Electronic Waste Management in schools, industries, and companies in Invercargill, Southland.

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Abstract
During the last 20 years, new technologies have continually developed with the latest designs including “smart” functions, which has resulted in many outdated appliances being thrown into landfills without consideration of their impact on the environment. This study investigated how industries, companies, and schools manage e-waste, how much e-waste has been produced per year and what recommendations are needed to be put in action to solve the problem that occurs in Invercargill, New Zealand. E-mail surveys and interviews were carried out during the data collection period to obtain information related to e-waste disposal within a firm. The email survey was completed by seven companies, four schools and two industries, and three interviews were conducted. The findings showed that all respondents from both conducted surveys and interviews are concerned with the possible increase of e-waste. There is also a significant amount of e-waste that is not being recycled and diverted from local landfills. In addition, it was found that there is no management plan available in schools, industries, and companies to control the quantity of e-waste disposed into landfills or for recycling. This study has demonstrated that there are no standard systems of e-waste disposal in schools, companies and industries in Invercargill, indicating that more needs to be done to improve e-waste disposal.

Introduction
Electronic waste (e-waste) is characterised as an array of electronic devices ranging from large household appliances such as refrigerators, air conditioners, cell phones, personal stereos, and consumer electronics to computers which have been discarded by their users
(Needhidasan, Samuel & Chidambaram, 2014). Valuable resources and rare earth metals can be recovered from dismantling obsolete electronic devices (Jang, 2010).

There were 44.7 million metric tonnes (Mt) of e-waste produced globally in 2016, and it will rise to 52.2 million Mt by 2021 (Baldé et al., 2017). In New Zealand, the government estimate that there are 80,000 tonnes of electrical and electronic waste disposed of into landfills per year and 25% originate from televisions, computers and computer accessories (Gertsakis et al., 2011). The current challenge of dealing with e-waste in New Zealand is the lack of any practical recycling schemes and e-waste collection facilities. Hence, the goal of this study was to determine the amount of e-waste that has been disposed by each school, company and industry in Invercargill, the urban centre of Invercargill (Figure 1).

Figure 1. Invercargill City Map.
Aim

The aim of this project was to undertake an in-depth analysis of e-waste management in schools, industries and companies to determine the amount of electronic goods disposed by each firm in Invercargill, New Zealand.

Methods

Secondary data collection method: desktop study to determine current e-waste management and practices in NZ and abroad.

- Various previous study papers were used to compare, evaluate, and combine information that is relevant to the research.

Quantitative method: e-mail surveys

- Used SurveyMonkey to create the survey.
- Contained seven questions (refer to Q1- Q7 under Result section).
- Sent to 10 different companies of which seven responded, 10 schools of which four responded, and 10 industries of which two responded.
- Note: The difference between a company and an industry is that companies are commercial business that aiming to make a profit whereas industry is defined as a brand of manufacture or a large commercial enterprise (Hawke, 2010, para 1-2; Deverson & Kennedy, 2005).

Qualitative method: a semi-structured interview

- The interview questionnaire was set out with ten specific questions.
- A 15-minute telephone interview was conducted in a open-ended manner.
Results

Quantitative data—E-mail surveys:
Q1. Types of electronic devices that have been disposed of by each company, school, and industry.

Overall, the most types of electronic devices that have been disposed by each company and school are screen and monitors whereas, both industries; A and B have disposed lamps and small IT devices the most (Figure 2).

Figure 2. Types of electronic devices that have been disposed by each company, each school, and each industry.
Q2. How much electronic wastes have been disposed per year? In kilograms.

As shown in Figure 3, most respondents have disposed under 100 kg of e-wastes per year. Moreover, 43% of respondents preferred to send their e-waste to a recycling centre; in contrast, 14% returned their damaged gadgets back to the producer (Figure 4).

Figure 3. How much have electronic wastes have been disposed per year? In kilograms.
Q3. Methods used to dispose e-waste

Figure 4. Methods used to dispose e-waste.

Figure 5 and Table 1 shows that most respondents sent their e-waste to local/provided landfills and are interested in recycling e-wastes, respectively. Furthermore, Figure 6 shows that 58% of the respondents has seen an increase in e-waste within their company over the last decade. In addition, 80% stated that there are no e-waste management plans in place or available (Figure 7).
Q4. Where does your company dispose their e-waste? Locally, internationally or both?

![Bar chart showing disposal locations]

Figure 5. Where has e-waste been disposed to—locally, internationally or both?

Q5. The interest in recycling damaged electronic items instead of dumping into landfills.

Table 1. The interest in recycling damaged electronic items instead of dumping into landfills.

<table>
<thead>
<tr>
<th>Respondents</th>
<th>YES / NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Companies (A, B, C, D, E, F, G)</td>
<td>YES</td>
</tr>
<tr>
<td>Schools (A, C, D)</td>
<td>YES</td>
</tr>
<tr>
<td>School B</td>
<td>No answer</td>
</tr>
<tr>
<td>Industry A</td>
<td>YES</td>
</tr>
<tr>
<td>Industry B</td>
<td>NO</td>
</tr>
</tbody>
</table>
Q6. Have you seen an increase in e-waste within your company over the last decade?

![Pie chart showing increase of e-waste over the last decade.]

*Figure 6. Experienced an increased in e-waste within your company over the last decade.*

Q7. Does your company have its own electronic waste management plan?

![Pie chart showing the percentage of e-waste management plans in place.]

*Figure 7. The percentage of e-waste management plan in place.*
Qualitative data- Interviews

Apart from the conducted e-mail surveys that were completed by seven companies, interviews were also conducted with three other different companies. The three companies interviewed will henceforth be referred to as companies 1, 2, and 3 for confidentiality. It was found that all three companies have disposed screens and monitors and small IT devices, however, company 2 also disposed large equipment and cooling and freezing equipment (Table 2). Both company 1 and company 2 have disposed under 100 kg of e-waste per year, whereas company 3 has disposed between 100 to 1000 kg of e-waste. As for the method of disposal, all companies have disposed their e-wastes by sending to recycling centre, however, company 1 has also discarded its e-wastes to the landfill and returned damaged devices back to the producer (Table 2).

All three companies were interested in recycling e-waste (Table 2). Therefore, each company has its respective method to reduce e-waste; company 1 and company 2 recycled their obsolete devices while company 3 would resell or gift any usable items. The results also showed that companies 1 and 3 sent their e-waste to local landfill. Company 2 elaborated on their e-waste disposal method which was done through a recycling company that sends their e-waste to overseas countries such as Japan and Australia. This is in line with company’s 2 policy on not sending its e-wastes to a landfill so as to ensure that the e-wastes are properly dealt with.

The Product Stewardship Scheme (PSS) is defined as, ‘when a producer, brand owner, importer, retailer or consumer accepts responsibility for reducing a product’s environmental impact’ (Ministry for the Environment, 2018). It was found that all three companies have not yet implemented this scheme. However, company 2 has applied Product Stewardship Scheme that emphasis on plastic waste rather than e-waste. Company 3 implemented its own manufacture scheme* to deal with e-waste. Only company 2 believed that implementing the PSS would yield benefits. None of the companies interviewed have published any findings with regards to e-waste disposal. Companies 2 and 3 showed concern over the possible increase of e-waste while company 1 believed that its e-waste production would remain constant.

*Note: Information on the types of manufacture scheme used by Company 3 was not obtained.
Table 2.
The qualitative data obtained from three companies.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Company 1</th>
<th>Company 2</th>
<th>Company 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Type of e-waste</td>
<td>Screens &amp; monitors, small equipment, and small IT &amp; telecommunication equipment</td>
<td>Screens &amp; monitors, small IT &amp; telecommunication, large equipment, and cooling and freezing equipment</td>
<td>Screens &amp; monitors, and small IT &amp; telecommunication</td>
</tr>
<tr>
<td>2. Amount of disposed e-waste</td>
<td>&lt; 100 kg</td>
<td>&lt; 100 kg</td>
<td>100 kg - 1000 kg</td>
</tr>
<tr>
<td>3. Method of disposal</td>
<td>Send to a recycling centre, discard to landfills, and return damage electronic gadgets to the producer</td>
<td>Send to a recycling centre</td>
<td>Send to a recycling centre</td>
</tr>
<tr>
<td>4. Method to reduce e-waste</td>
<td>Recycling and return obsolete electronic gadgets back to the producer</td>
<td>Recycling and use electronic gadgets until the end-of-life</td>
<td>Resell or gift any usable items.</td>
</tr>
<tr>
<td>5. Dispose e-waste at a local or international landfill?</td>
<td>Local</td>
<td>International</td>
<td>Local</td>
</tr>
<tr>
<td>6. Interest in recycling e-waste</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>7. Implementation of Product Stewardship Scheme (PSS)</td>
<td>Not available</td>
<td>Available but for plastic waste</td>
<td>Not available but use manufacture scheme</td>
</tr>
<tr>
<td>8. Benefits of PSS</td>
<td>-</td>
<td>Believed that there would be benefit</td>
<td>-</td>
</tr>
<tr>
<td>9. Provide publications regarding your e-waste disposal</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>10. Possible increase of e-waste in company</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
Discussion

The findings show that screens & monitors and small IT & telecommunication items were the top two types of e-waste that have been disposed. This is because current technology assemblages are made of vulnerable materials; in consequence, devices have a short lifespan (Vats and Singh, 2014; Veit and Bernardes, 2015).

Based on the electronic equipment survey conducted by MFE in 2006, their findings show a lower amount of e-waste compared with the present findings: (i) the usage of screens and monitors has increased from 15% in 2006 (MFE, 2006, p. 20) to 27% (present study), and (ii) small IT and telecommunication equipment increased from 14.3% in 2006 (MFE, 2006) to 24% (present study). Moreover, most companies disposed under 100 kg of e-waste per year because the average weight of current small electronic devices is less than 2 kg, peripheral devices (including printer) weigh around 6 kg and computer weigh about 25 kg (MFE, 2006; Dutta et al., 2017).

Based on the WasteNet Southland Annual Report 2016-2017, there is no data on the quantity of recycled e-waste in Invercargill, but the finding indicated 43% of e-waste are sent to recycling centre. It is also found that there is lack of data on e-waste disposal contained in general municipal waste. Besides, some companies and recyclers export their e-waste to other countries due to the markets for e-waste are largely overseas.

Findings from both conducted surveys and interviews show that all respondents are concerned with the possible increase of e-waste, thus, they are interested in recycling e-waste to lessen pollution.

There is no management plan available to control the quantity of e-waste disposal into landfills or for recycling because respondents were not concerned with their low amount of e-waste and/or they just considered to create one after being approached. Lastly, the biggest barrier to the establishment of a Product Stewardship Scheme for e-waste, is the cost.
Conclusion

This study has demonstrated that there are no standard systems of e-waste disposal in schools, companies and industries in Invercargill. This gives an indication that more needs to be done to improve e-waste disposal. All the corporate companies should develop a suitable e-waste policy to tackle the issues of high obsolete rate of e-waste in their firms. There is also a significant amount of e-waste that is not being recycled. There is need to create awareness on environmental management of e-waste among all the stakeholders and request cooperation in the disposal of the same. The result also concludes that e-waste collection and recycling would be a good cause rather than harm to the environment, thereby fostering a sustainable society. In addition, the study has verified that it is difficult to establish a product stewardship scheme for e-waste because it is too expensive and there’s no funding from the government. Therefore, full support from the government and other private institutions would be ideal. The study has also demonstrated that there is a huge gap in research on e-waste recycling in New Zealand. Hence, further studies are required to fill in the knowledge gap and collect and record data in relation to electronic and electrical equipment waste in a more comprehensive manner. This research brings into focus the existing nature of e-waste disposal and hence establishes that more research and development should be encouraged in this area.
REFERENCES


