European Journal of Social Sciences Studies
ISSN: 2501-8590
ISSN-L: 2501-8590
Available on-line at: www.oapub.org/soc

DOI: 10.46827/ejsss.v8i4.1474 Volume 8 | Issue 4 | 2023

HOUSEHOLD E-WASTE MANAGEMENT PRACTICES IN GWANDA TOWN, ZIMBABWE

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Abstract:
This study investigates household e-waste management practices at Ward 9, Gwanda in Zimbabwe. A descriptive cross-sectional study design was used in which a sample of 125 participants was selected through random sampling with the aim of determining the nature, quantities and management practices of electronic waste in the study area. Data was collected through the use of a pre-tested questionnaire and key informant interviews. Observation pictures were also taken to document the methods used by households to manage the e-waste. Collected data were analysed using the Statistical Package for Social Sciences (SPSS) version 20.0 and presented using tables and graphs. The study found that on average each household unit generated the following quantities and types of e-waste: electrical irons (0.68±0.68), kettles (0.53±0.50), stoves (0.34±0.54), televisions (0.26±0.44) and decoders (0.18±0.44). With regards to household e-waste management, 54.4% of the participants reported that they disposed of it in designated sites, 24.8 % kept it at their homes, 15.2 % burnt or incinerated it and only 5.2 % sold it to recyclers. In light of these findings, this investigation concludes that residents use unsustainable household e-waste management practices which may endanger their environment and personal health. The study recommends that waste managers of Gwanda municipality and the Environmental Management Agency should (i) conduct e-waste awareness campaigns to households in

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order to improve on management practices, (ii) develop a sound e-waste management strategy, and (iii) consider strengthening the efforts on e-waste recycling.

Keywords: e-waste management practices, sustainable development, ward 9, Gwanda, Zimbabwe

1. Introduction

The United Nations Environment Program (UNEP) (2009) estimates that each year approximately 40 million tonnes of e-waste is generated worldwide. Furthermore, UNEP (2011) projected that by the end of 2015, e-waste generation rates would rise to 40–70 million tonnes per year. Similarly, Winmer et al. (2005) report that in rich countries e-waste constitutes approximately 8% of municipal waste by volume. It is the fastest-growing waste stream in developed and several developing countries (Ravi, 2012). Several factors have been identified as contributing to the increase in household e-waste. Firstly, the reduced lifespan of electronic waste has been reported to produce significant quantities of e-waste due to the subsequent procurement of new replacements. According to Wedmer and colleagues (2005), the lifespan of a brand-new computer was 4.5 years in 1992 and fell to 2 years by 2005 and continues to decrease. Secondly, Laurent *et al.* (2014) assert that it is easy to purchase new equipment rather than repair outdated equipment. Such purchasing tendencies may increase the fraction of e-waste appliances in household waste. Similarly, Jang (2010) attributes the increase in quantities of e-waste to consumers' demands in relation to new electronic goods. Thirdly, the export of less durable technology such as computers from developed to developing countries has been reported to account for a growing proportion of household e-waste (ILO, 2012). The high e-waste generation rates may have adverse human health and environmental impacts. It is therefore important to investigate the management practices of e-waste in order to suggest better measures to safeguard human health and environmental quality.

Previous studies conducted in several developing countries such as China and South Africa document that e-waste quantities in household waste streams are increasing (Chan *et al*., 2007; Wang *et al*., 2009; Rajaran and Pekeur, 2014). According to a forecast based on a logistic model and material flow analysis by Yu *et al*. (2010), the volume of obsolete PCs generated in developing regions will exceed that of developed regions by 2016–2018. Jain and Reseen (2006) reported that in India household e-waste is a major environmental issue requiring attention. In Zimbabwe, a few studies have investigated e-waste management practises and risks. Masocha and Tevera (2003) reported that both ignorance and lack of interest have resulted in poor electronic waste management in Zimbabwe. Notably, there is a dearth of research in the Zimbabwean context investigating household e-waste management practises. Consequently, this study seeks to add to the available literature on household e-waste management practices in the Zimbabwean context, by focusing on Gwanda town, which is one of Zimbabwe's provincial towns.

In Gwanda town no studies have examined household e-waste management challenges and their possible solutions. Yet waste managers in the town council and the Environmental Management Agency need to understand the nature and quantities of household e-waste streams so as to design sound waste management plans and policies. In order for municipalities to be effective it requires them to be able to embrace the concept of sustainability in household e-waste management (Lauret *et al*, 2014). In addition, according to Williams (1995), agencies that handle, transport, recycle or dispose of household e-waste need specific guidance to ensure that the growing waste is managed. Consequently, this study aims to provide useful information on how e-waste can be properly managed for planning purposes and policy-making by these authorities.

2. Types and Quantities of Household E-waste

According to the European Union (2002), there are various types of e-waste generated from various sources and they include:

- Huge household appliances like refrigerators and washing machines.
- Small household devices such as toasters, irons, coffee makers and hairdryers.
- Information and telecommunications equipment such as laptops, mobile phones, printers, photocopiers and scanners.
- Consumer equipment such as televisions, electric tooth brushers and stereo equipment
- Lighting equipment such as fluorescent lamps.
- Toys such as play station etc.
- Medical equipment, and
- Automatic dispensers.

2.1 E-Waste Quantities

Worldwide, about 40 million tonnes of e-waste are generated yearly (UNEP, 2009) and in industrialised countries, e-waste is about 8% of municipal solid waste (Winmer *et al.*, 2005). According to Bushehri (2010), at least 130 million monitors, televisions and computers become waste yearly and the number is particularly growing in countries such as the US. Thus, e-waste is a major problem for developed countries and requires sound interventions to protect human health and the environment. In developing nations such as China, Hicks et.al highlighted that annually purchased new computer devices were 5 million whilst purchased new televisions were 10 million in number. According to Balde et.al (2015) e-waste increases annually. Studies done in developing countries such as China and South Africa also document that e-waste quantities in household waste streams are increasing (Chan *et al*., 2007; Wang *et al*., 2009; Rajaran and Pekeur, 2014). The increase in e-waste quantities is due to the shorter life span of electrical equipment (Widmer *et al.*, 2005; Zeng *et al.*, 2015).

3. E-waste Management Practices

There are several methods described in literature with regard to e-waste management. The methods include: i) recycling, ii) re-use iii) incineration and iv) landfilling. They include:

3.1 Recycling

Recycling is the extraction and processing of waste streams into new products and is done in various settings such as backyards, formal and informal industries. The recycling in such settings often result in contamination of the environment, particularly soil, water and air with toxic chemicals (Bigden *et al*., 2005, Widmer and Lombard, 2005). Babu *et al*. (2007) highlight that the success and sustainability of recycling is dependent on: i) labour costs, ii) the economy structure in particular existence of the informal sector, iii) regulatory framework and the ability to adapt to future changes in relation to quantities and quality of waste streams. In a study of the causes of the failure of recycling programs for spent batteries in China, Sun *et al. (*2015) identified the lack of properly situated collection points and low knowledge levels of residents with regard to policies on battery management as the main causes. Similarly, Joseph (2007) reported that the lack of knowledge is a setback with regard to environmentally sustainable waste management. Babu *et al*. (2007) report that e-waste recycling is essential for the purposes of reducing the waste quantities requiring treatment and for prompting the recovery of useful materials in e-waste. Thus, recycling not only promotes sound environmental protection but has economic benefits.

3.2 Landfill

According to the USEPA, in the USA at least 4,6 million tons of e-waste are deposited in landfills. Toxic substances in electronic products may leach into the soil with time or may be released to contaminate the atmosphere. Such releases may endanger human life and damage the environment.

3.3 Incineration

Incineration is the controlled burning of waste with or without material recovery (Tchobanoglous *et al*., 1993). Thus, incineration may release pollutants into the air such as mercury and cadmium. Mercury has been associated with human health effects such as birth abnormalities in infants, brain damage, skin and respiratory diseases (Pukett & Smith, 2002; Ecroignard, 2006). Mercury also accumulates in fish. Also, incineration may emit dioxins into the air. According to Anon (2002), at least 90% of e-waste is landfilled whilst, in some nations, a huge portion is incinerated.

3.4 Re-use

Some products can be reused for other purposes. However, Hart (2007) cautions that re-use will in the long term not solve the e-waste problem as the obsolete product will eventually be disposed of and most e-waste products re-used have a short life span.

4. Awareness of E-waste Health and Environmental Impacts

In a study of the failure of recycling programs for spent batteries in China, Sun *et al*. (2015) identified the lack of properly situated collection points and low knowledge levels of residents with regard to policies on battery management as the main causes. In some countries, for example, Greece, e-waste is separately collected from generation sources and safely treated in specially designed facilities (Gaidajis, Angelakoglou and Aktsoglou, 2010). E-waste can have several impacts on human health and the environment. In China, Qu *et al.* (2007) investigated worker exposure to PBDEs in an e-waste recycling setting. The authors found high PBDE levels in the blood serum of workers.

Similarly, some past studies found high levels of Cd and Pb in the blood of main children residing near e-waste recycling plants (Zheng *et al*., 2008; Huo, 2007). In human hair samples, several researchers found various toxic e-waste chemicals (Wang *et al*., 2009; Ha *et al*., 2009). Among Ghanaian workers high levels of Pb, Fe and Sb were found in the urine of workers employed in e-waste recycling (Asante *et al*., 2012). Literature shows that improper e-waste management results in the release of toxic chemicals such as mercury, lead and cadmium into the environment (Dickson, 2006). Table 1 below shows some health effects of some e-waste components.

Table 1: E-waste components and human health effects
(Pukett & Smith, 2002; Zheng et al, 2008; Ecroignard, 2006)

E-waste ingredient	Health impacts	Source
Lead	Damages the nervous system, circulatory system and kidneys	Zheng *et al*, 2008; Huo, 2007
Arsenic	Carcinogenic, damage to the central nervous system	Ecroignard, 2006; Pukett & Smith, 2002
Mercury	Damages the brain, skin and respiratory diseases	Ecroignard, 2006; Pukett & Smith, 2002
Nickel	Liver damage	Ecroignard, 2006; Pukett & Smith, 2002

Goldberg *et al*. (1999) investigated health risks from hazardous landfills by assessing the distance of residence from the landfill site. They reported an excess risk of pancreatic cancer, prostate cancer, and non-Hodgkin lymphomas. In addition, a study by Pukkala and Pönkä (2001) reported more cancer risk for the inhabitants of houses that were constructed in a former dumpsite containing hazardous waste that included e-waste. Gensburg *et al*. (2009) research reported elevations in the frequency of kidney and bladder cancers for the inhabitants exposed to the Love Canal landfill site which contained e-waste. A study by Comba *et al*. (2003) in Mantua investigated the relationship between the prevalence of soft tissue sarcomas (STS) and residence near e-waste sites and reported a substantial increase in the risk of STS. In Italy, a study conducted by Zambon *et al*. (2007) found similar results. In Britain, Elliott *et al.* (2001) reported the association between waste exposure and some cancer types.

5. Research Methodology

Questionnaires were administered by conducting door-to-door home visits to the head of each selected household unit. Such an approach to questionnaire administration improved the return rate since questionnaires are immediately collected back after completion (Shamoe and Reshie, 2009). The questionnaires were pretested in a sample of 10 household heads of the Pakama suburb. Unclear questions were rephrased so as to improve the reliability and validity of these data collection instruments. Also, the research subjected all respondents to the same questions in order to obtain valid and reliable data. The questionnaires contained questions on: i) respondents' demographic characteristics, ii) types and quantities of household electronic waste generated, iii) household e-waste management practices and iv) awareness of the health and environmental impacts of e-waste.

Key informant interviews were also carried out for officers engaged in waste management activities, using a structured interview guide. The officers were drawn from Gwanda municipality and from the Environmental Management Agency (EMA). Their views were recorded in pre-designed interview guides. During field visits, the researcher observed and recorded the methods used to manage e-waste, the e-waste types and quantities generated by households. Such observations helped to triangulate information gathered using the questionnaire, thus improve on the quality of data gathered. The study generated both qualitative and quantitative data. Data was analysed using the statistical package for social sciences (SPSS version 20) and presented using descriptive statistics. Open-ended questions which elicited qualitative data were analysed according to themes.

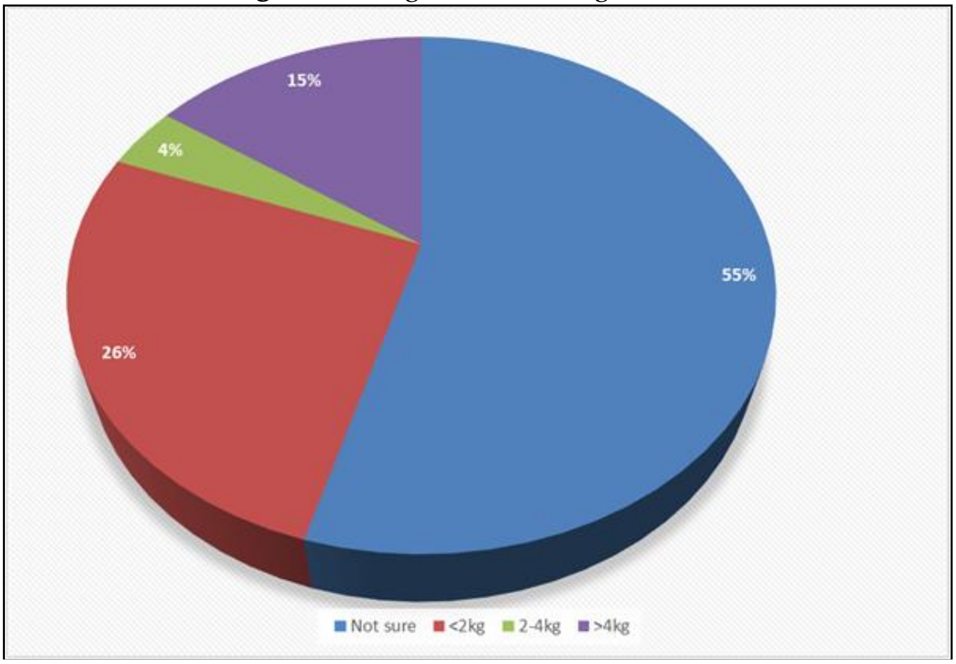
6. Types and Quantities of E-waste

6.1 Weight of Household E-waste Generated

Figure 1 below shows the weight in kgs of e-waste generated in each house in Ward 9, Gwanda town. The information was obtained through questionnaire interviews with each selected household head per household unit.

Most respondents (>50%) were not sure how much e-waste they produced per month. However, waste management officers in the Environmental Management Agency and Gwanda Municipality reported that approximately 0.5 tonnes of household e-waste waste are generated in Gwanda town.

Figure 1: Weight of e-waste generated



Source: Primary data

6.2 Quantities of Electrical Gadgets

Table 2 below shows the quantities of functional and non-functional electrical gadgets among respondents.

Table 2: Quantities of electrical gadgets among respondents (n=125)

Electrical gadget	Status (mean ± SD)	
	Non-functional	**Functional**
Iron	0.68±0.68	1.01±0.30
Television	0.26±0.44	0.86±0.56
Kettle	0.53±0.50	0.89±0.56
Stove	0.34±0.54	0.95±0.44
Decode	0.18±0.44	0.76±0.50

Source: Primary data.

The study found that on average each household unit generated the following quantities and types of e-waste: electrical irons (0.68±0.68), kettles (0.53±0.50), stoves (0.34±0.54), televisions (0.26±0.44) and decoders (0.18±0.44). Thus, the greatest number of e-waste types generated by each household was mainly electrical irons (0.68±0.68) whilst the least was decoders (0.18±0.44). In the near future, the proportion of these e-waste types may increase as each household on average also had a functional iron, television, kettle, stove and decoder. According to Balde et.al (2015) e-waste increases annually. Studies conducted in countries such as China and South Africa also document that e-waste quantities in household waste streams are increasing (Chan *et al.*, 2007; Wang *et al.*, 2009; Rajaran and Pekeur, 2014).

The increase in e-waste quantities is due to the shorter life span of electrical equipment (Widmer *et al.*, 2005; Zeng *et al.*, 2015). Similarly, key informant interviews conducted with officers at Gwanda Municipality and the Environmental Management Agency revealed that some household e-waste types generated at Gwanda were television sets, radios, microwave stoves, cell phones, refrigerators and dismantled computer gadgets. During the present study's field visits images of the following were taken: i) dismantled computer gadgets (Figure 2), ii) scrap washing machines (Figure 3) and iii) dysfunctional stoves and refrigerators.

Through an informal interview of a household engaged in repairing of desktop computers, the household head indicated that some scrap desktop computers in his storeroom belonged to clients who failed to claim them after being notified that they were beyond repair. However, some of the desktop computers (Figure 3) belonged to the son of the head of the concerned household who used to repair the computers and were being kept in the storeroom in the hope of future re-use of some parts or selling the useful parts to interested parties.

Figure 2: Images of dismantled computer gadgets

Source: Primary data

Figure 3: Scrap washing machine

In one of the visited household electronic gadgets were dumped or kept outside the house. These were a washing machine (Figure 3), two-plate stove and refrigerator (Figure 4). These scrap gadgets were no longer very useful and they were willing to dispose them by selling at any price. The refrigerator was said to have a possible buyer who had made a promise to purchase it for a price of US$20. There appear to be no alternative e-waste collection points available to Ward 9 residents. In a study of the failure of recycling programs for spent batteries in China, Sun *et al*. (2015) identified the lack of properly situated collection points and low knowledge levels of residents with regard to policies on battery management as the main causes.

6.3 Household E-waste Management Practices

Despite its potential negative impacts dumping was commonly used. Similarly, information gathered through key informant interviews in the present investigation supports that dumping of e-waste without any waste segregation was commonly practised by residents of Gwanda (Figure 4).

Figure 4: Household e-waste management practices

Source: Primary data

No separate system was in place to separately collect and manage e-waste. In some countries, for example, Greece, e-waste is separately collected from generation sources and safely treated in specially designed facilities (Gaidajis, Angelakoglou and Aktsoglou, 2010). Thus, there seems to be a need for local authorities to consider setting up sound e-waste collection and management programmes. In addition, the present study also found that a large portion of e-waste was kept at home probably with the hope of future use of some parts. About 6 % of respondents said they sell e-waste to waste recyclers (Figure 4). Noteworthy, key informant interviews with Gwanda municipality waste management officers showed that small quantities of household e-waste were currently being recycled or reused by the Gwanda Health Clubs Teams. Consequently, the officers observed that there was a need to promote waste separation at source and recycling through using mechanisms such as community education. Babu *et al*. (2007) report that e-waste recycling is essential for the purposes of reducing the waste quantities requiring treatment and for prompting the recovery of useful materials in e-waste. Thus, Gwanda Municipality and the Environmental Management Agency may need to consider strengthening e-waste recycling as a method of managing e-waste.

6.4 Awareness of Health and Environmental Impacts of E-waste

Table 3 shows Gwanda residents' awareness levels of health and environmental impacts.

Table 3: Awareness levels on health and environmental impacts of e-waste

Variable	Response (%)
Are you concerned about your environment?	Not concerned: 56.8 Concerned: 32.0 Very concerned: 11.2
Do you know that some components of electronic devices contain toxic materials?	Yes: 37.6 No 62.4
Are you aware that toxic materials require special treatment?	Yes: 39.2 No: 6.4 Not applicable: 54.4
Does your disposal or treatment method for e-waste have any environmental impacts?	Yes: 37.6 No: 4.8 Not sure: 57.6
Does your involvement in e-waste handling have any negative impacts on your health?	Yes: 29.6 No: 3.2 Do not know: 67.2

Source: Primary data.

Over 50% of respondents reported that they were not concerned about the impacts on the environment and over 67% said they were not aware of the impacts on their health. This suggests that awareness campaigns are required to increase respondents' knowledge in this regard. The findings are in agreement with those obtained through key informant interviews with officers in the Gwanda municipality and the Environmental Management Agency. The officers rated residents' knowledge of e-waste management as very low and highlighted supportive evidence of the rating as the: i) non-practice of waste segregation and ii) indiscriminate dumping or burning of e-waste despite associated human and environmental risks. In a study of the causes of the failure of recycling programs for spent batteries in China, Sun et.al (2015) identified the lack of properly situated collection points and low knowledge levels of residents with regard to policies on battery management as the main causes. Similarly, Joseph (2007) reported that the lack of knowledge is a setback with regard to environmentally sustainable waste management.

7. Conclusions

One of the objectives of this study was to identify the demographic characteristics of respondents. The number of females was almost twice that of males. The higher proportion of persons above 38 years in this study could be due to the study design which prioritised enrolling the owner of each house where feasible. Most participants had attained at least a secondary level of education and were literate, and thus had the capacity to complete the administered questionnaires to give their own opinions. The second objective of this study was to determine the types and quantities of e-waste generated in the study area. This study found that the mean number of non-functional electrical gadgets were in the order: iron (0.68±0.68) > kettle (0.53±0.50) > stove (0.34±0.54) > television (0.26±0.44) > and decoder (0.18±0.44). The third objective of this study was to examine household e-waste management practices. This study found that the main method used to manage household e-waste was dumping in designated sites together with other residential waste types.

No system was in place to separately collect and manage e-waste. Also, a large portion of e-waste was kept at home probably with the hope of future use of some parts. Lastly, this study sought to establish the level of awareness of the respondents on the health and environmental impacts of e-waste in Ward 9, Gwanda urban. Over 50% of respondents reported that they were not concerned about the impacts on the environment and over 67% said they were not aware of the impacts on their health. Residents use unsustainable household e-waste management practices which may endanger their environment and personal health. However, opportunities exist to correct such practices through awareness campaigns. It is critical to note that e-waste has serious implications for sustainable development in Zimbabwe and in Gwanda in particular. As such, there is a need for the country to document policy on it if sustainable development has to be achieved.

Based on the current study's findings the following recommendations are proposed: Firstly, waste managers should conduct awareness campaigns in order to increase residents' awareness of sound e-waste management practices and increase awareness on the health and environmental impacts of e-waste. Secondly, waste managers need to develop a sound e-waste management strategy to deal with the potential rise in e-waste quantities. This study found that each household had at least a functional iron, television, kettle and decoder and when they become obsolete more e-waste would be produced. Thirdly, Gwanda Municipality and the Environmental Management Agency may need to consider strengthening e-waste recycling as a method of managing e-waste. Finally, there is a need to conduct further studies on e-waste generation and management in the commercial sectors and high and medium-density suburbs. This will hopefully result in sustainable approaches at both local and national levels.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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