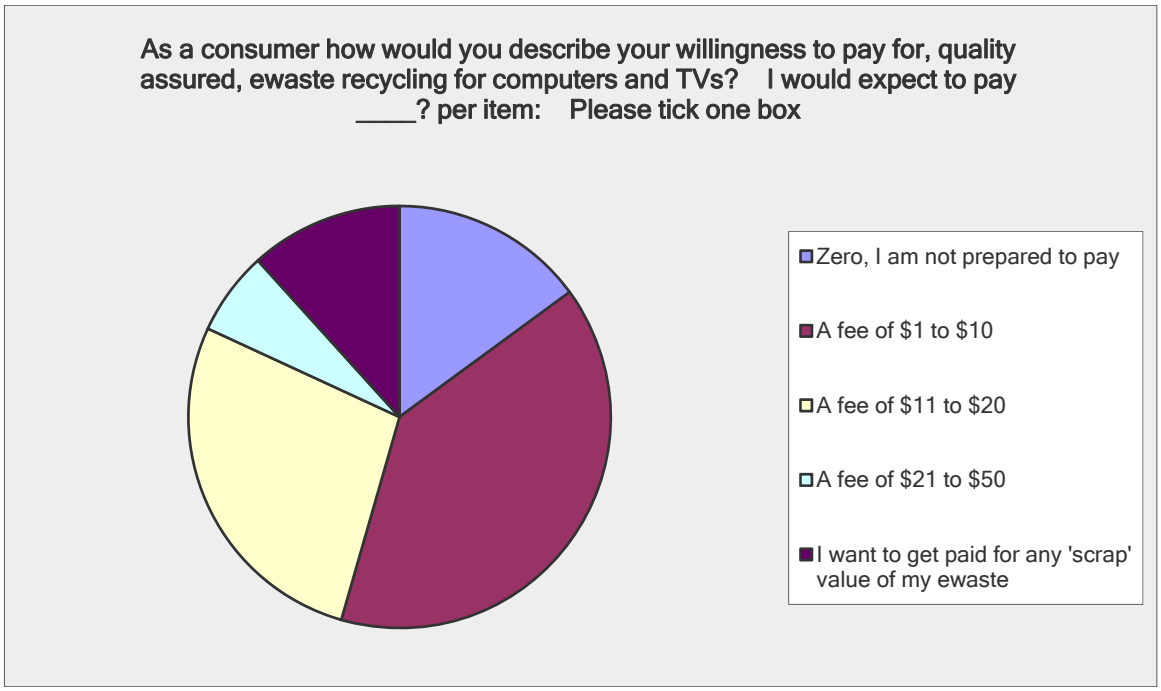
| In your opinion, what is the best approach for New Zealand in dealing with ewaste issues? (Please tick any boxes which apply) | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| Status quo works ok /no change. | 0.9% | 7 |
| Leave it up to the free market | 3.1% | 24 |
| Maintain a 'voluntary only' approach to product stewardship for ewaste | 2.7% | 21 |
| Government intervention is required | 40.6% | 313 |
| User pays at drop-off | 6.5% | 50 |
| Free public drop-off | 76.8% | 591 |
| People get paid for any scrap value when dropping off ewaste | 33.1% | 255 |
| Compulsory registration and licensing of ewaste recyclers | 27.7% | 213 |
| Banning ewaste from landfill | 49.7% | 383 |
| Adopt national ewaste recycling standards to protect environmental and human health | 66.5% | 512 |
| Dont know | 1.8% | 14 |
| Other (please specify) | | 84 |
| | *answered question* | 770 |
| | *skipped question* | 32 |




N.B. This question is found in the current research survey as question 21.

**Appendix 5.2.3 2012 Survey Question 18**

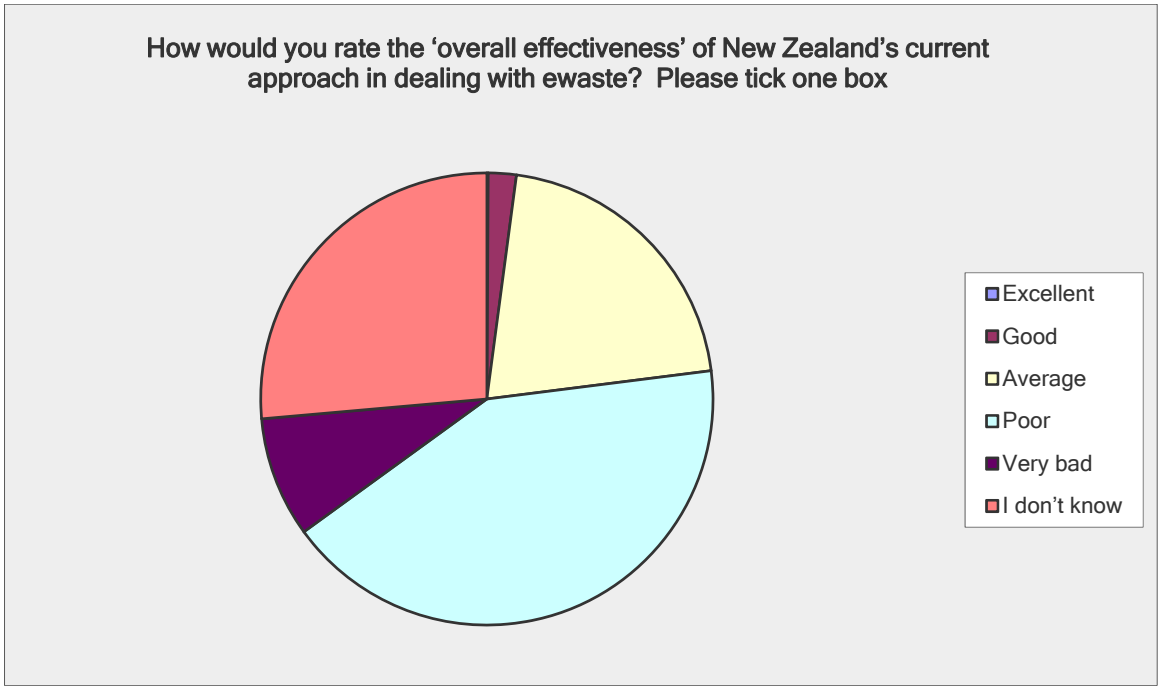
| As a consumer how would you describe your willingness to pay for, quality assured, ewaste recycling for computers and TVs? I would expect to pay ____? per item: Please tick one box | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| Zero, I am not prepared to pay | 14.9% | 110 |
| A fee of $1 to $10 | 39.5% | 291 |
| A fee of $11 to $20 | 27.4% | 202 |
| A fee of $21 to $50 | 6.4% | 47 |
| I want to get paid for any 'scrap' value of my ewaste | 11.7% | 86 |
| Any comment | | 107 |
| *answered question* | | 736 |
| *skipped question* | | 66 |




N.B. This question is found in the current research survey as question 19.

**Appendix 5.2.4 2012 Survey Question 19**

| How would you rate the 'overall effectiveness' of New Zealand's current approach in dealing with ewaste? Please tick one box | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| Excellent | 0.1% | 1 |
| Good | 2.0% | 15 |
| Average | 20.9% | 154 |
| Poor | 42.0% | 309 |
| Very bad | 8.6% | 63 |
| I don't know | 26.4% | 194 |
| Any comment | | 47 |
| | *answered question* | 736 |
| | *skipped question* | 66 |



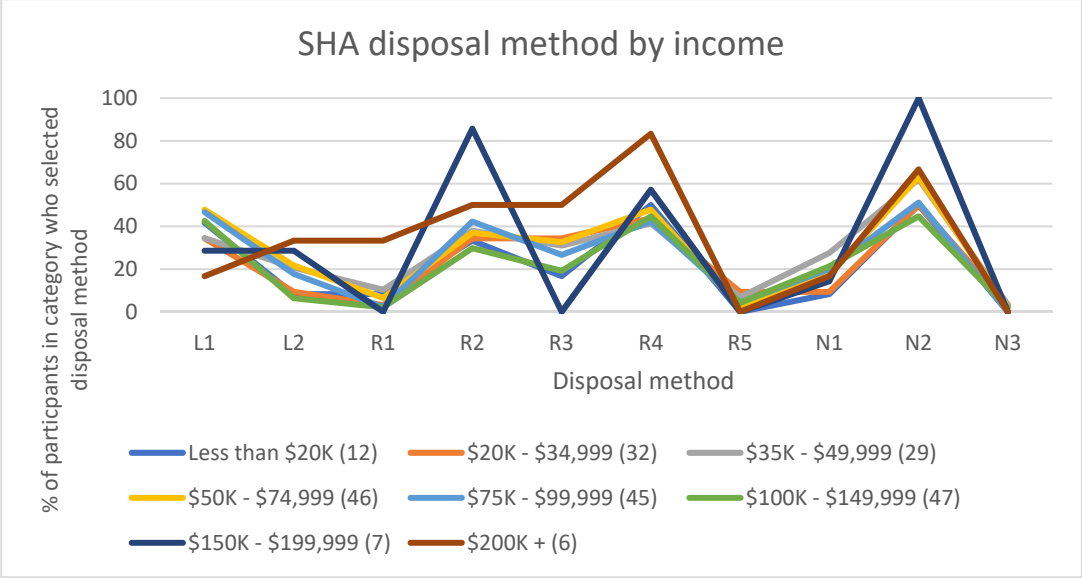

N.B. This question is found in the current research survey as question 20.

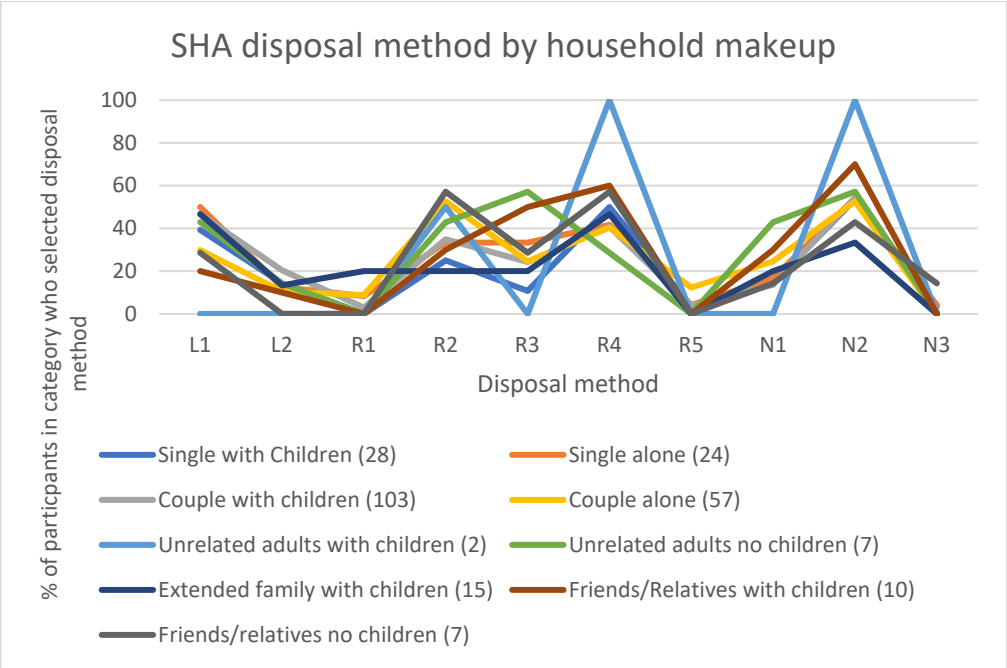
## Appendix 6.1. Relationship Investigation Graphs

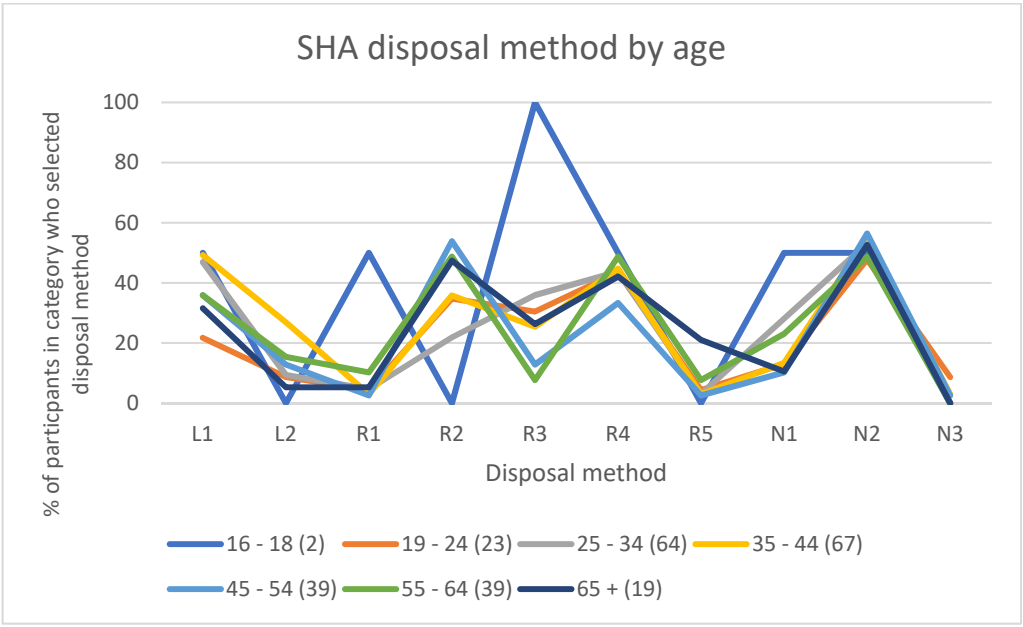
The following graphs show a broad pattern analysis conducted on the results of question 12 of the survey utilising line graphs to indicate spread in results. The broad pattern analysis found no between significant correlation in behaviours related to the demographic and recycling behaviour patterns, however, further research could delve deeper into the data.

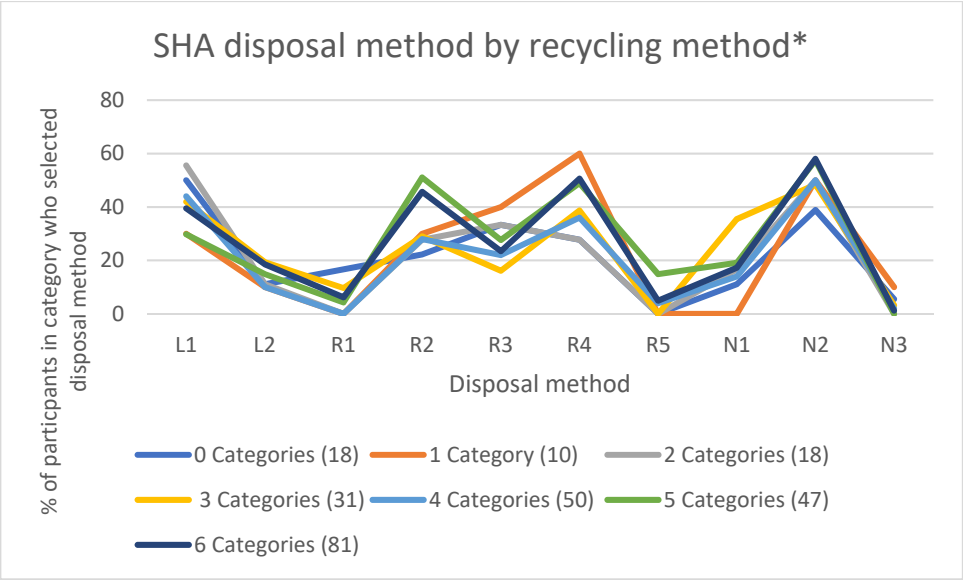
*General household recycling method is calculated by the number of times a respondent selected that they "always" recycled across the six general recycling categories.

### Appendix 6.1.1 Small Household Appliances (SHA) Relationship Investigation




SHA disposal method by household makeup
% of particpants in category who selected disposal method
100
80
60
40
20
0
L1
L2
R1
R2
R3
R4
R5
N1
N2
N3
Disposal method
Single with Children (28)
Single alone (24)
Couple with children (103)
Couple alone (57)
Unrelated adults with children (2)
Unrelated adults no children (7)
Extended family with children (15)
Friends/Relatives with children (10)
Friends/relatives no children (7)

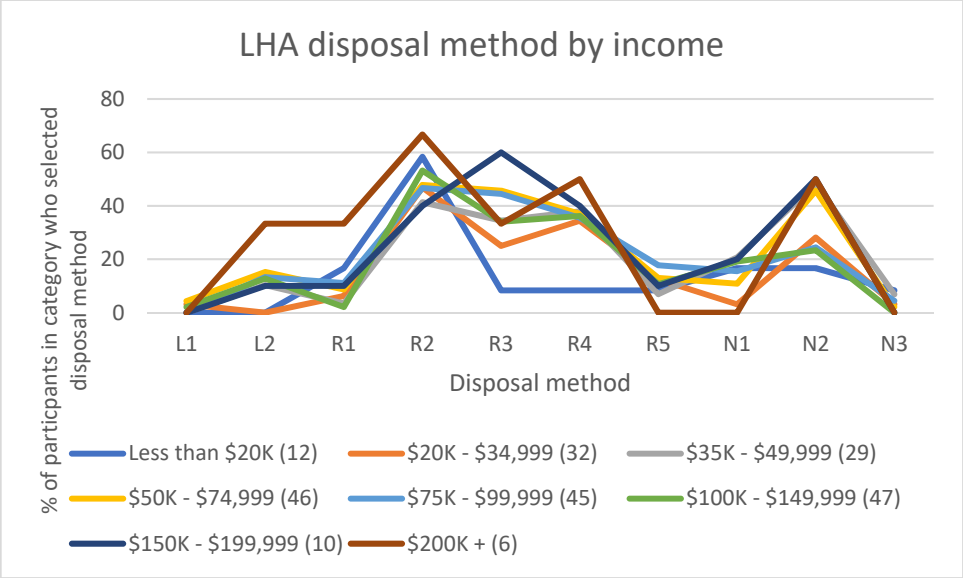

SHA disposal method by age
% of particpants in category who selected disposal method
100
80
60
40
20
0
L1
L2
R1
R2
R3
R4
R5
N1
N2
N3
Disposal method
16 - 18 (2)
19 - 24 (23)
25 - 34 (64)
35 - 44 (67)
45 - 54 (39)
55 - 64 (39)
65 + (19)

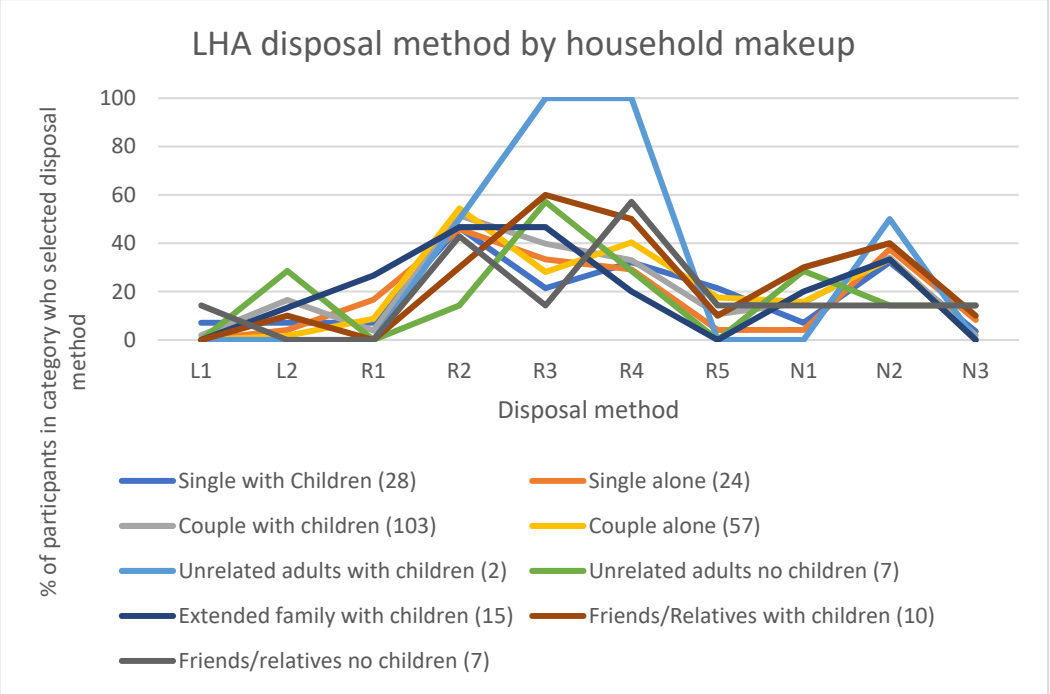


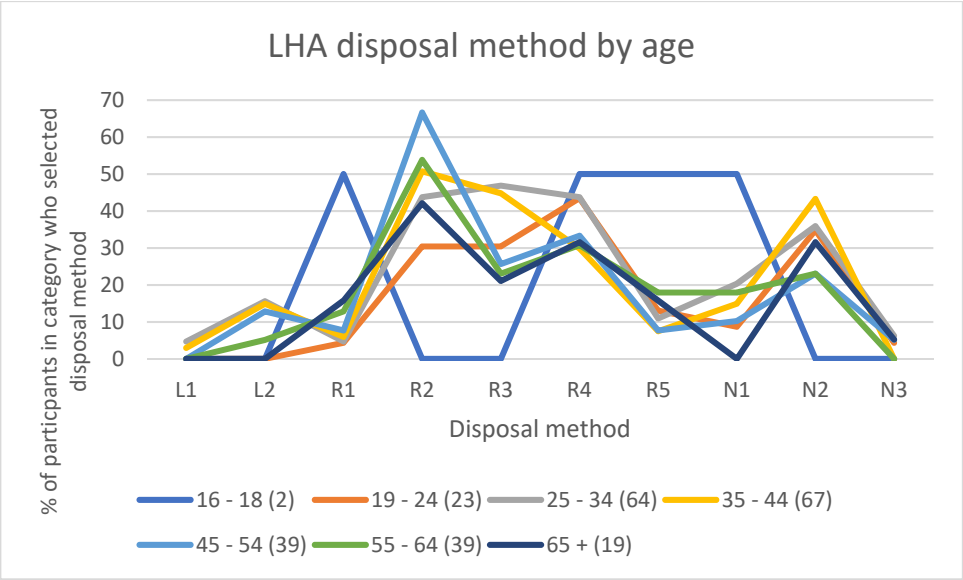

Disposal Method Key

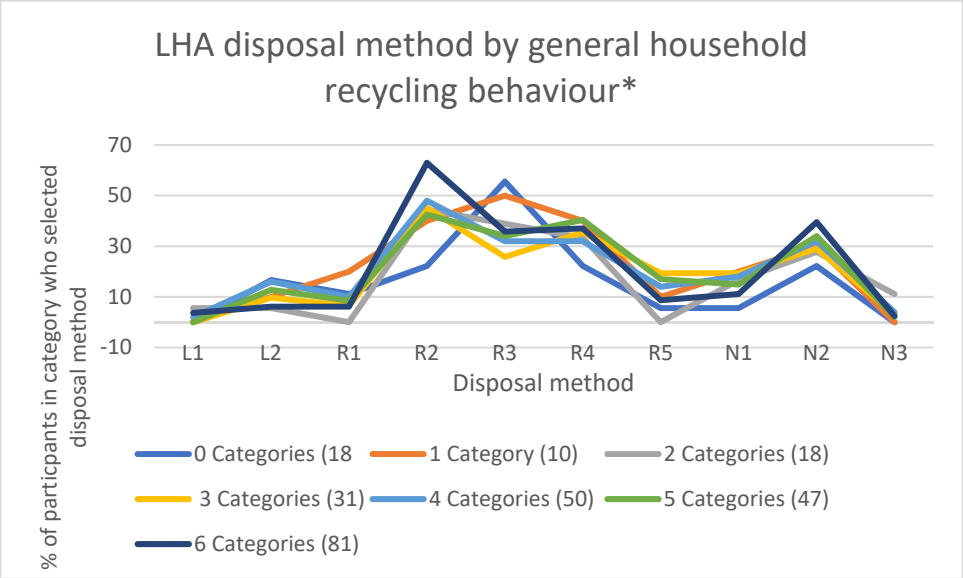
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

**Appendix 6.1.2 Large Household Appliances (LHA) Relationship Investigation**



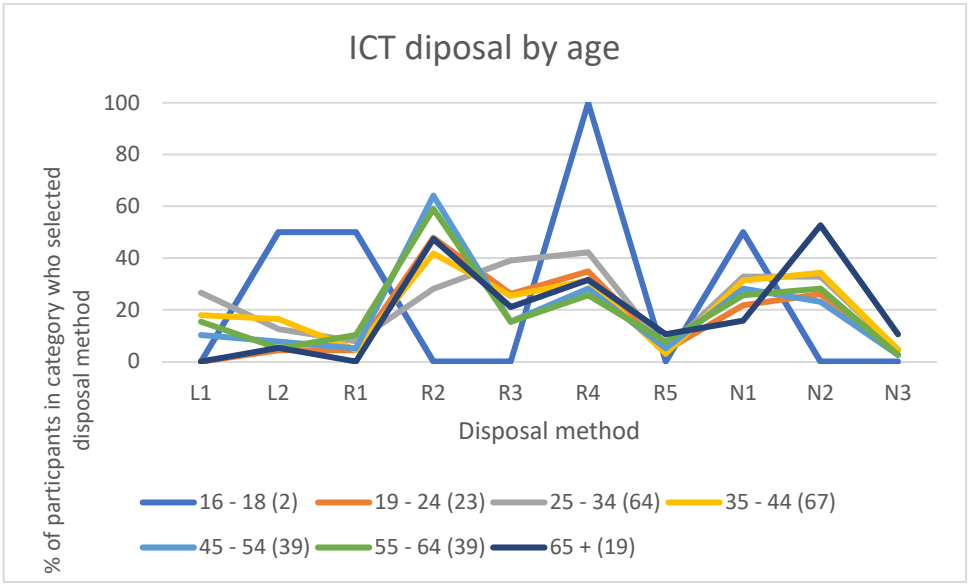


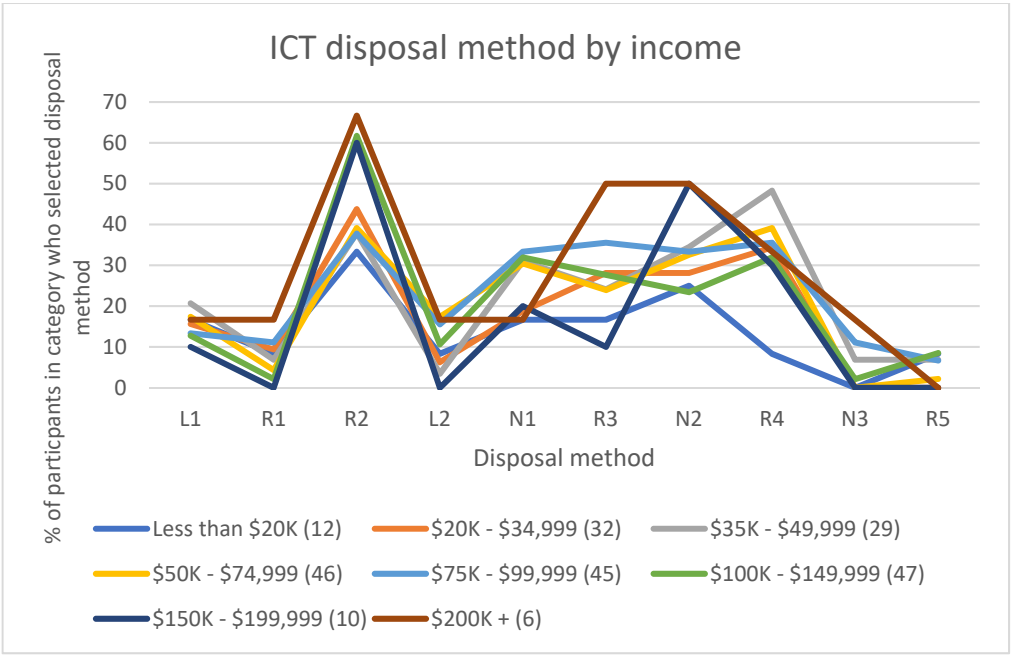



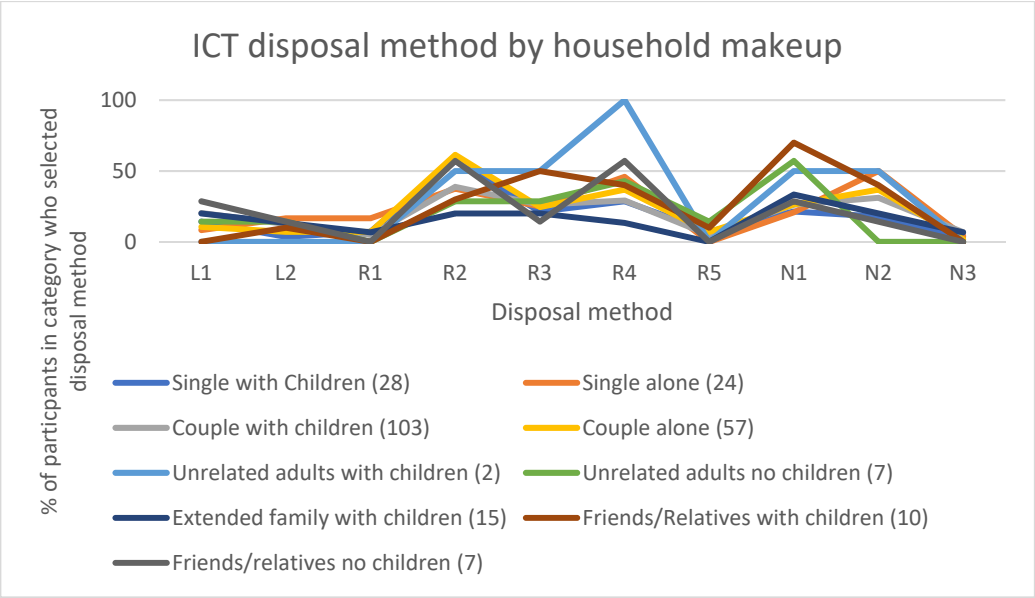

Disposal Method Key

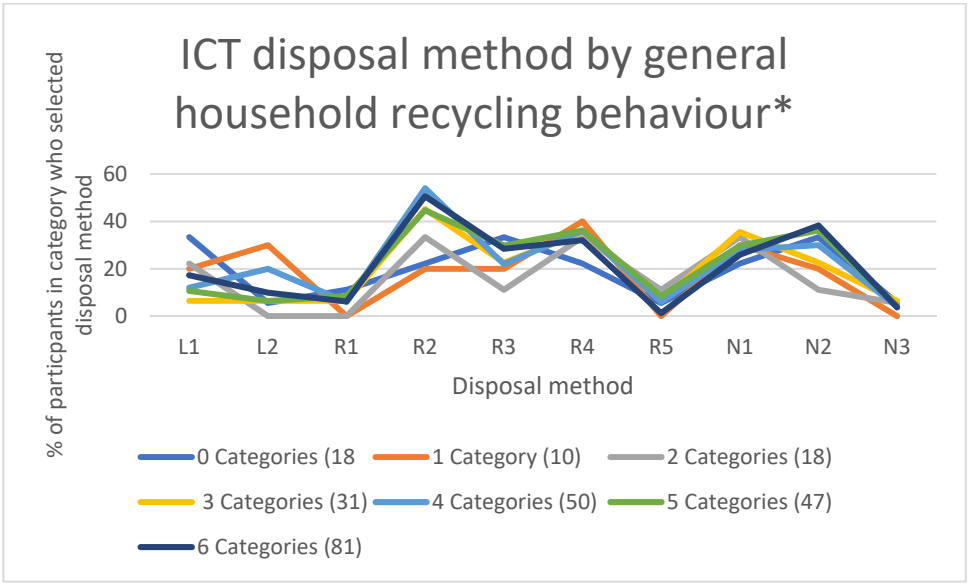
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

**Appendix 6.1.3 ICT Equipment (ICT) Relationship Investigation**



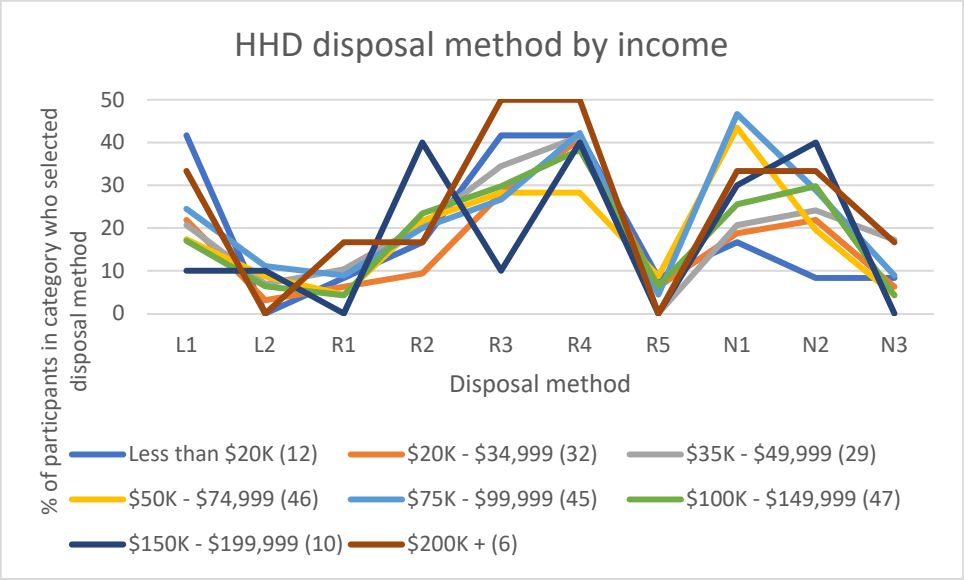


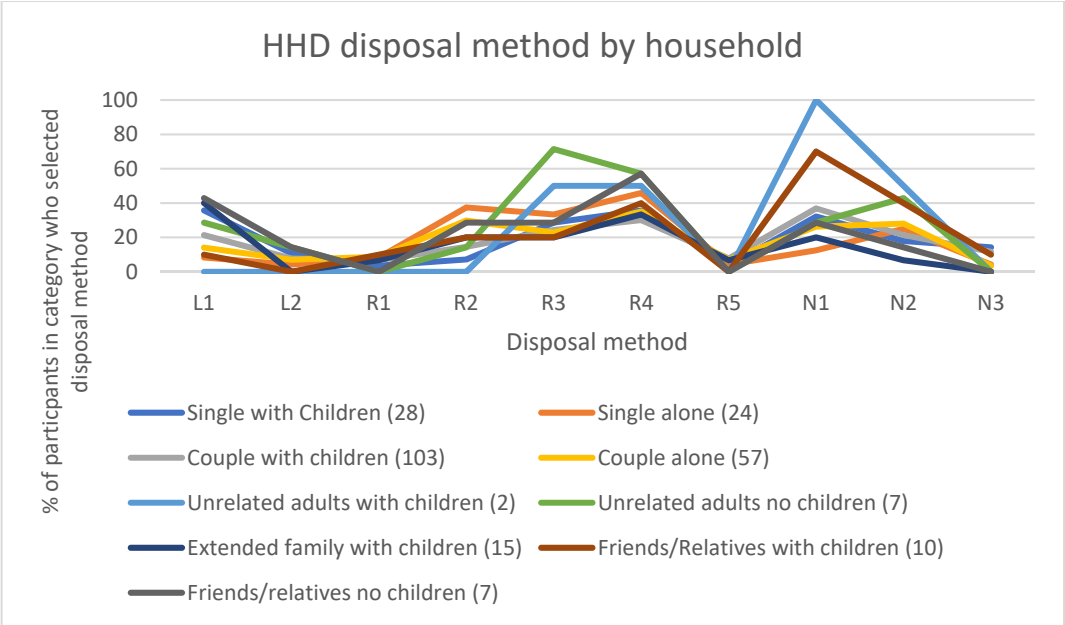



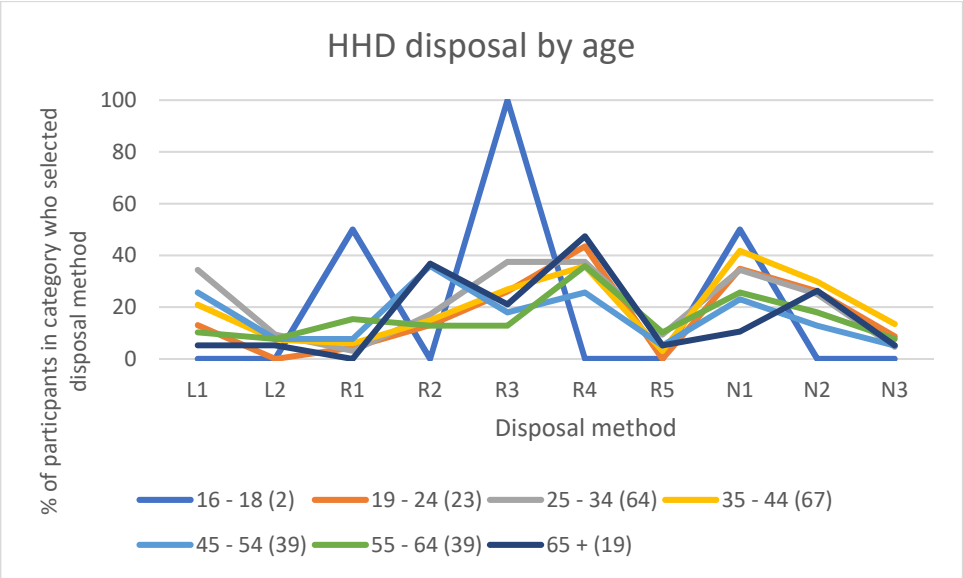

Disposal Method Key

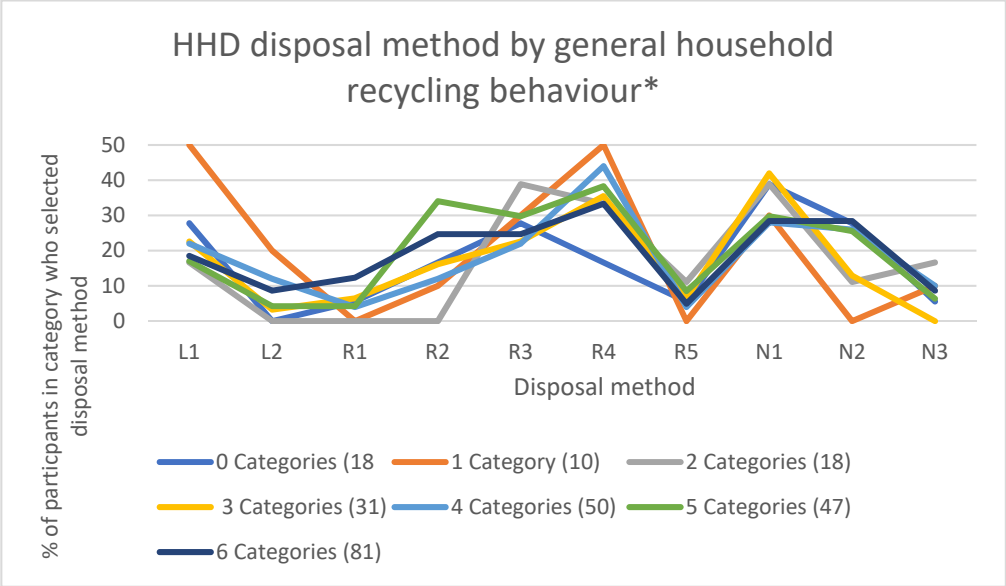
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

**Appendix 6.1.4 Handheld Devices (HHD) Relationship Investigation**



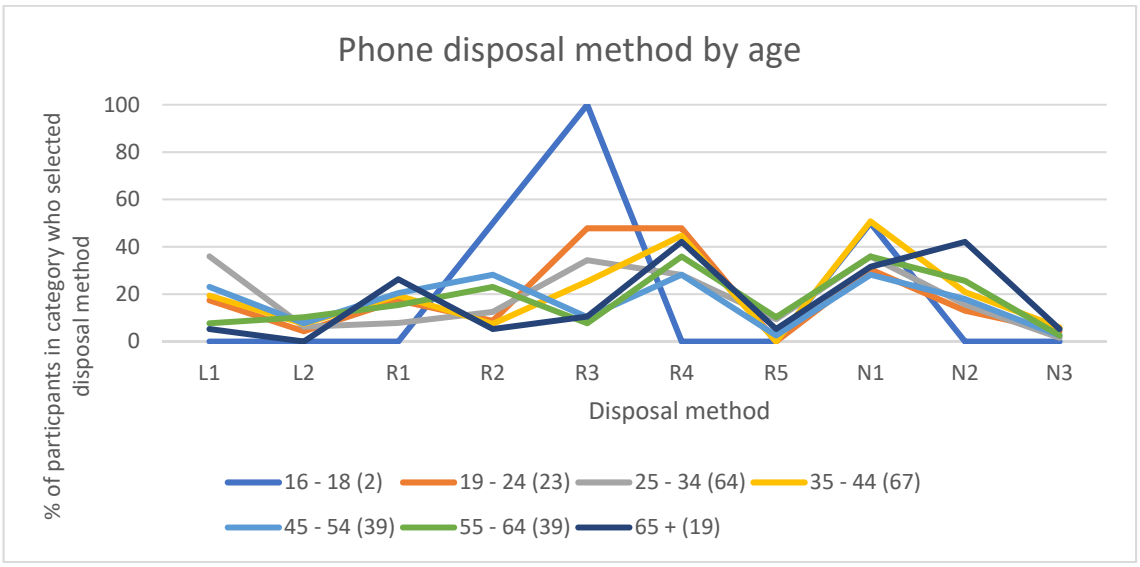


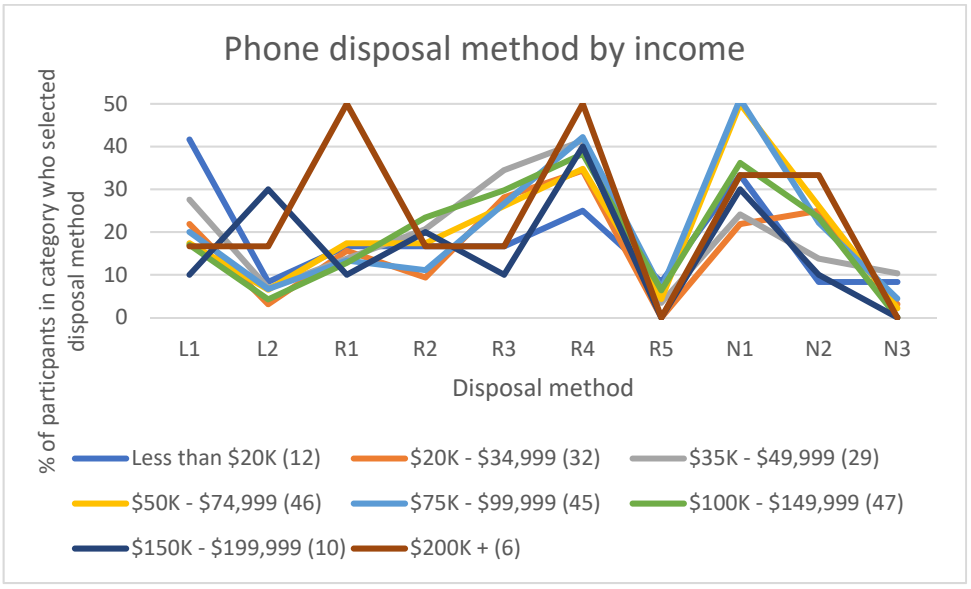



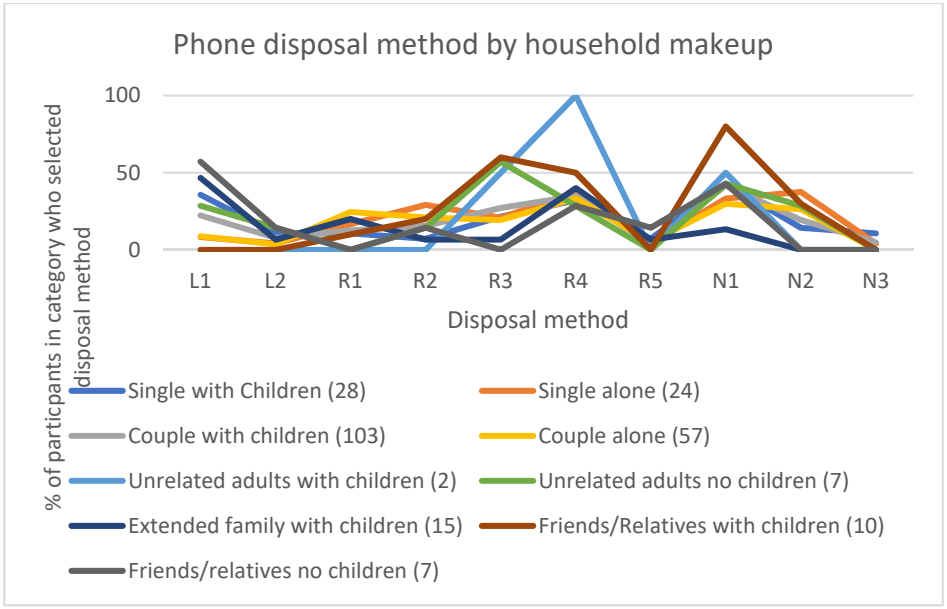

Disposal Method Key

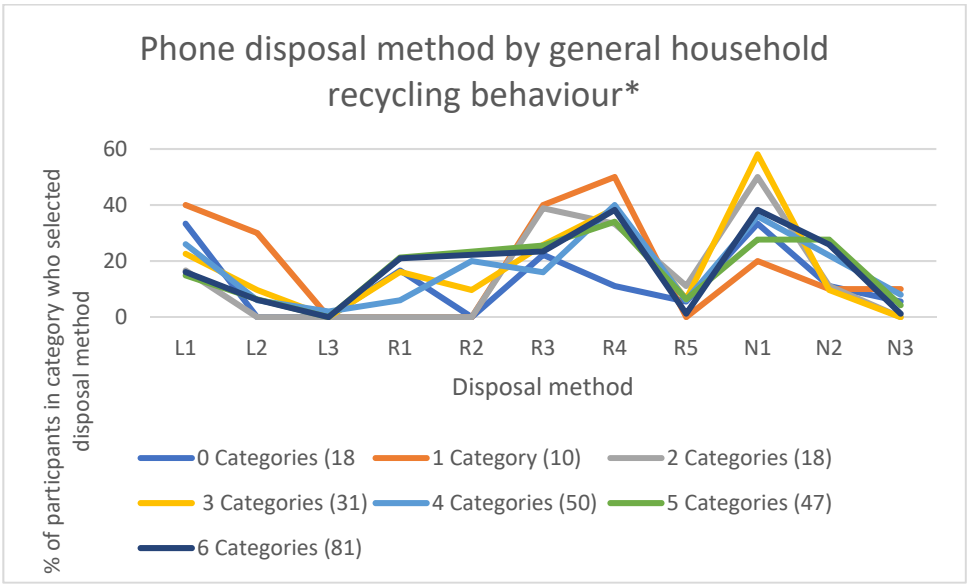
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

**Appendix 6.1.5 Cellphone/Smartphone (Phone) Relationship Investigation**



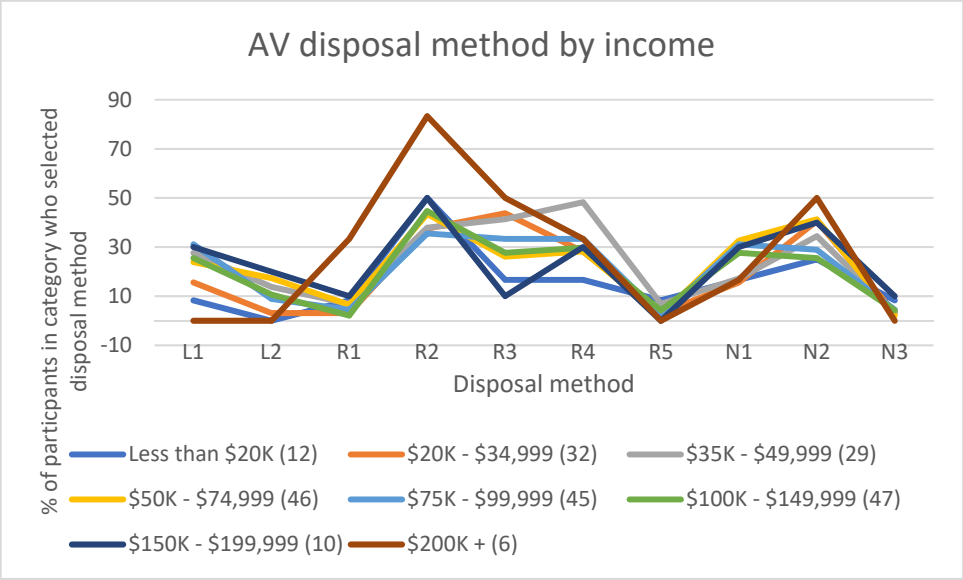


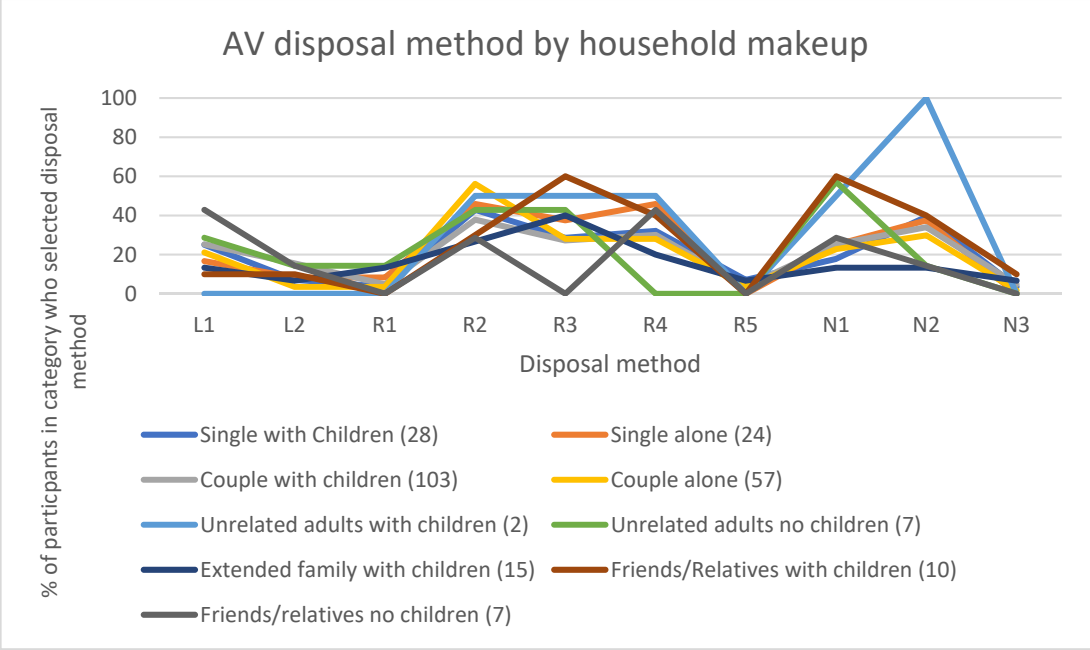



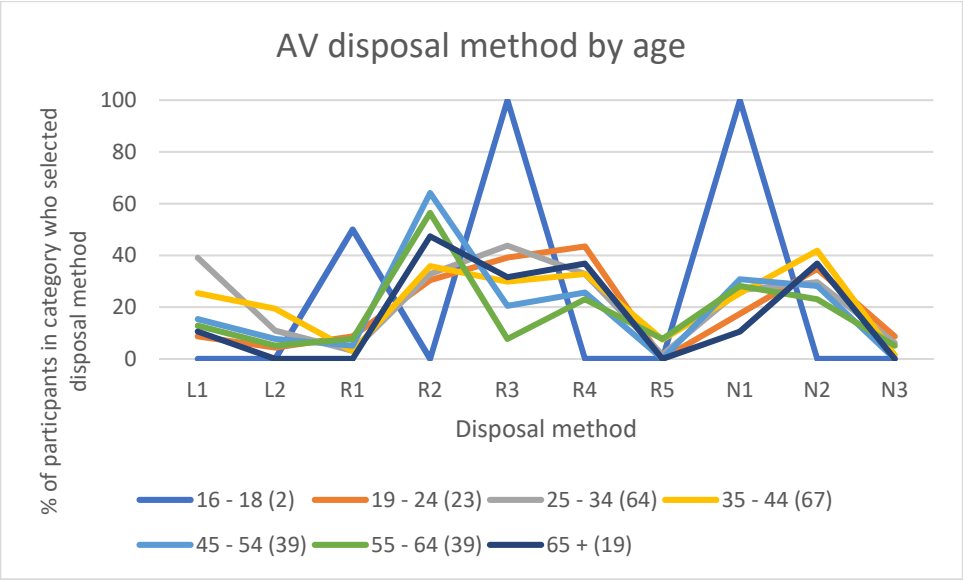

Disposal Method Key

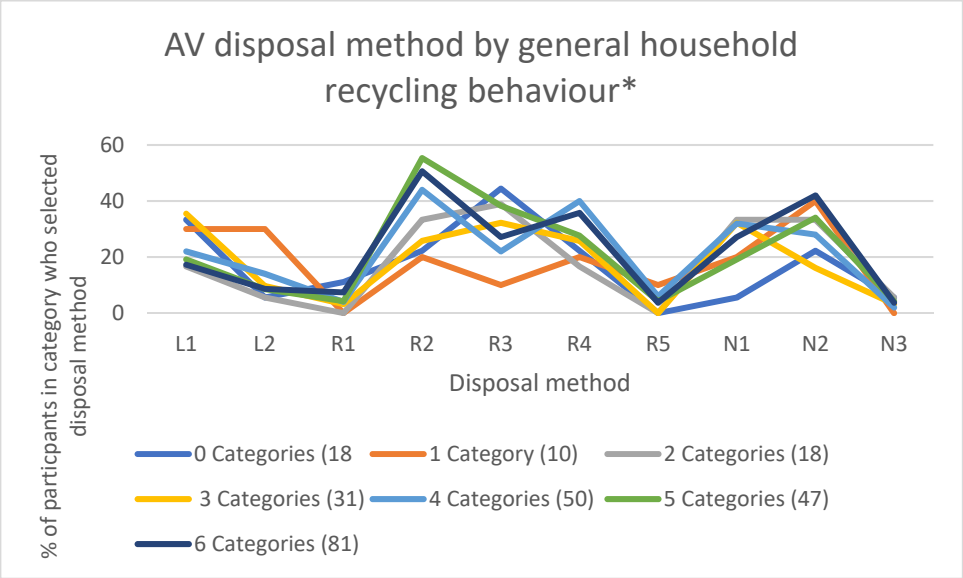
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

**Appendix 6.1.6 AV Equipment (AV) Relationship Investigation**



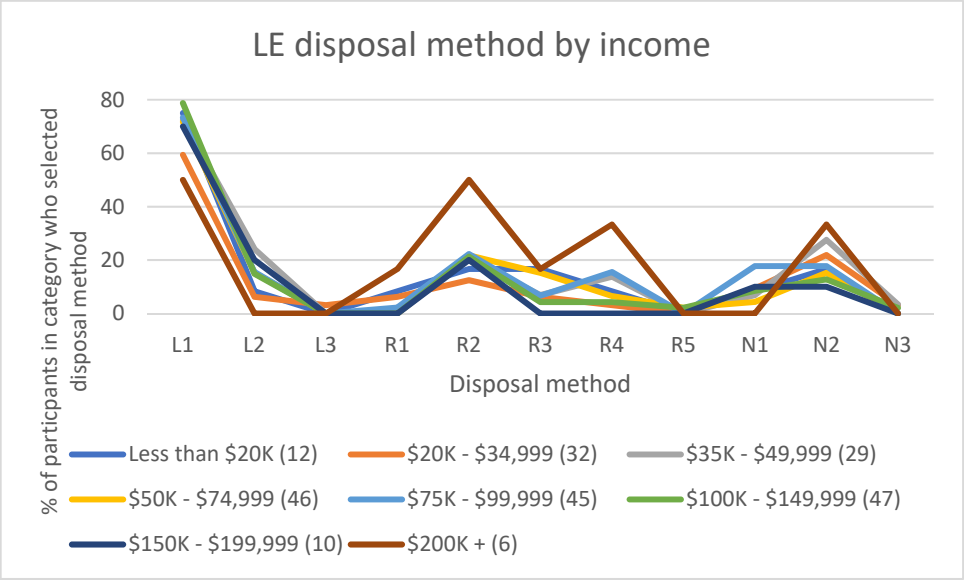


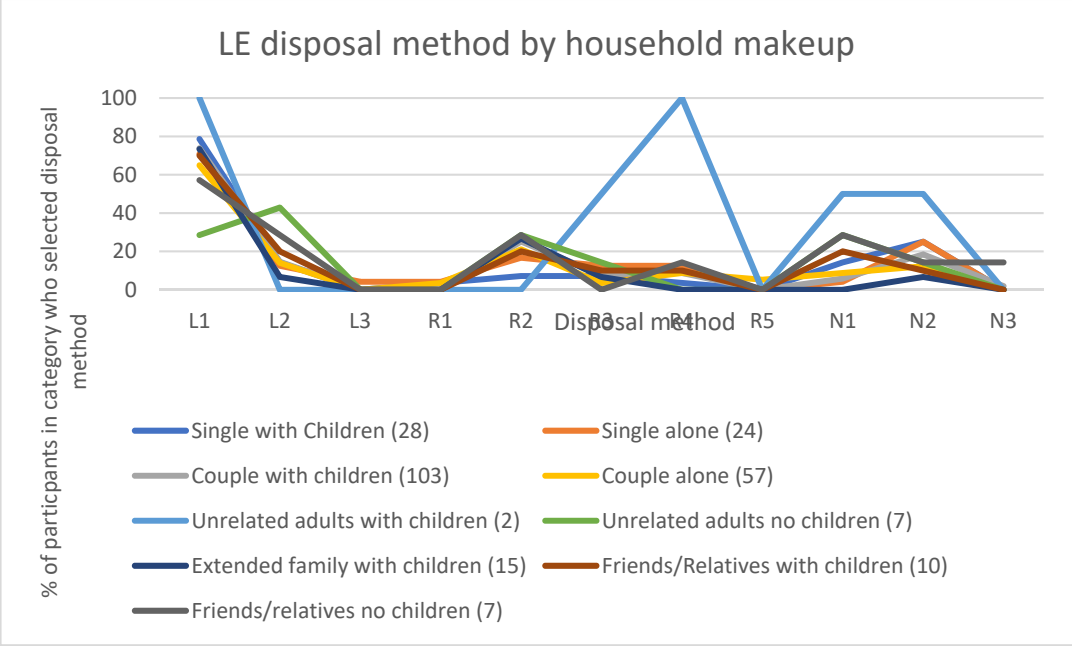



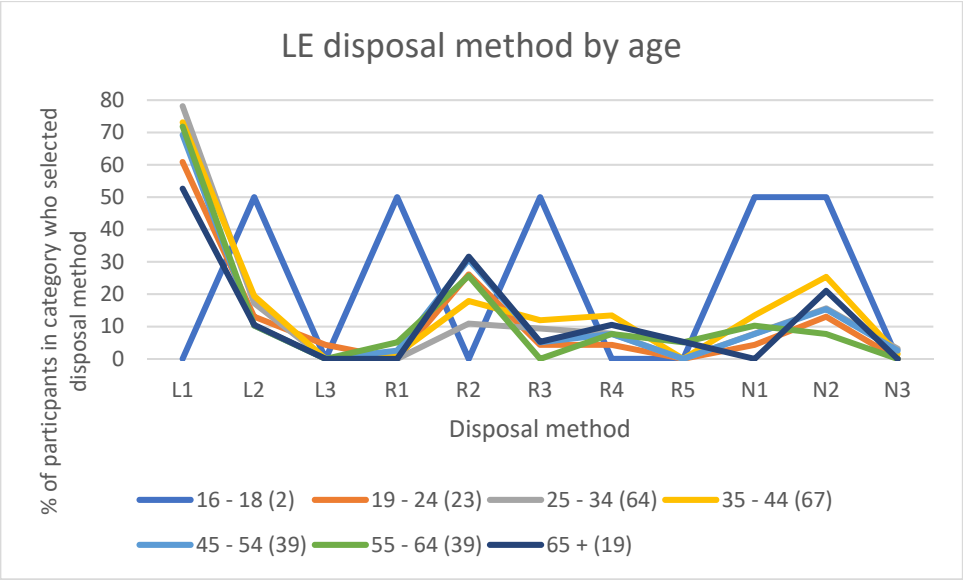

Disposal Method Key

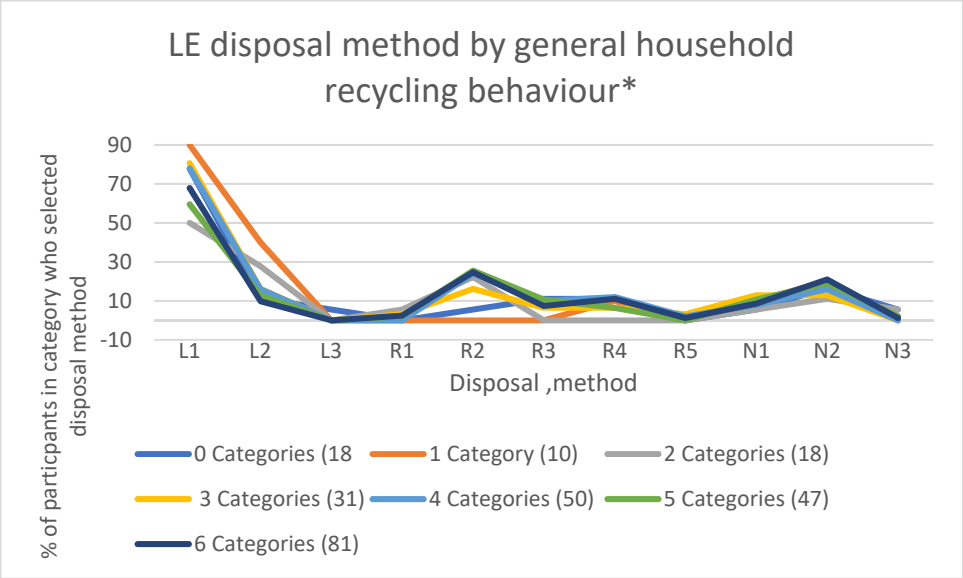
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

**Appendix 6.1.7 Lighting Equipment (LE) Relationship Investigation**



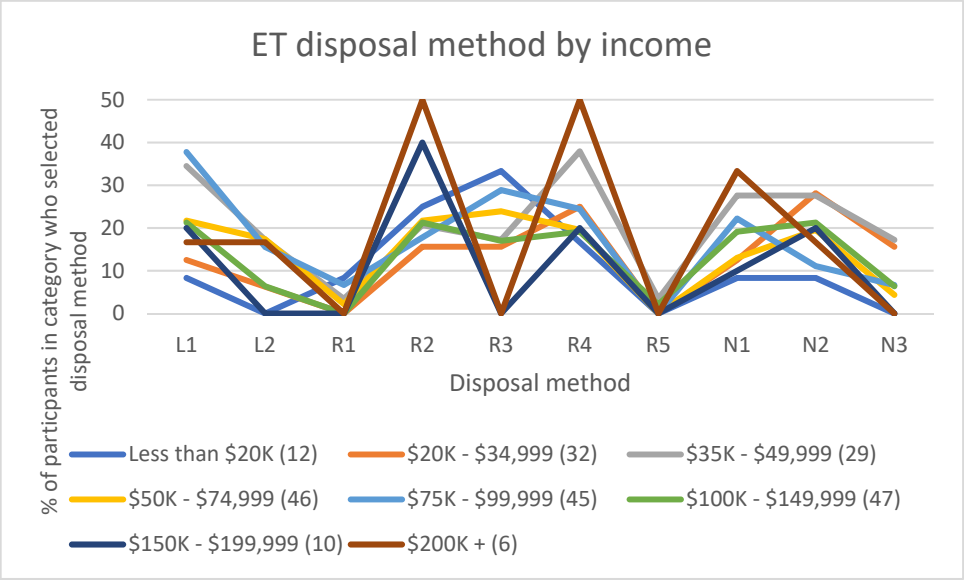


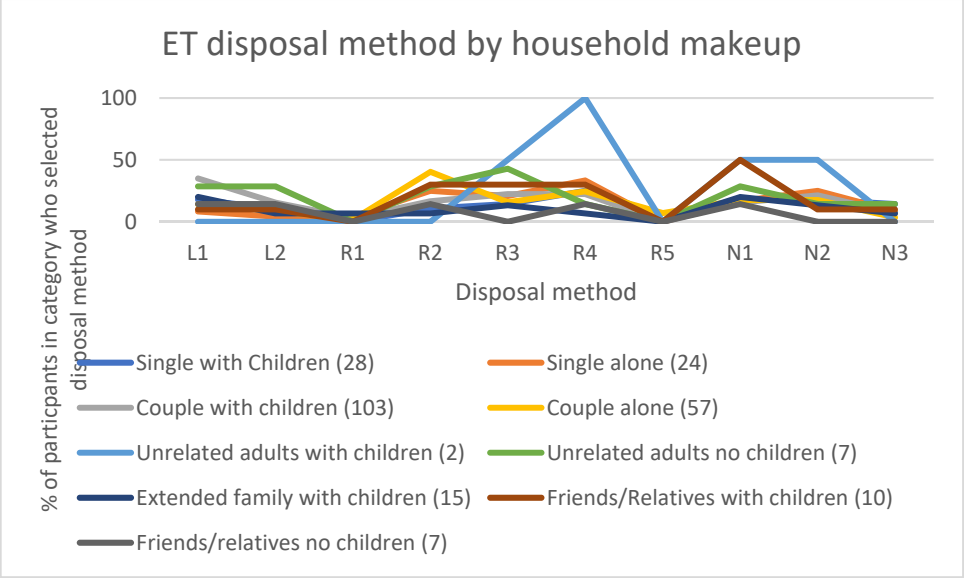



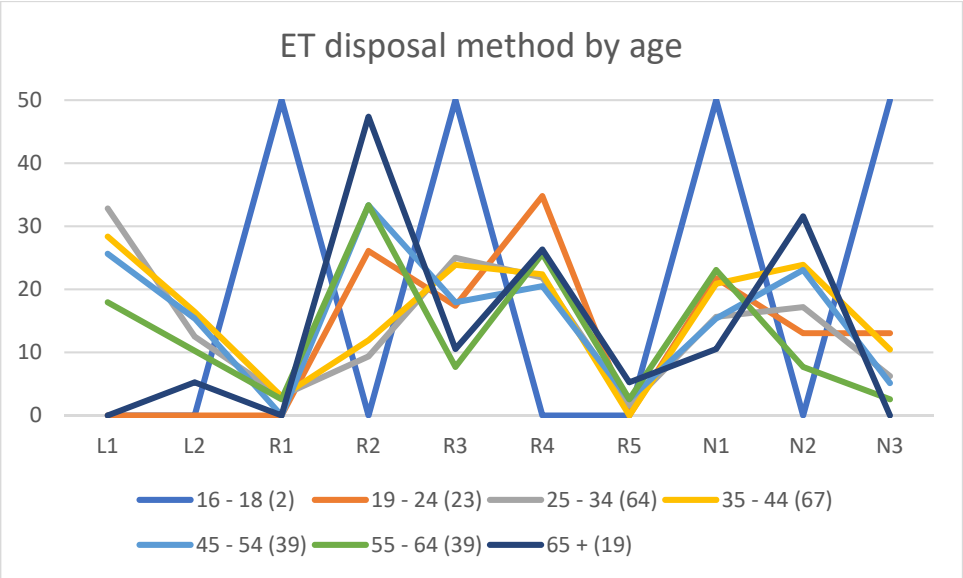

Disposal Method Key

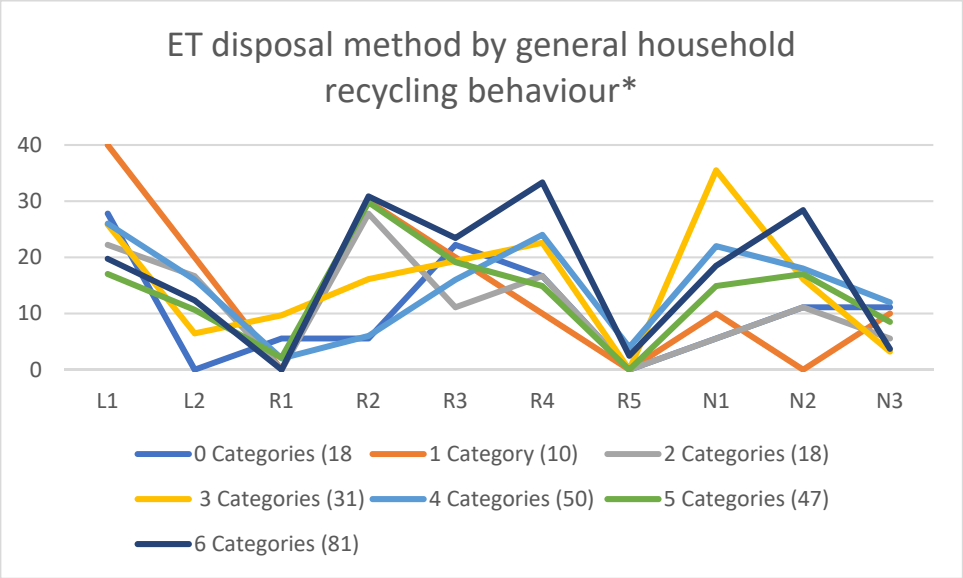
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

**Appendix 6.1.8 Electrical Tools (ET) Relationship Investigation**



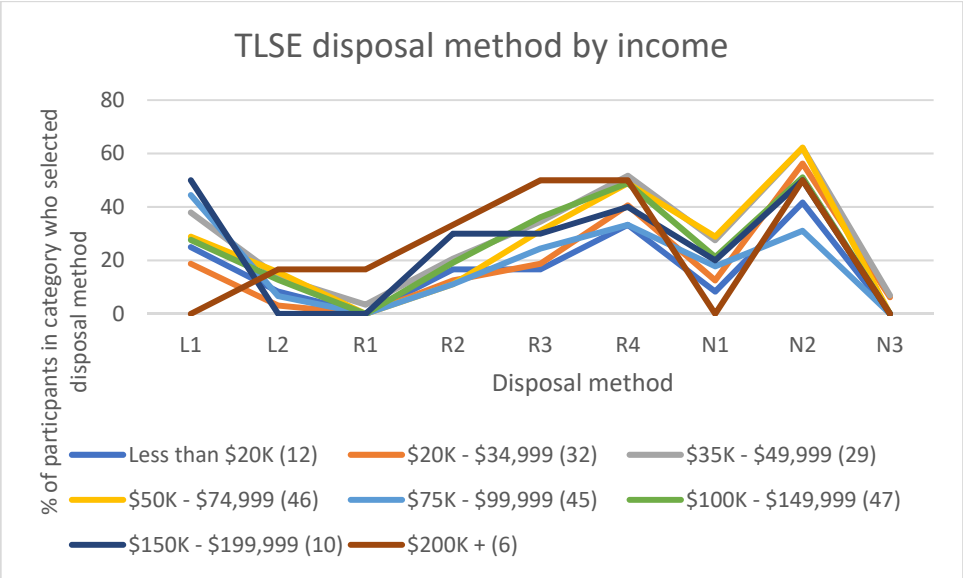


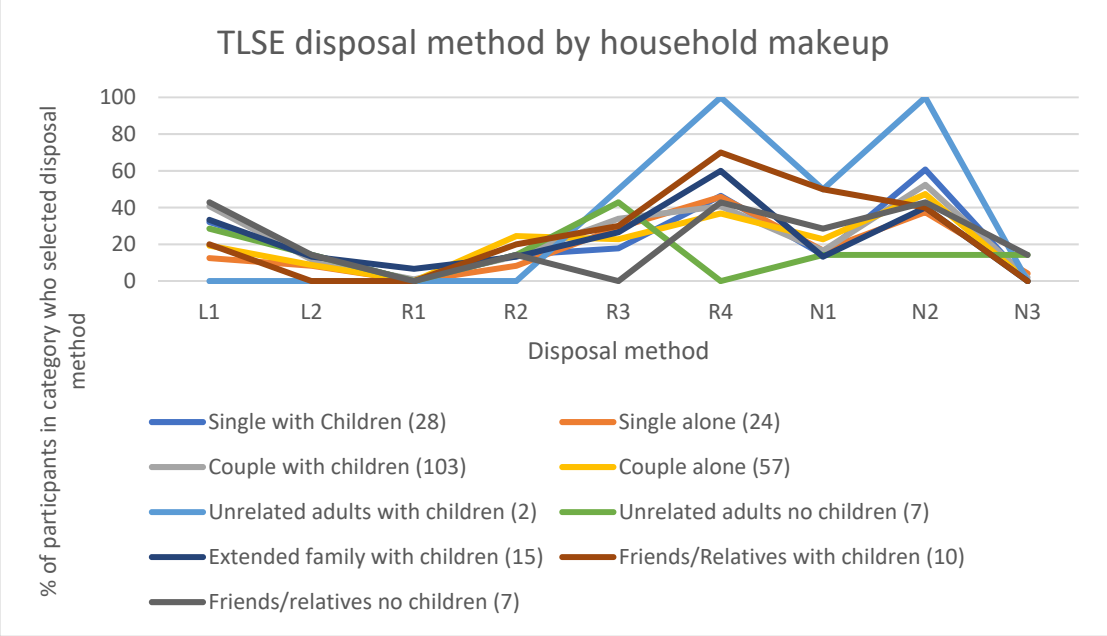



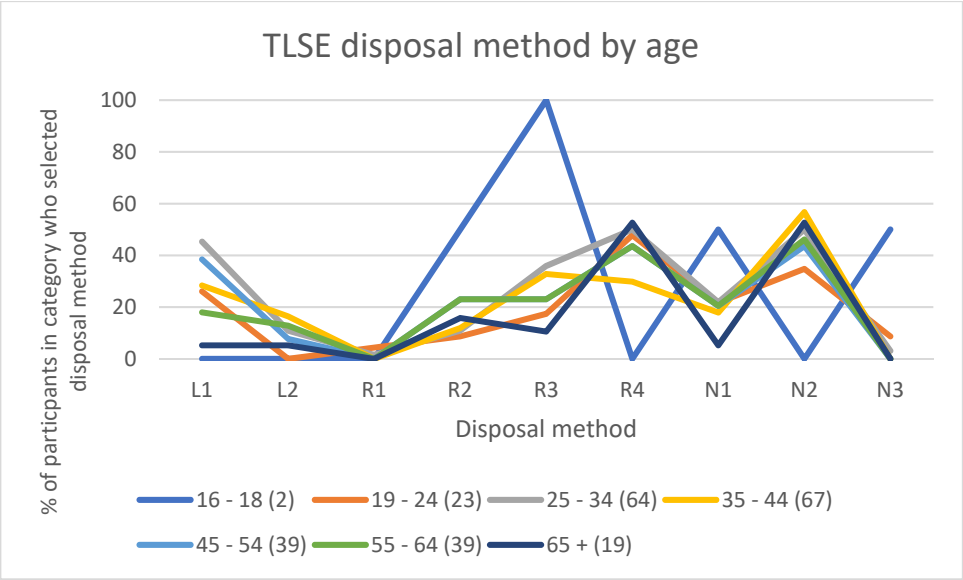

Disposal Method Key

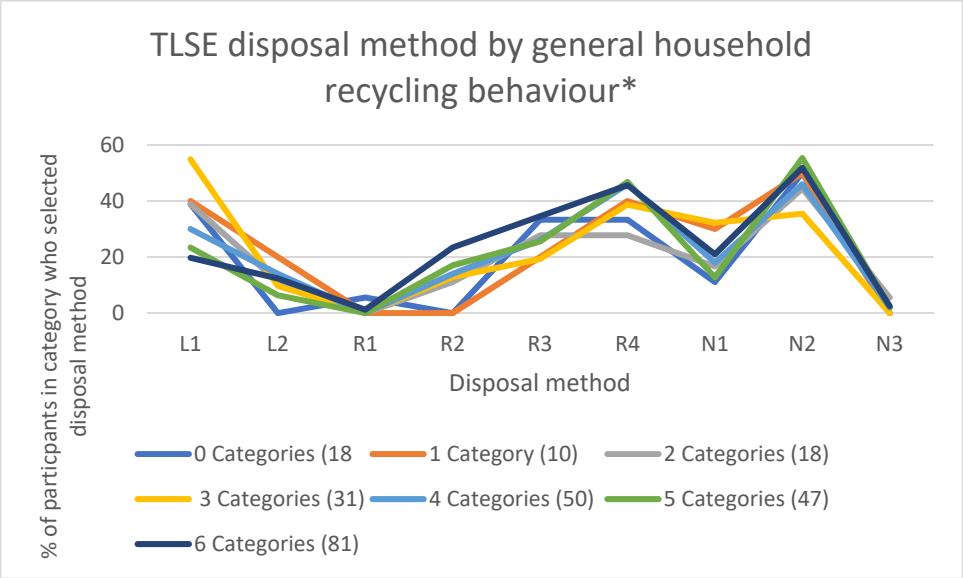
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

**Appendix 6.1.9 Electrical Toys, Leisure and Sports Equipment (TLSE) Relationship Investigation**





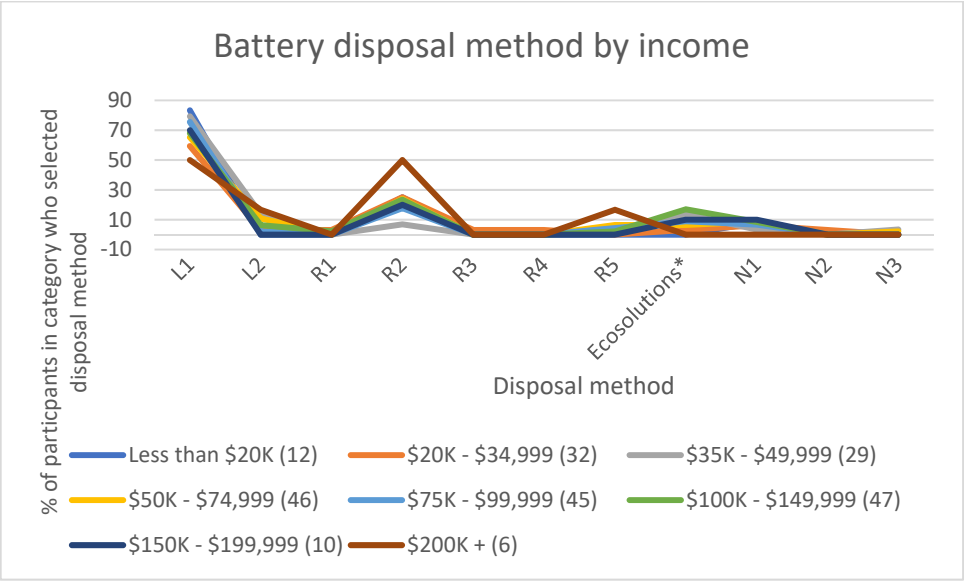



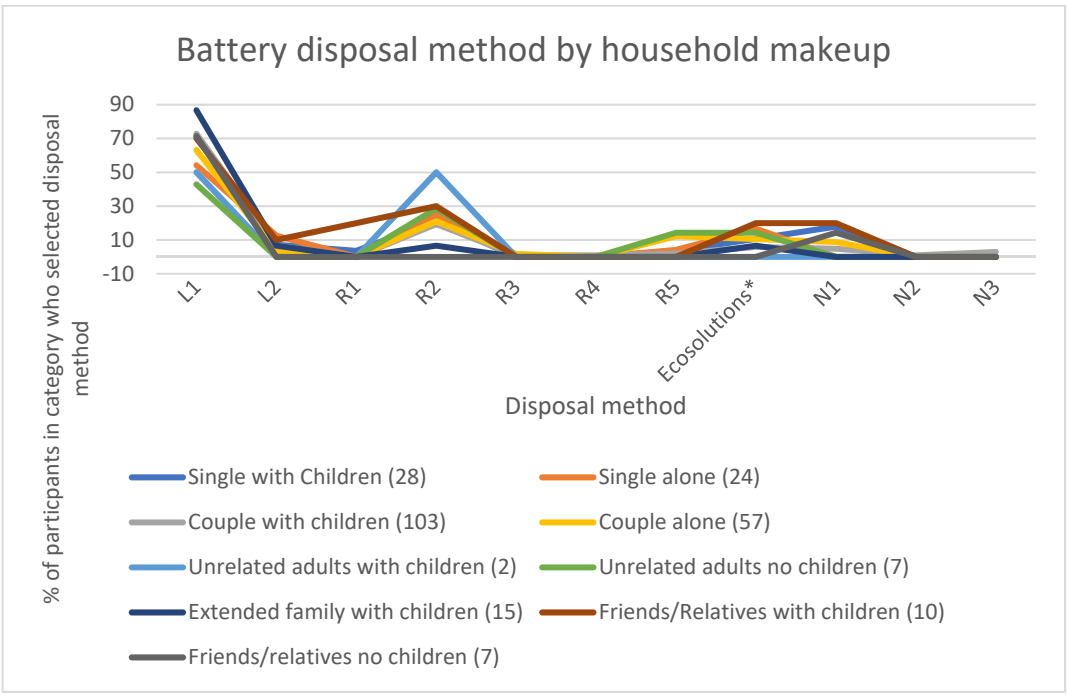

Disposal Method Key

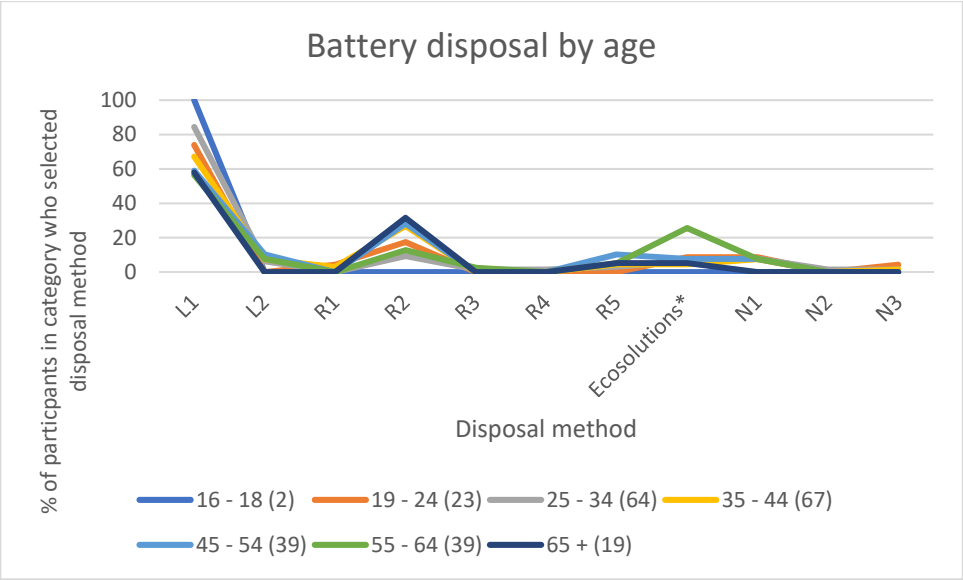
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

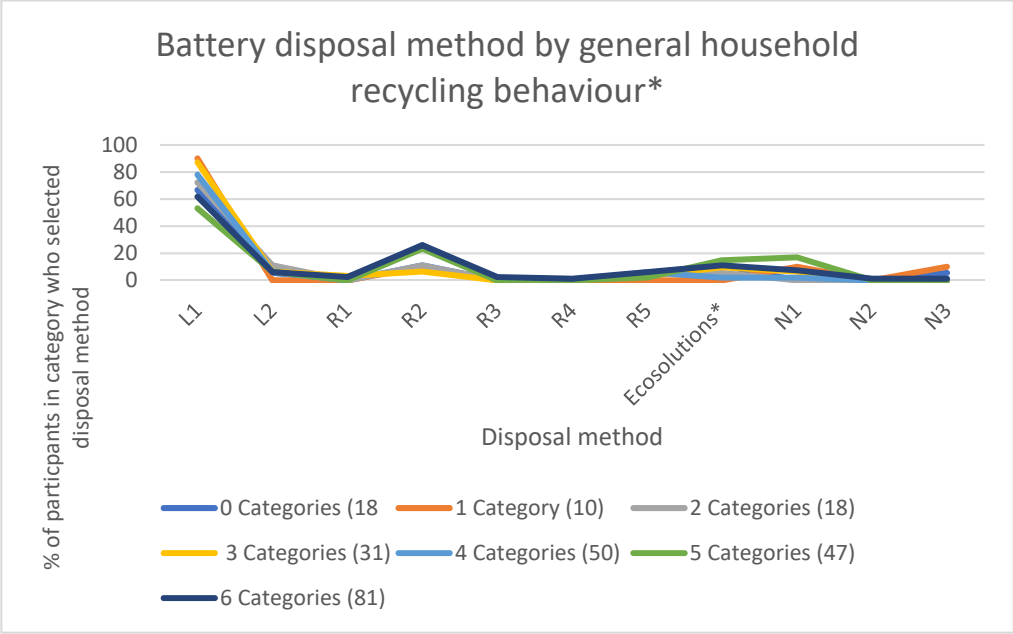
**Appendix 6.1.10 Battery Relationship Investigation**

*Ecosolutions is a local battery recovery initiative



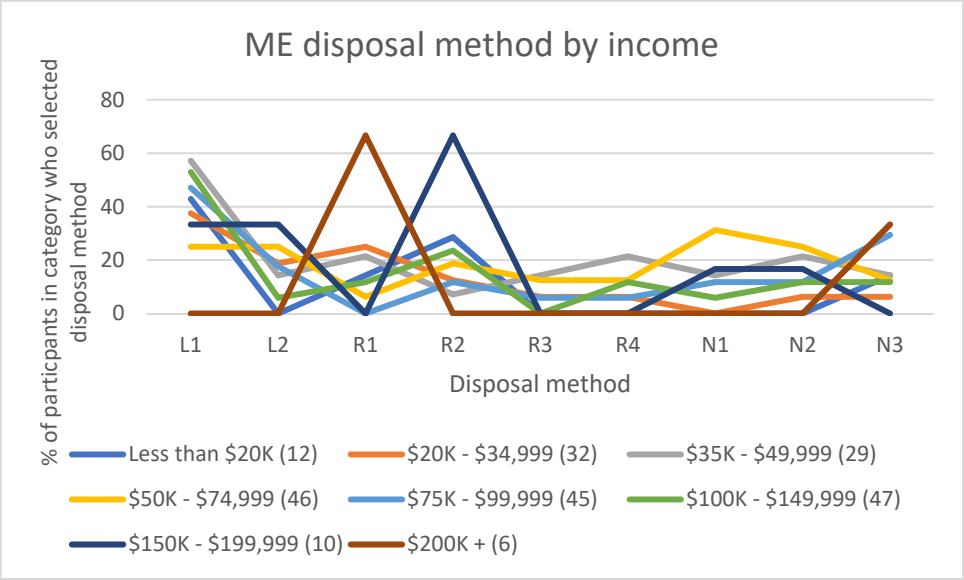


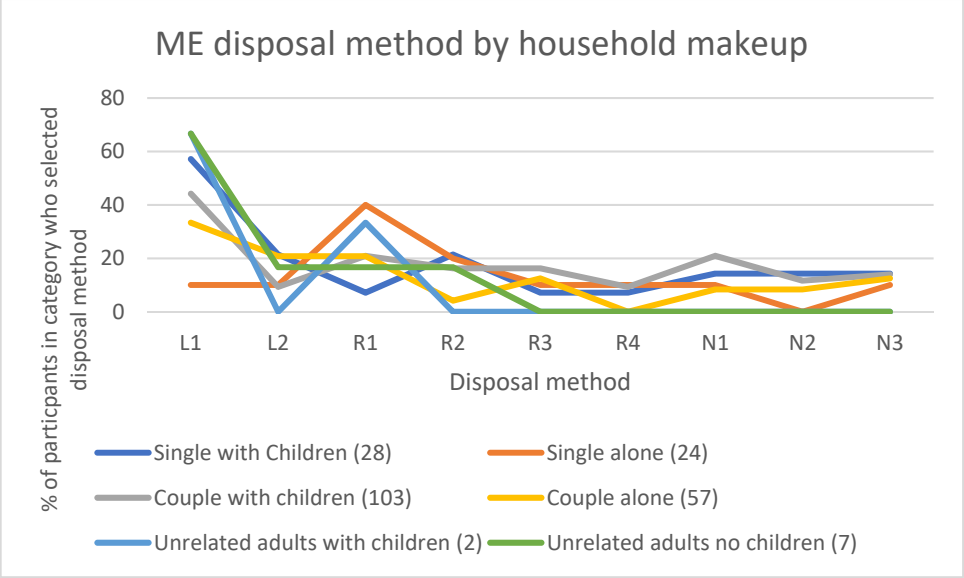



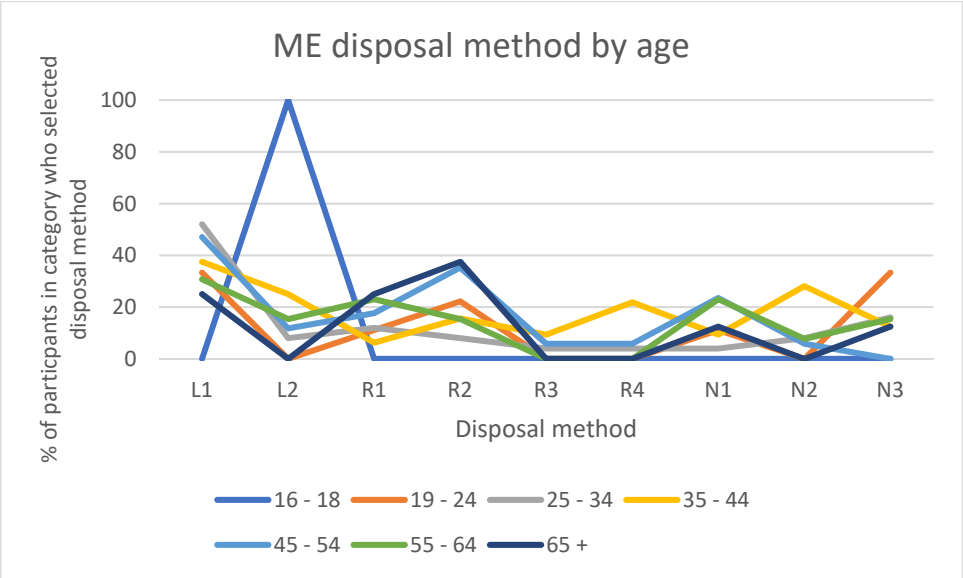

Disposal Method Key

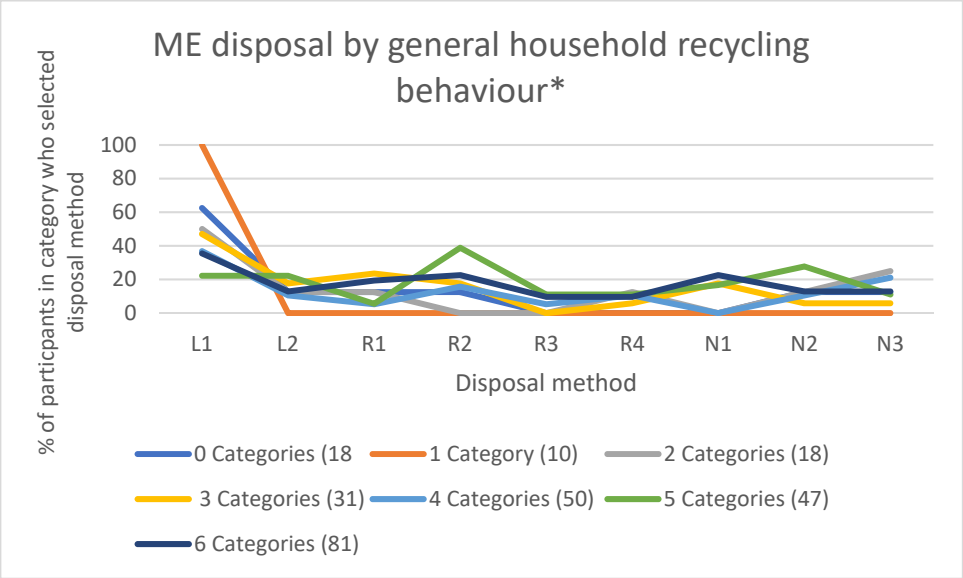
| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

**Appendix 6.1.11 Medical Equipment (ME) Relationship Investigation**






Disposal Method Key

| | |
|---|---|
| L1 | Household Rubbish |
| L2 | Waste Transfer Landfill |
| L3 | Fly Tip |
| N1 | Store |
| N2 | Charity |
| N3 | Don't Know |
| R1 | Return to Retailer |
| R2 | Waste Transfer Recycling |
| R3 | Sell |
| R4 | Give Away |
| R5 | Other |

## Appendix X. Figures and Tables Copyright Permissions

| Figure | Figure Type | Permission Status |
|---|---|---|
| Figure 1.1 Composition of e-waste in Western Europe in 2000 (Source: International Copper Study Group, 2003, as cited by Widmer et al., 2005, p. 440)<br>Widmer, R., Oswald-Krapf, H., Sinha-Khetriwal, D., Schnellmann, M., & Böni, H. (2005). Global perspectives on e-waste. Environmental Impact Assessment Review, 25(5 SPEC. ISS.), 436–458. https://doi.org/10.1016/j.eiar.2005.04.001 | Pie Chart | License agreement received via email |
| Figure 1.2 An illustration of the planned obsolescence of cell phones. (Source: Mohr, J., 2017. Rethink It - End Planned Obsolescence. Retrieved 30 September 2017, from https://www.facebook.com/Joe-Mohr-246170232187930/) | Illustration | Written permission received via email |
| Figure 2.1 Fluxes of contaminants associated with e-waste from producers to receivers and ultimately to humans. (Source: Robinson, 2009, p.189)<br>Robinson, B. H. (2009). E-waste: An assessment of global production and environmental impacts. Science of The Total Environment, 408(2), 183–191. https://doi.org/10.1016/j.scitotenv.2009.09.044 | Flow Chart | License agreement received via email |
| Figure 2.2 Children burn the plastic casings of e-waste in Accra, Ghana, to access the precious metals inside (Source: Curtis, S. (2011). Ghana slum faces growing e-waste problem. Retrieved from http://www.techweekeurope.co.uk/ workspace/ghana-slum- faces) | Photograph | Email sent to request permission.<br>Response not yet received.<br>Follow up email sent 6/12/18 |
| Figure 2.3 The 'Waste Hierarchy' and its relationship with e-waste. (Source: Image adapted from https://greenerneighbourhoods.net/resources/waste/) | Adapted Diagram | Website is now defunct so unlikely copyright is an issue. |
| Figure 2.4 An example of the typical material fraction in WEEE (Source: Empa, 2005, as cited by Widmer et al. 2005, p. 445) | Pie Chart | License agreement received via email |
| Figure 2.6 The transition from product stewardship to full EPR (Source: EPR Canada, 2017, p, 2) EPR Canada. (2017). 2016 EPR summary report. Retrieved from http://www.eprcanada.ca/reports/2016/EPR-Report-Card-2016.pdf | Image | Email sent to request permission.<br>Response not yet received.<br>Follow up email sent 6/12/18 |
| Figure 2.7 The circular economy model (Source: Image retrieved from www.spcadvance.com) | Image | Permission to use has been given however attribution must be changed to www.bluegreen.org and the image must be replaced with the one emailed that includes the branding.<br>Changes added 6/12/18 |
| Figure 3.1 Sources and destinations of refuse and diverted materials. (Whangarei District Council, 2012, p. 36) | Flow Chart | Email sent to request permission.<br>Response not yet received.<br>Follow up email sent 6/12/18 |
| Figure 4.1 Barr et al.'s path diagram of recycling behaviour (Source: Barr et al., 2003, p. 413).<br>Barr, S., Ford, N. J., & Gilg, A. W. (2003). Attitudes towards recycling household waste in Exeter, Devon: Quantitative and qualitative approaches. Local Environment, 8(4), 407–421. https://doi.org/10.1080/13549830306667 | Flow Chart | No permission required unless published. |

| | | |
|---|---|---|
| Figure 4.2 Moser, Ekstrom and Kasperson's phases and subprocesses throughout the adaptation process. (Source: Moser, Ekstrom, & Kasperson, 2010, p. 22027)<br>Moser, S. C., Ekstrom, J. A., & Kasperson, R. E. (2010). A framework to diagnose barriers to climate change adaptation. Proceedings of the National Academy of Sciences of the United States of America, 107(51), 22026–22031. https://doi.org/10.1073/pnas | Diagram | Permission not required for educational use. |
| Figure 4.3 The structural elements of the diagnostic framework: interacting actors, the governance and larger socio-economic context, and the system of concern. (Source: Moser, Ekstrom, & Kasperson, 2010, p. 22028) | Diagram | Permission not required for educational use. |
| Figure 4.4 Moser, Ekstrom and Kasperson's scope and scale of adaptation to climate change (Source: Moser, Ekstrom, & Kasperson, 2010, p. 22027) | Diagram | Permission not required for educational use. |
| Figure 7.1 Proportion of New Zealand population with access to kerbside recycling in 1996 compared with 2006. (Source: Stats NZ, 2008) | Bar graph | Creative commons license. Permission not required. |
| Figure 7.4 Scope and scale of adaptation to appropriate e-waste management – orange arrow indicates where the author proposes Whangarei District sits currently (adapted from Moser, Ekstrom, & Kasperson, 2010, p. 22027) | Diagram | Permission not required for educational use. |
| Table 1.1 Indicative list of EEE which falls into the EU Directive WEEE categories (Source: European Parliament and the Council of the European Union, 2012, Annex II) | Table | Permission is not required |
| Table 2.1 Lifespan and weights of common e-waste items (Source: Robinson, 2009, p. 184) | Table | License agreement received via email |
| Table 2.2 Common hazardous substances found in e-waste and their possible health impacts. (Source: Kiddee et al., 2013, p. 1239)<br>Kiddee, P., Naidu, R., & Wong, M. H. (2013). Electronic waste management approaches: An overview. Waste Management, 33(5), 1237–1250. https://doi.org/10.1016/j.wasman.2013.01.006 | Table | License agreement received via email |
| Table 3.1 The NZ e-waste scape: key national waste management policy documents, legislation, non-governmental initiatives, and supranational waste directives (Sources: Farrelly & Tucker, 2014, p.13; MFE, n.d.) Farrelly, T., & Tucker, C. (2014). Action research and residential waste minimisation in Palmerston North, New Zealand. Resources, Conservation and Recycling, 91, 11–26. https://doi.org/10.1016/j.resconrec.2014.07.003 | Table with minor adaptation | License agreement received via email |