

ASSESSING E-WASTE MANAGEMENT WITHIN THE MANGAUNG METROPOLITAN MUNICIPALITY, SOUTH AFRICA

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ABSTRACT

With rapid advancements in technology the evolution and demand for electronic/electric devices have drastically increased. The exponential increase in the use of technology, to meet the needs of the fast paced information era, has led to electronic and electrical devices being discarded, or disposed of, at a quicker rate than in the past. This has resulted in the fastest growing form of solid waste, called e-waste. E-waste is categorized as hazardous waste and can be harmful to the environment and health if not disposed of in a responsible manner. The emphasis is therefore to look at alternatives, such as reusing, refurbishing, or recycling, in order to minimise the disposal of this toxic waste form into landfill sites. This exploratory study concentrated on Mangaung Metropolitan Municipality (MMM) South Africa and revealed that e-waste management practices are a concern in this metropolitan area. The level of e-waste awareness and practices show that initiatives in MMM need to be expedited in order to adhere to e-waste best practices that have been implemented nationally and internationally.

Keywords: *E-waste; E-waste management; E-waste awareness; E-waste action plan*

1. Introduction

With technological advancements, the need for electronic devices has become imperative to business operations and domestic use. Businesses require systems that are able to drive productivity and sales, while homes require technology for automation, entertainment, and to facilitate a modern lifestyle. The devices however will need to be replaced at a given point in time due to failure or new technologies that render older devices obsolete. This results in the disposal of out- of-date equipment which is referred to as e-waste. E-waste management is a fairly new concept and is one of the intractable environmental issues in the 21st century.

E-waste has become a concern due to the high volumes in which it is generated, the hazardous constituents it often contains (such as lead, mercury, and chromium), and the lack of regulations applicable to its disposal or recycling. E- waste management has become a global issue and much emphasis has been placed on the subject due to the detrimental environmental consequences of improper practices. The incorrect handling of

e-waste potentially creates both an environmental disaster and a health hazard.

2. Research Context: Background

Electronic waste (*e-waste*) is a term used loosely to refer to obsolete, broken or irreparable electronic devices (Luther, 2010:1). E-waste is sometimes referred to as WEEE, or *Waste from Electrical and Electronic Equipment* (Maczulak, 2010:36). Irresponsible disposal of e-waste can pose a risk to health and the environment as it contains many toxic substances, such as lead, mercury, or chromium, as well as plastics treated with brominated flame retardants (Luther, 2010:1). The components of electronic products create an environmental hazard as tons of e-wastes are discarded in illegal dump sites where no monitoring takes place. Older model computers, monitors and televisions are bulky and take up landfill space, and, as they weather, they begin to leak a steady stream of hazardous materials into the environment (Maczulak, 2010:36).

The problem of e-waste is better managed in developed countries and the EU (European Union) has pioneered initiatives regarding the responsible management of e-waste in its member states. A new WEEE Directive has been published and adopted by the council which forces more stringent collection and recycling targets at an ambitious 85% of WEEE generated (European Commission, 2013). The problem in developing countries (*similar to South Africa*) is compounded by poor infrastructure for solid waste management. Co-disposal of e-waste on these hazardous dumpsites is generally practiced and this is potentially an environmental and health time bomb, unless appropriate safeguards and regulatory control measures are introduced and implemented (ATE - Advanced Tropical Environment, 2012:12).

3. The Research Problem

The core problem which this study addresses revolves around the current e-waste management practices within MMM, the level of awareness regarding e-waste disposal, and the infrastructure for e-waste collection and recycling. E-waste is a rapidly growing form of solid waste and is becoming one of the largest waste streams. Due to the lack of public awareness regarding recycling and disposal of e-waste, the End-of-Life (EoL) equipment ends up in the Municipal Solid Waste (MSW) stream which could be detrimental to the environment and cause potential health issues. E-waste has garnered significant interest due to the rapidly increasing levels of disposal, the toxic materials it contains, and on the other hand the valuable materials it possesses when properly recycled. E-waste therefore presents both threats and opportunities to MMM. This study aims to highlight how these threats could be mitigated; the opportunities that could be explored, and possibly with more regulations and awareness, could prompt everyone within the city to become more environmentally responsible.

4. Aim and objective of the study

The aim of this research is to garner and provide information on e-waste management within MMM. The research utilizes e-waste legislation and best practices of other municipalities (nationally and internationally), to possibly provide a benchmark for the current practices. From the findings, suitable recommendations could be made to the governing bodies within MMM, and public organizations, in order to raise awareness of e-waste and the environmentally responsible management of the issue. Within this context, the major objectives were identified as follows:

- ☐ To ascertain the level of awareness of e-waste management in MMM;
- ☐ To investigate the amounts of e-waste entering the MSW stream; and
- ☐ To compare the current practices within the city to national and international best practices.

5. Brief literature review

There have been many studies conducted in the past that have assessed the magnitude of e-waste in South Africa. ATE (2012); Bondolfi (2007); Widmer & Lombard (2005:3) and Dittke, et al. (2008) are some contributors to the available information in this regard:

With the most recent information ATE (2012:17) explains that South Africa has a population of 5-8 million, and generates an estimated 2 million tons of e-waste per year. Formal recyclers process approximately 20% of that amount of e-waste. The rest is either in storage, recycled informally, added to the domestic waste stream, or dumped illegally. UNEP (United Nations Environment Program) forecasts that obsolete computers, both in China and in South Africa will rise by 500% in 2020 compared to their 2007 levels (Wang, et al., 2012). Additionally, apart from domestic generation, developed countries will increase their exports of e-waste into China and Africa by 50-80%. This is driven by the demand for second hand electronic products as well as the business opportunities that those products will offer in terms of refurbishing and recycling.

According to ATE (2012:17) the recycling of e-waste and non-ferrous and ferrous metals is well established in South Africa, but a large informal sector still remains. The recycling systems for e-waste do not conform to any standards and are not suitable for many materials. South Africa is lacking in terms of recycling materials such as CRT tubes, brominated plastics and printed circuit boards, making recycling of these non-viable. This has led to some e-waste becoming a social and environmental hazard. UNEP analysed 11 countries for the sustainable e-waste recycling potential, and studies have revealed that South Africa has the potential to adapt pre- and to some extent, end-processing technologies to suit the country's needs, following a technology and knowledge exchange (Lundgren, 2012:41). Another area of concern is that there is no specific legislation which governs e-waste, even though a National Environmental Management Waste Act was passed in 2009 to deal with Hazardous waste and introduce measures such as Extended Producer Responsibility [EPR] (ATE, 2012:17).

South Africa does not have specific legislation for e-waste, but rather several pieces of legislation and by-laws which govern the disposal of hazardous or non-hazardous waste (ATE, 2012:26). This has been summarized as follows:

- ☐ The problem with e-waste in South Africa is that because there is no dedicated legislation dealing with e-waste, it is seen from a different perspective, thereby confusing the problem.
- ☐ There is no uniform way in dealing with or enforcing any laws on e-waste as this is handled by various government departments at different levels.
- ☐ Municipal by-laws hinder recycling and collection activities as e-waste is encapsulated in the same containment as hazardous waste and is collected, transported and stored in a similar manner.

A summary of Legislation in South Africa which impacts on e-waste management is

illustrated in the table 1 below:

Table1. Summary of Legislation in South Africa with an impact on e-waste management (Bondolfi: 2007:123)

Law or Regulation	Major Content
Constitution	Deals with basic environmental rights (including access to information). Sets out the allocation of powers for different levels of government. While provinces set the standards of environmental control within a national framework, local authorities are expected to administer the legislation, supplementing it with by-laws where necessary.
The National Environmental Management Act (Act 107 of 1998) (NEMA)	Amongst other things, NEMA lays out principles for waste management. These include avoidance or minimization, and the “remediation of pollution”, Waste reduction, re-use, recycling and proper disposal, as well as the “polluter pays” and “cradle to grave” principles are emphasized.
The Municipal Services Act (Act 32 of 2000)	Includes principles for effective local governance.
The Occupational Health and Safety Act (Act 85 of 1993)	Deals with health and safety in the workplace.
The Environment Conservation Act (ECA)	Deals with the protection and controlled utilization of the environment. The ECA makes provision for an Environmental Impact Assessment (EIA), which is needed for any waste disposal activities. An amendment delegates the administration of waste disposal to the Department of Economic Development, Tourism and Environmental Affairs (the detea). The permitting of waste disposal sites is guided by a series of documents dealing with minimum requirements.
The White Paper on Integrated Pollution and Waste Management	Deals with the allocation of environment and waste management functions and powers. Has also included the development of the National Waste

	Management Strategy, which is a Danish-funded joint venture between the Department of Economic Development, Tourism and Environmental Affairs, and the Department of Water Affairs and Forestry. The emphasis is on “holistic waste and pollution management”. Recycling is one of the short-term priority areas identified.
The Health Act	Promotes healthy living and working conditions. Relevant to the potential health risk implications of e-waste.
The Hazardous Substances Act	Regulates the management of hazardous substances and hazardous waste.

Subsequent to Bondolfi’s study in 2007, the Department of Environmental affairs published the National Domestic Waste Collection Standards in 2008 which is affiliated to the National Environmental Management: Waste Act 2008 (Act no. 59 of 2008). The standards document refers to the collection of recyclable waste. The only reference of e-waste states that it requires clearly marked drop-off centres at well-advertised locations (The detea, 2013:1).

The information above demonstrates that although there are many laws and regulations in South Africa that deal with waste on a broader scale, there are no laws or regulations that deal with e-waste specifically.

South Africa has some better developed recycling facilities, when compared to other African countries, where the majority of the collected e-waste is recycled (Empa, 2009). However due to the absence of an efficient take back scheme for consumers together with the lack of appropriate financing mechanisms for collectors and recyclers, only a fraction of the e-waste (estimated 10%) currently finds its way to recyclers (Finlay & Liechti, 2008).

With over a decade of experience, Switzerland has one of the best established e- waste management systems worldwide (Swiss ewaste, 2013; Sinha-Khetriwal, et al., 2005:492). Switzerland is supporting developing and newly industrialized countries like China, India, South Africa, Peru and Colombia in the establishment of environmentally sound, resource-conserving recovery systems for e-waste, thanks to funding by the State Secretariat for Economic Affairs (SECO) and technical assistance from the Swiss Federal Laboratories for Materials Testing and Research (Empa) (Basel Convention, 2011). The SECO programme is facilitating the development of a national e-waste management strategy jointly with the IT Association of South Africa (ITA) and the e-Waste Association of South Africa (eWASA) (Empa, 2009).

In an attempt to resolve the e-waste problem in South Africa, Hewlett Packard, with the help of Empa, the Global Digital Solidarity Fund (DSF), and other local community

forums joined hands, which resulted in the construction of a pilot Material Recovery Facility (MRF) in Cape Town (Dittke, et al., 2008). The MRF was designed to carry out the following functions:

- ☐ Collection and sorting of e-waste
- ☐ Testing and refurbishment of suitable equipment
- ☐ Dismantling and stripping of e-waste that cannot be refurbished
- ☐ Manufacturing of “waste to art” products from suitable and non-toxic e-waste components
- ☐ Creating opportunities for entrepreneurship
- ☐ Educational and awareness creation activities
- ☐ Training and educating previously disadvantaged individuals

Pilot sites were also established in Gauteng and Durban/Ethekewini (Bondolfi, 2007 and ATE, 2012). These sites proved to be successful in establishing an e-waste management framework in the regions. With this background the eWASA blueprint for e-waste management in South Africa envisages an industry-led take back system with legislative requirements for producers/importers/distributors to take back old and end-of-life products (Ecroignard, 2006). Also, in a successful e-waste management system, the focus will be to reduce, reuse, repair and recycle effectively, thereby minimising waste and hazardous waste disposal (Maczulak, 2010).

E-waste management within MMM is a concern due to the following reasons:

- ☐ There is a general lack of public awareness of what e-waste is within MMM.

Public awareness reduces the environmental impact of the use of electrical

/ electronic products (EPA, 2012). A total of 52% of respondents stated that they either do not know what e-waste is or they are not completely sure. Forty eight percent of respondents claimed that they know what e-waste is, but when asked “What e-waste stands for?”, only 37% knew the meaning. This implies that the majority of citizens in MMM are unaware of what e- waste is. Another area of concern is the lack of awareness of e-waste disposal sites or the infrastructure to support it. The results illustrate that

86% of respondents have never disposed of e-waste before. The remaining

14% have taken e-waste to a point for disposal. So some of MMM’s e- waste is being recycled, but most of it is in storage, mostly because there is no take back system (Bondolfi, 2007). This therefore implies that there are collection points available within MMM for e-waste disposal, but these could be limited to business employees or there is a lack of awareness of the collection points.

- ☐ The citizens of MMM consider the concepts of reuse, refurbishment and recycling as important or very important to them. In a successful e-waste management system, the focus should be to reduce, reuse, repair or recycle, to minimise waste generation and hazardous waste disposal (Bondolfi, 2007; ATE, 2012 & Ecroignard, 2006). Awareness campaigns should incorporate these concepts in order to provoke the thought process before disposal (EPA, 2012).
- ☐ There are a high number of electrical / electronic devices in use within MMM. The responses however illustrate that there are minimal numbers of electrical/electronic devices that are stored or disposed of by the citizens of MMM.

This indicates that there could be a bias in the responses received, as there are electrical/electronic devices that are being purchased and are in use, but there is no correlation to the numbers of the devices being disposed of or being stored. In other words, the number of electrical electronic devices coming into the market must be in proportion to the number of devices being stored or disposed of (Goodship & Stevels, 2012).

- When respondents disposed of e-waste, there were a high number of disposals into the garbage bin at home or the office. The result of this is that much of the MMM's e-waste is ending up in the MSW and ultimately into the landfill sites (StEP, 2009). The processes or infrastructure for e-waste disposal is clearly an issue within MMM. Citizens are willing to drop off e-waste, but they are not sure where or how to responsibly dispose of it.
- An opportunity could exist for formal and informal collection services for e-waste within MMM. StEP (2009) suggests that this could be taken by government, retailers, OEM's or commercial entities. Respondents indicate that they would use services if provided for free but are not willing to utilize a service if a payment is required. This implies that respondents are not entirely aware of the implications of irresponsible e-waste disposal or that the laws or regulations that should govern disposal are not effectively communicated or enforced. Should there be more stringent laws which hold citizens responsible for their waste (Polluter Pays); collection initiatives would be more feasible for collectors (Bondolfi, 2007).
- The opportunity for e-waste businesses within MMM could be an area of investigation or exploration. Respondents state that they will be interested in investing in a sustainable business opportunity. However, further studies could explore those opportunities by taking all stakeholders into consideration.

6. Research methodology

The methodology used in this study was partly desktop studies which involved downloading data from government departments, electronic journals and previous studies. This secondary data was used as information to set the framework to compare the current practices with previously set principles. Primary data was also obtained and for this research, quantitative methods were utilized. The data collected was used to assess the level of awareness of e-waste within MMM and the willingness of residents and businesses to participate in e-waste best practices. Additionally the information was utilized to determine what type and quantities of electrical and electronic / consumer goods were utilized in the population, and the frequency of discarding of e-waste. Observations were also conducted at the Bloemfontein South landfill site to possibly quantify the amounts of e-waste disposed by residents and businesses in MMM.

7. Research findings

The online survey (questionnaire) utilized in the collection of primary data consisted of two sections, which were broken down into Demographic questions and Survey Questions. The survey was emailed to over 300 individuals and business owners, being possible respondents within the MMM. A valid sample size of a minimum of one hundred random respondents was considered for this study. The survey achieved a total of 105 (one hundred and five) responses.

7.1 Section 1: Demographic Questions

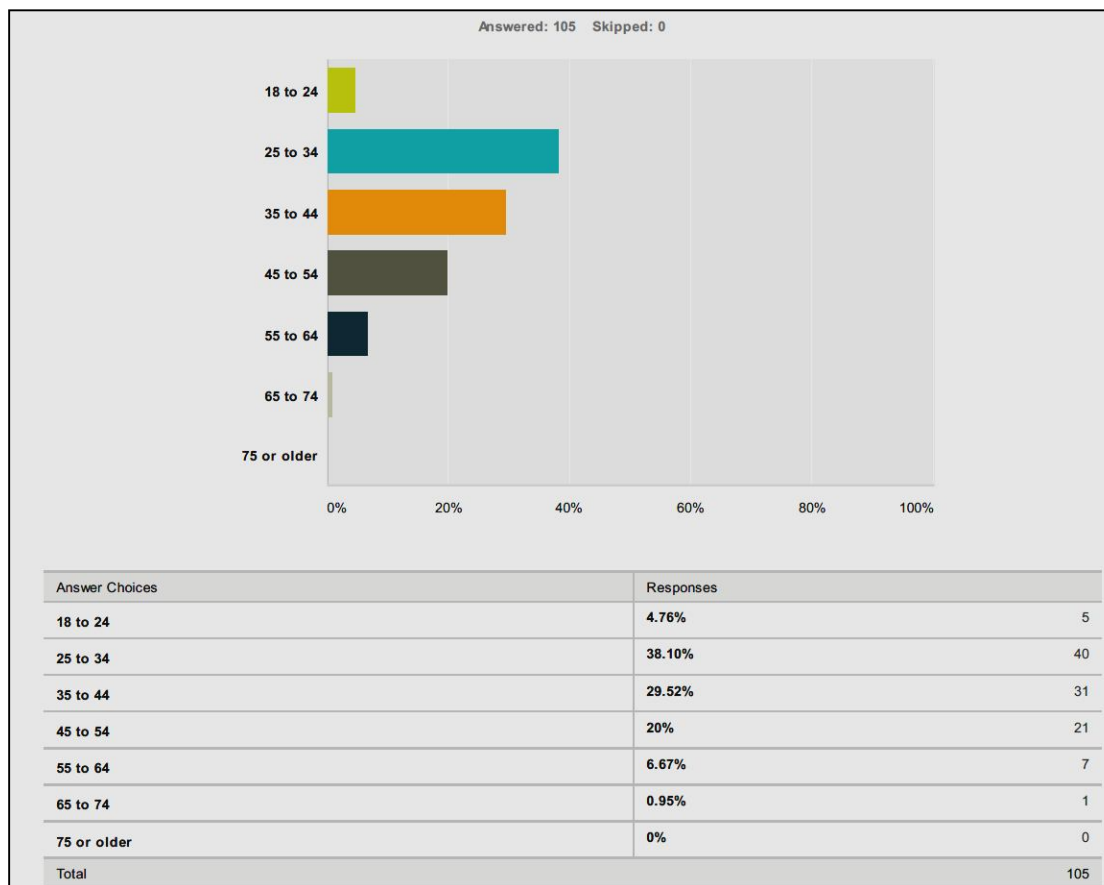
The first section of the online questionnaire consisted of 5 demographic questions, designed to obtain the demographic information of the respondents.

Question 1: “What is your age?”

All respondents answered this question and the responses are illustrated in Figure

1 below. The responses received illustrates that majority of the respondents (38.10%) were between the ages of 25 to 34, followed by 29.52% of respondents between the age group of 35 to 44. This shows that a combined majority of 87.62% were between the ages of 25 to 54 years of age.

Figure1. Age profile



Question 2: How many years have you lived in Mangaung Metropolitan

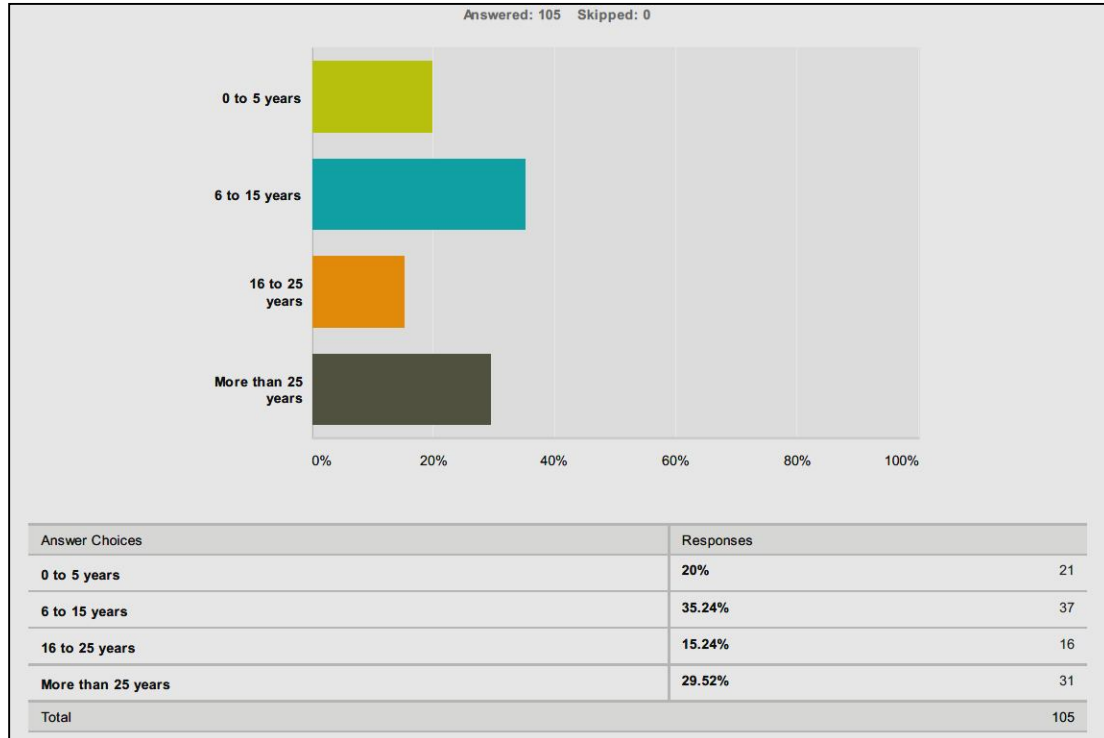
Municipality

2

The aim of this question was to deduce how long the respondents have lived in the metropolitan area and possibly deduce whether responsible or sustainable recycling practices have been embedded within the Metropolitan culture. The response rate for this question was 100% with a total of 105 responses. Figure 2 below illustrates that 35.24% of respondents have been in MMM for 6 to 15 years while 44.76% have resided in the metropolitan for 16 years and over. The results show that 20% of all the respondents

have lived for less than 5 years within the metropolitan. Figure 7 below illustrates the responses in graphical format.

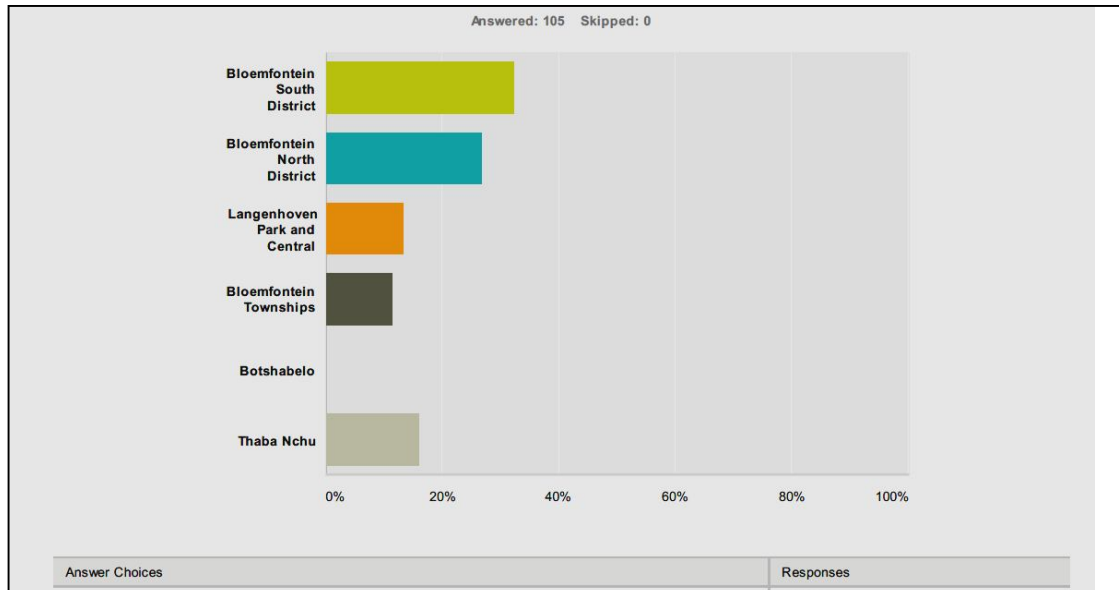
Figure 2. Years living in Mangaung Metropolitan Municipality



Question 3: In which area do you reside?

Question 3 aimed at gathering information on the area of residence of the respondents. This was significant to see if respondents answered differently from different areas and also to ensure that the sample representation was from all areas. Seventy two per cent of the respondents were from within the city of Bloemfontein. This included the areas of Bloemfontein South, North, Central and Langenhoven Park. The response from Bloemfontein Township was 11.43%, while Thaba Nchu showed a response of 16.19%. Unfortunately there were no respondents from the Botshabelo area. Figure 3 below shows the responses to this question.

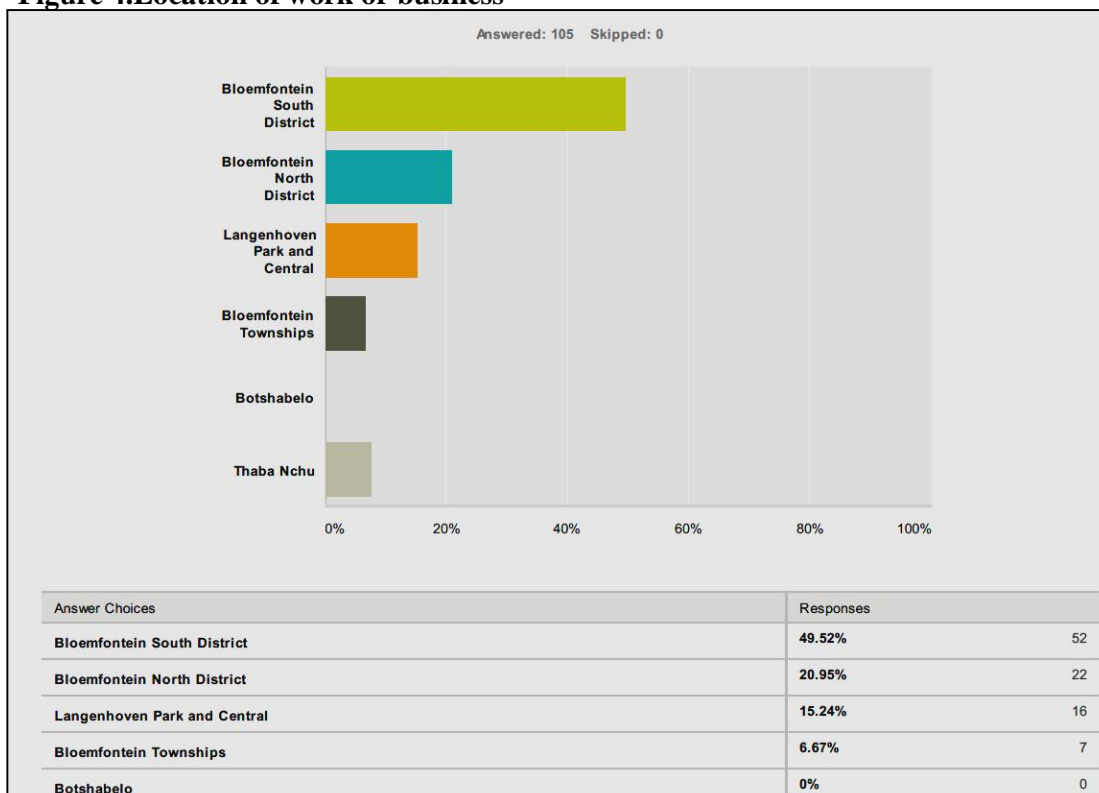
Figure3. Residential Area



Question 4: Location of work or business?

This question was posed to respondents to find out the area of their work or business. The responses would help in deducing business areas where e-waste collection points can be established. Fifty two per cent of respondents were employed or have businesses in the Bloemfontein South District. Twenty two per cent and 16% were from the Bloemfontein North and Langenhoven Park/Central areas respectively. Figure 4 below displays the responses graphically.

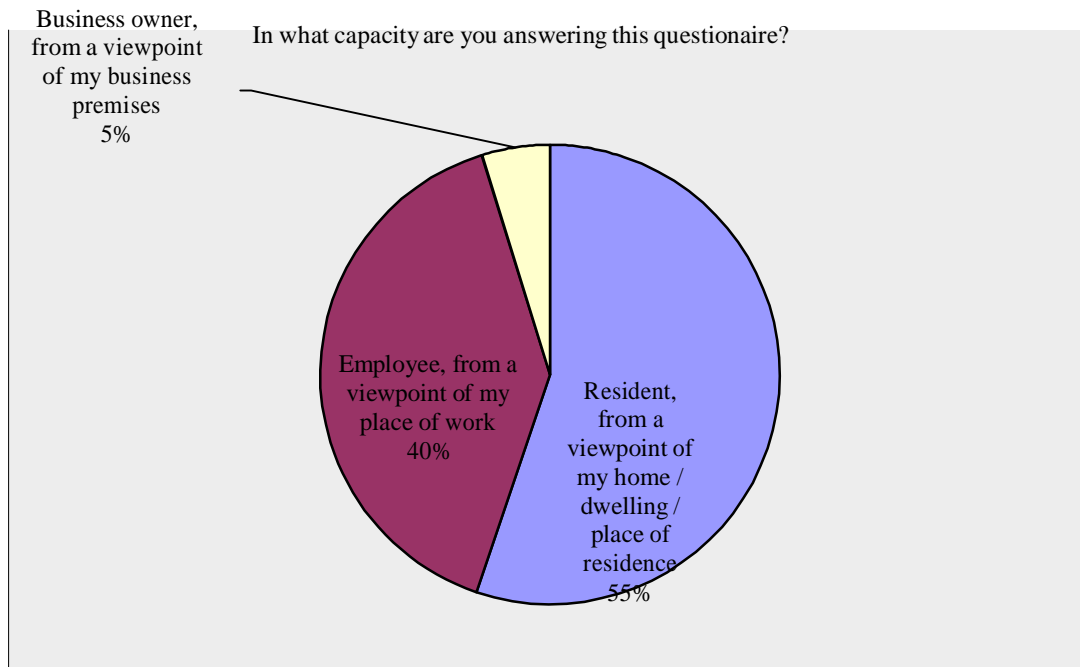
Figure 4.Location of work or business



Question 5: In what capacity are you answering this questionnaire?

This question would supply information on the capacity in which the respondents were answering the survey. The responses would enable us to separate the respondents into categories of residents, employees or business owners. Fifty five per cent of respondents answered the questionnaire as residents of MMM, while 40% were from an employee's viewpoint. Only 5% answered from the viewpoint of a business owner. Figure 5 below illustrates the responses to this question.

Figure 5. Answering capacity

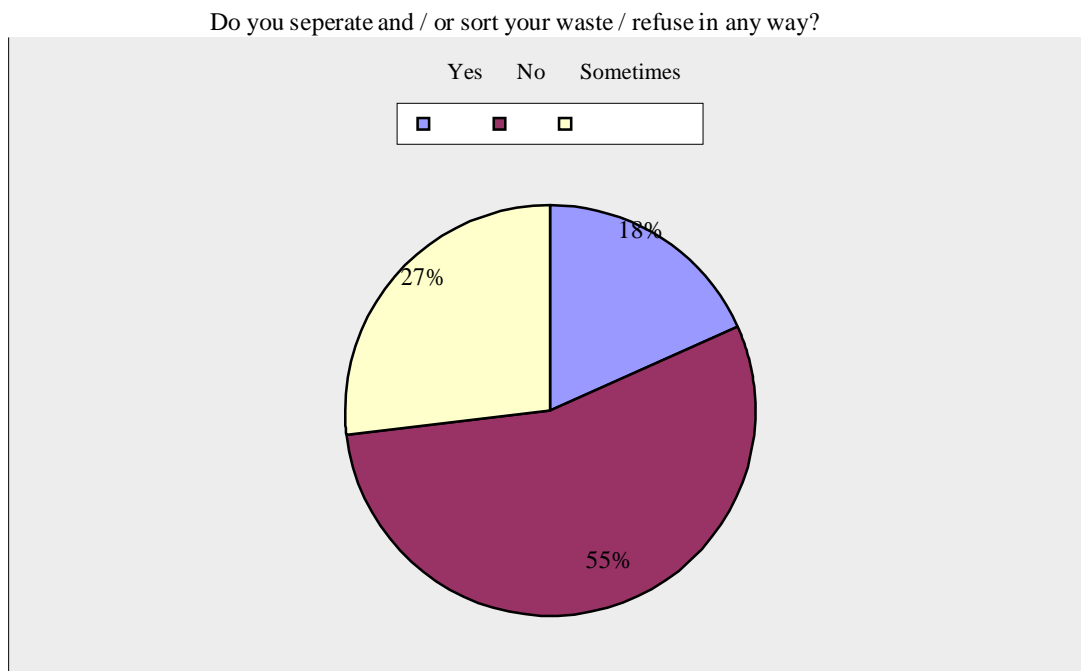


7.2 Section 2: Survey Questions

Question 6: Do you separate and/or sort your waste/refuse in any way?

Question 6 was posed to respondents to gather information on general waste management and recycling habits of the community. This question was constructed with question logic. If respondents answered “Yes” or “Sometimes”, then they will be presented with Question 7. If respondents answered “No”, then they were automatically presented with Question 8. The responses show that 55% of the community is not actively involved in general waste management or recycling, while 18% state that they perform waste management. Twenty seven percent of the respondents state that they perform general waste management sometimes.

Figure 6. Separation of waste



Question 7: Why do you separate and/or sort waste / refuse. Indicate reason under “Other” if applicable.

Question 7 had 43 responses as it was part of the question logic as explained in question 6. The responses in Figure 7 shows that 32.56% of citizens utilize professional recycling collection services for general waste, while 48.84% of respondents support the informal recycling collection (street collectors). The remaining 30.23% of respondents separate general waste for composting. This illustrates the presence of professional and informal recycling collectors within MMM. These stakeholders could be incorporated into an e-waste management system in the future.

Question 8: Are you aware of informal recyclers (Street Collectors) in your area who collect on municipal waste collection days?

Question 8 was presented to all respondents to deduce if respondents had knowledge of the informal recycling collectors in their area. The significance of this question is to quantify the level of the awareness of the informal sector within MMM. The informal sector will form an integral part and will be invaluable to the success of an e-waste management system. The responses show that 63% of residents are aware of the informal collectors in their area, while 37% of the responses are unaware. Figure 8 refers.

Figure 7. Reason for separation of waste

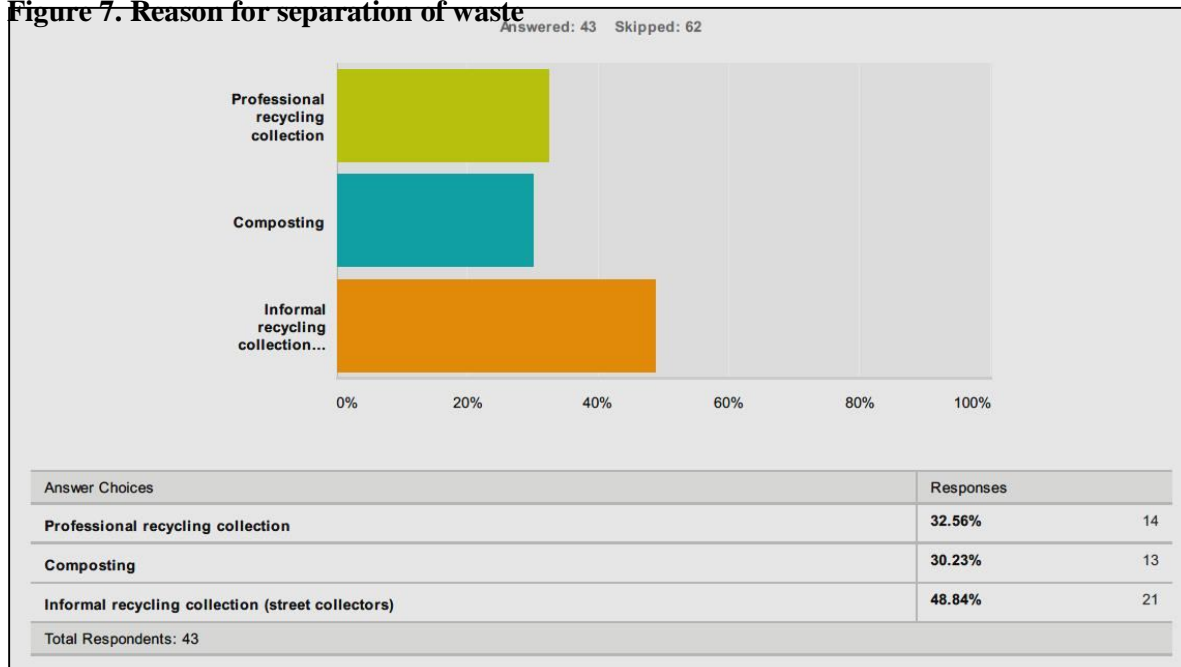
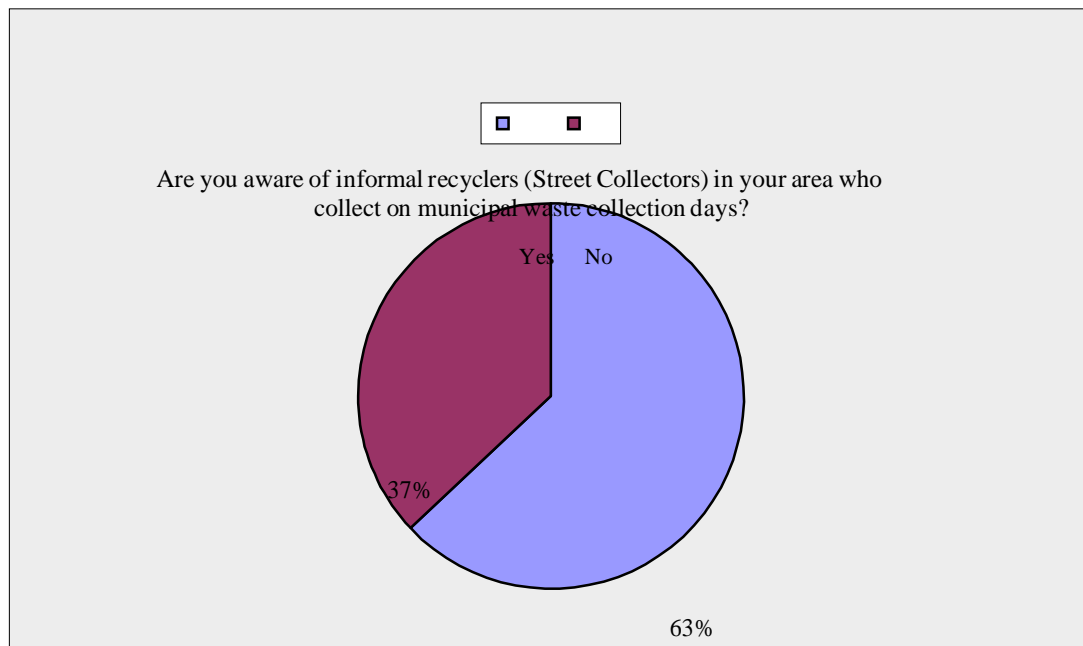


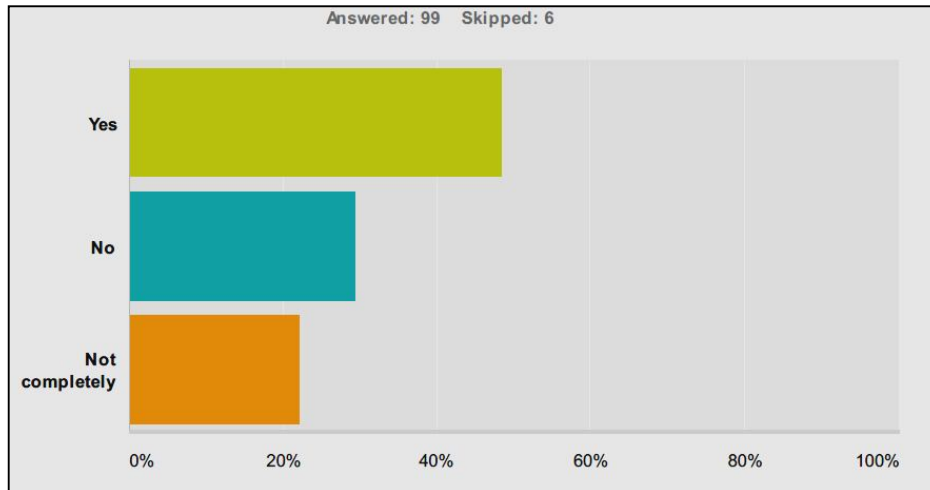
Figure 8. Informal Recyclers



Question 9: Do you know what e-waste is?

This question was a straightforward question aimed at determining if respondents are aware of what e-waste is. The responses show that 48.5% stated that they know what e-waste is, 29.3% indicate that they do not know what e-waste is, while 22.2% are not completely sure what e-waste is. Figure 9 refers.

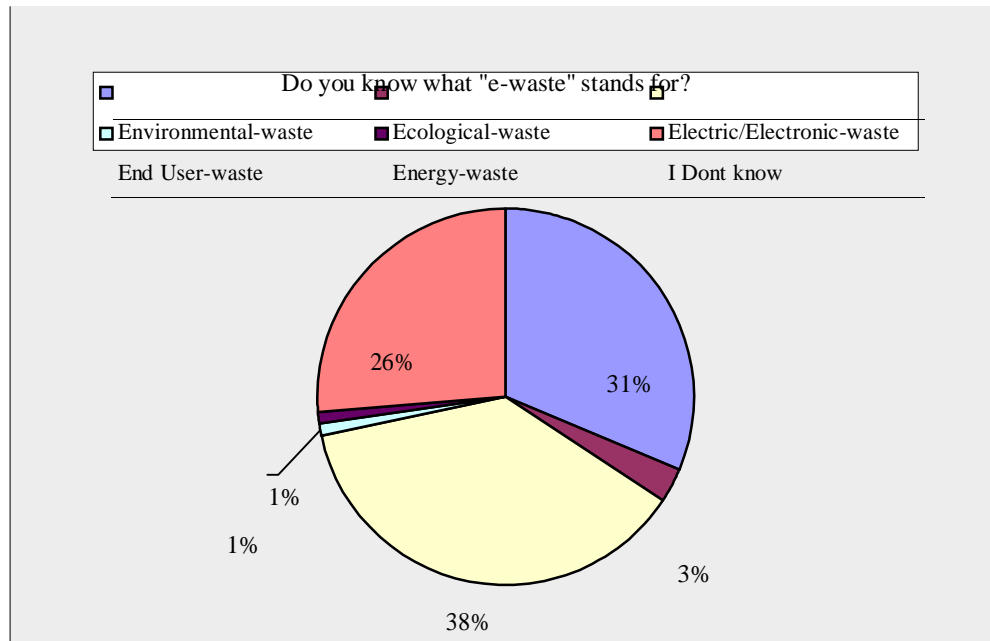
Figure 9. Do you know what e-waste is?



Question 10: Do you know what e-waste stands for?

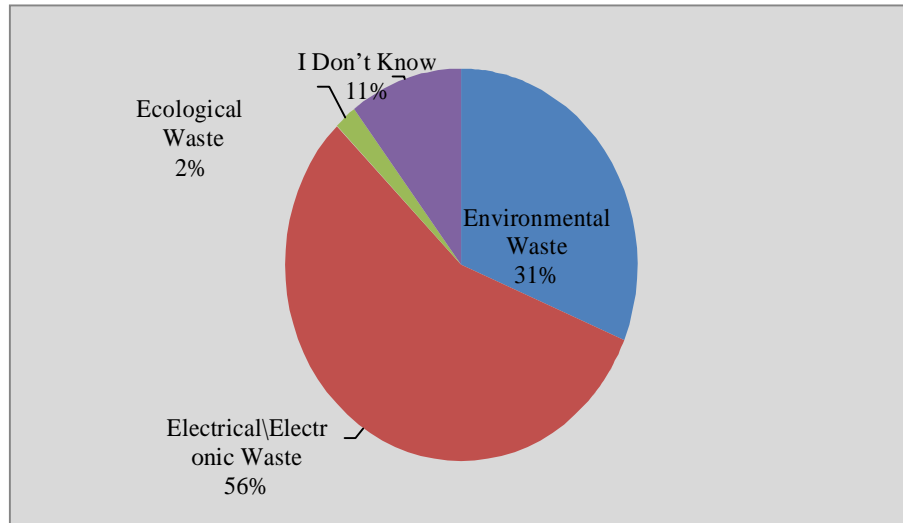
This question was added to ensure validity for the previous question. From the responses to this question it can be deduced if respondents who answered "Yes" in question 9 actually knew what e-waste was. The responses show that the majority of respondents at 38% knew that e-waste stands for electrical/electronic- waste. A close second was that 31% of the respondents incorrectly answered that e-waste stands for environmental-waste, while 26.3% stated that they did not know what e-waste stands for. Figure 10 below illustrated the responses graphically.

Figure10. What e-waste stands for?



A further analysis was performed on all the respondents who answered “Yes” in question 9 to deduce if they actually knew the correct answer to Question 10. Figure 11 below illustrates the information for all respondents who answered “Yes” in question 9. The results show that 56% of the respondents who answered “Yes” were correct, while 31% chose “Environmental-waste”, 2% chose “Ecological- waste” and 11% did not know the answer. The result show that even though 48.5% of respondents stated that they knew what e-waste stands for in question 9, only 56% of the 48.5% respondents really did know.

Figure 11. Further analysis of Question 9



Question 11: Electrical/Electronic devices in use?

This question was aimed at quantifying the average number of devices which respondents currently have in use. The quantifiable results can be found in Table 2 below:

Table2. Quantities of Electrical/Electronic devices currently in use

Please indicate the number of electrical / electronic devices that you have in your home / office (in active use). Choose "0" if you do not have an applicable device.								
Answer Options	0	1	2	3	4	5	6+	Response Count
Communication Appliances (eg. cellphones,	1	11	17	22	10	10	15	86
Computers (eg. Desktop PCs, Laptops, etc)	5	23	23	10	7	3	14	85
Computer peripherals (eg. mice, PC Speakers,	12	13	15	11	8	4	19	82
Large Appliances (eg. Washing Machine, Dryer,	7	19	15	12	13	10	10	86
Small Appliances (eg. Kettle, Toaster, Heaters etc)	3	17	10	16	10	12	17	85
Gardening Equipment (eg. Lawn Mower, Weed Eater,	41	16	14	4	3	0	7	85
Entertainment Appliances (DVD / CD players, TVs,	5	11	18	12	16	8	14	84
Cleaning Appliances (eg. Floor Polishers, Vacuum	26	35	9	4	1	2	6	83
Health and Beauty Appliances (Hair Dryers, Curlers,	17	22	22	9	7	1	5	83
DIY Appliances (Drills, grinders, etc)	30	11	7	11	5	4	15	83
answered question								86
skipped question								19

From the results of the data presented in the table above, further analysis was done by calculating the Mean and Standard Deviation. The Mean highlights the average number of items in each category that is in use by the respondents. The standard deviation is calculated to show the variation or dispersion from the average. The data shows that the standard deviation is high on most answer

options, which expresses that the number of items differs widely between respondents. This is illustrated in Table 3 below:

Question 12: Do you have any electrical / electronic devices stored (not in use)? Please choose "0" if none in storage.

This question was similar to Question 11 above. The question was aimed at quantifying the number of items that the respondents had stored away. Table 4 below show the quantities of items stored by respondents.

Table3. Statistical Analysis of Quantities of EEE currently in use

Answer Options	n	% Percent	Mean	Standard Deviation
Communication Appliances	86	81.905	3.384	1.688
Computers	85	80.952	2.659	1.874
Computer peripherals	82	78.095	2.951	2.137
Large Appliances	86	81.905	2.872	1.865
Small Appliances	85	80.952	3.376	1.902
Gardening Equipment	85	80.952	1.294	1.778
Entertainment Appliances	84	80	3.226	1.826
Cleaning Appliances	83	79.048	1.386	1.674
Health and Beauty Appliances	83	79.048	1.88	1.618
DIY Appliances	83	79.048	2.265	2.296

Table 4. Quantities of Electrical/Electronic devices currently in storage

Do you have any electrical / electronic devices stored (not in use)? Please choose "0" if none in storage:								
Answer Options	0	1	2	3	4	5	6+	Response Count
Communication Appliances (eg. cellphones,	49	13	8	8	3	1	3	85
Computers (eg. Desktop PCs, Laptops, etc)	55	20	4	0	2	1	3	85
Computer peripherals (eg. mice, PC Speakers,	45	12	13	5	2	0	5	82
Large Appliances (eg. Washing Machine, Dryer,	64	12	6	1	1	0	1	85
Small Appliances (eg. Kettle, Toaster, Heaters etc)	54	11	12	2	3	1	1	84
Gardening Equipment (eg. Lawn Mower, Weed Eater,	76	5	2	0	0	0	1	84
Entertainment Appliances (DVD / CD players, TVs,	57	20	3	1	0	1	2	84
Cleaning Appliances (eg. Floor Polishers, Vacuum	73	9	1	0	0	0	1	84
Health and Beauty Appliances (Hair Dryers, Curlers,	66	11	6	1	0	0	1	85
DIY Appliances (Drills, grinders, etc)	69	6	6	1	0	0	2	84
<i>answered question</i>								86
<i>skipped question</i>								19

Similar to question 11, a further analysis was conducted on the data that is presented in Table 4 above. As a result the mean and standard deviations were calculated in Table 5 below.

Table5. Statistical Analysis of Quantities of Electrical/Electronic devices currently in storage

Answer Options	n	Percent	Mean	Standard Deviation
Communication Appliances	85	80.9	1.035	1.569
Computers	85	80.9	0.694	1.38
Computer peripherals	82	78.09	1.11	1.648
Large Appliances	85	80.95	0.435	0.981
Small Appliances	84	80	0.762	1.286
Gardening Equipment	84	80	0.1786	0.7471
Entertainment Appliances	84	80	0.548	1.166
Cleaning Appliances	84	80	0.2024	0.7409
Health and Beauty Appliances	85	80.95	0.3765	0.8994
DIY Appliances	84	80	0.393	1.087

The statistical analysis of the data illustrates that there is a low mean, which indicates that there is minimal storage of old equipment. The standard deviation is low which indicates that the number of items differs slightly between respondents. There could however be a bias in answering this question as the storage of e- waste is not always easily quantifiable. The definition and understanding of what e-waste is could also lead to a biased outcome.

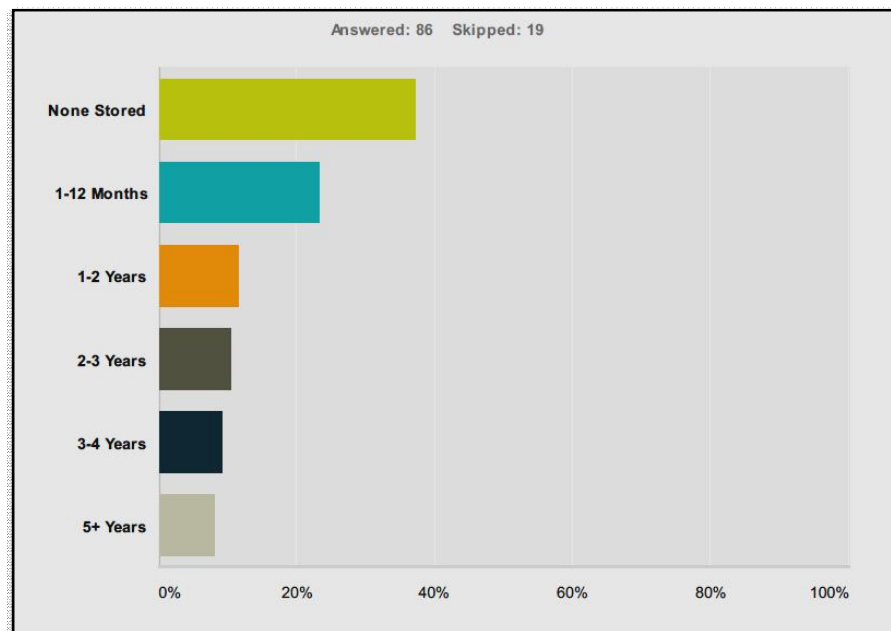
Question 13: For how long have you had electrical / electronic devices in storage?

This question was aimed at identifying the length of time that e-waste is in storage. Table 6 below illustrates the responses received to this question. The responses show that 37.21% of respondents state that they do not have any e-waste stored, while 23.26% claim to have e-waste stored for less than a year. The remaining responses are displayed in the table below.

Table6. Responses to e-waste stored

Answer Choices	Responses	
None Stored	37.21%	32
1-12 Months	23.26%	20
1-2 Years	11.63%	10
2-3 Years	10.47%	9
3-4 Years	9.30%	8
5+ Years	8.14%	7
Total		86

Figure 12 below illustrates responses from Table 6 above in a graphical format. Figure 12. Graphical format of responses to e-waste stored

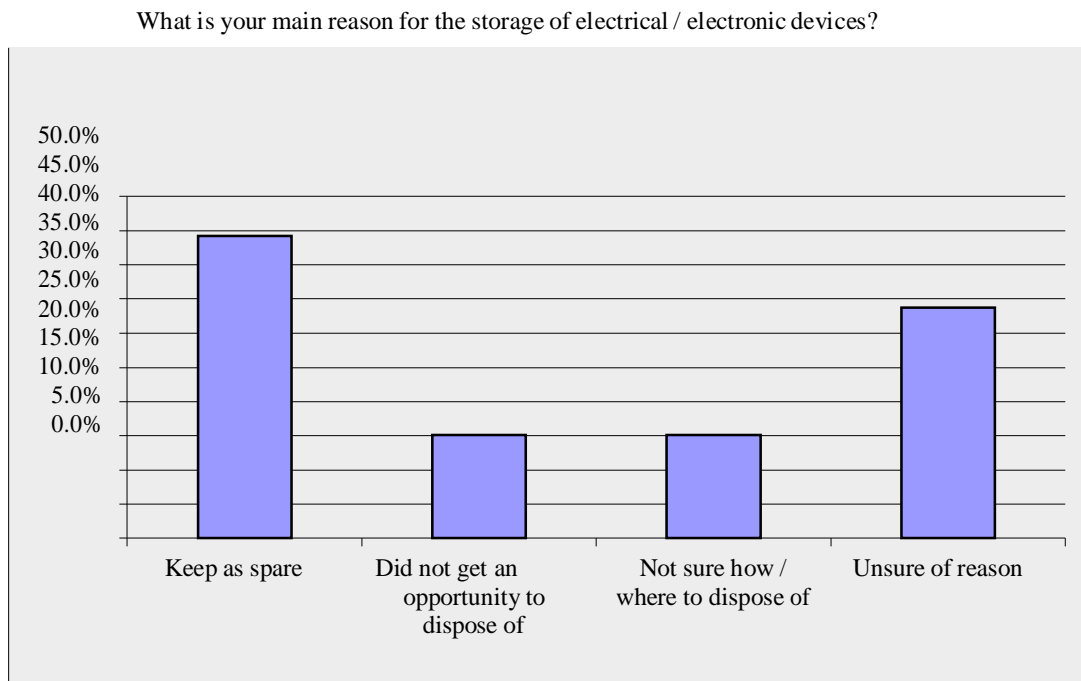


This data shows that of the total number of respondents to the survey, 63% of respondents have e-waste stored away.

Question 14: What is your main reason for the storage of electrical / electronic devices?

The storage of e-waste could be due to a lack of awareness of proper e-waste disposal and recycling procedures. This question was aimed at unearthing the reasons why respondents stored away e-waste. From Figure 13 below, the main reason for respondents storing e-waste is to keep it as a spare (44.19%). Just over 15% of respondents did not get an opportunity to dispose of the equipment, while the other 15% was not sure of how or where to dispose of e-waste. A high percentage of respondents (33.72%) were unsure of the reason why they have e-waste stored away. The responses to this question clearly indicate that there is a general lack of awareness of what to do with electrical / electronic equipment that has become obsolete. Respondents keep e-waste as a spare as they are unaware of re-use or refurbishing processes. With effective awareness campaigns, the storage of e-waste could be minimized as the remaining 64% of respondents would have a clear understanding of what to do with e-waste.

Figure 13. Reasons for storage of e-waste



Question 15: Please indicate any electrical/electronic devices that you have discarded or disposed of.

The aim of this question was to quantify the disposal of electrical/electronic devices. The result of this question assists in supporting Question 16 in identifying how e-waste is being disposed of. Majority (60% - 80%) of respondents stated that they have not disposed of any of the listed devices. Table 7 below indicates the results.

Table 7. Results of devices discarded or disposed of

Please indicate any electrical / electronic devices that you have discarded or disposed of? Please choose "0" if none:								Response Count
Answer Options	0	1	2	3	4	5	6+	
Communication Appliances (eg. cellphones,	56	14	5	5	1	1	3	85
Computers (eg. Desktop PCs, Laptops, etc)	68	9	5	1	0	0	3	86
Computer peripherals (eg. mice, PC Speakers,	63	7	7	2	1	0	3	83
Large Appliances (eg. Washing Machine, Dryer,	74	7	4	1	0	0	0	86
Small Appliances (eg. Kettle, Toaster, Heaters etc)	52	21	11	2	0	0	0	86
Gardening Equipment (eg. Lawn Mower, Weed Eater,	73	8	2	0	0	1	0	84
Entertainment Appliances (DVD / CD players, TVs,	59	15	7	2	2	0	0	85
Cleaning Appliances (eg. Floor Polishers, Vacuum	69	11	6	0	0	0	0	86
Health and Beauty Appliances (Hair Dryers, Curlers,	66	8	6	4	1	0	0	85
DIY Appliances (Drills, grinders, etc)	73	6	2	0	1	0	1	83
<i>answered question</i>								86
<i>skipped question</i>								19

The data presented in the Table above can also be further analysed statistically (in Table 8 below). From the analysis it can be determined that there is a low mean, which indicates that the disposal of old equipment is very low. The high standard deviation in most answer options indicate that the number of items discarded or disposed of differs significantly between respondents. This could indicate that certain respondents dispose of a number of items compared to other respondents who have never disposed of similar items.

Table 8. Statistical analysis of devices discarded or disposed of

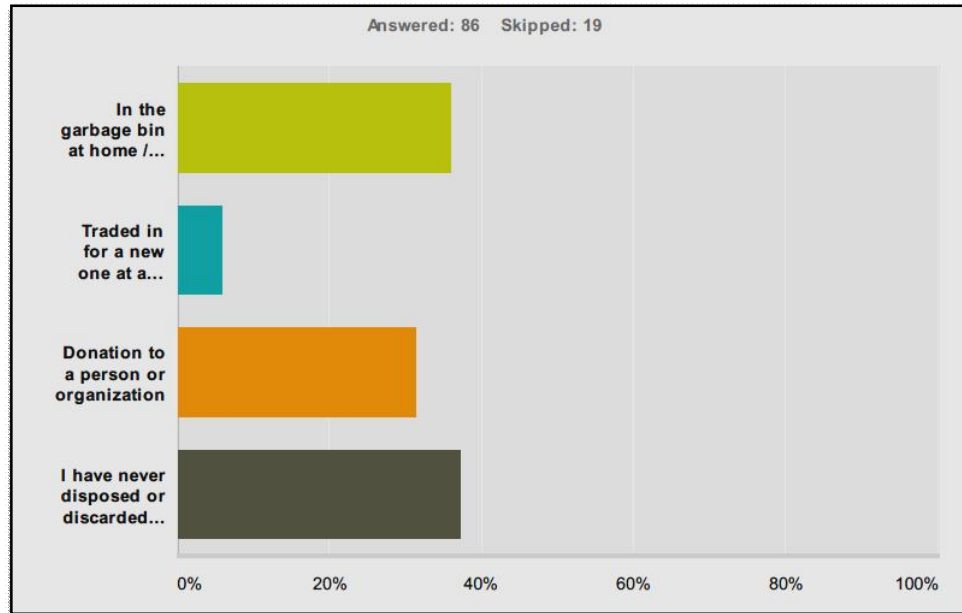
Answer Options	<i>n</i>	Percent	Mean	Standard Deviation
Communication Appliances	85	80.95	0.776	1.451
Computers	86	81.9	0.465	1.224
Computer peripherals	83	79.04	0.59	1.344

Large Appliances	86	81.9	0.2093	0.5763
Small Appliances	86	81.9	0.5698	0.805
Gardening Equipment	84	80	0.2024	0.6727
Entertainment Appliances	85	80.95	0.5059	0.921
Cleaning Appliances	86	81.9	0.2674	0.5826
Health and Beauty Appliances	85	80.95	0.4235	0.9047
DIY Appliances	83	79.04	0.241	0.8638

Question 16: How did you discard or dispose of items listed in the question above?

This question continued from Question 15 to probe into the respondents habits of e-waste disposal. Figure 14 below illustrates the responses received regarding discarding and disposal of equipment.

Figure 14. How have items been disposed of?



The majority of respondents at 37.21% stated that they have never disposed of or discarded e-waste before, while 36.05% of respondents discarded their e-waste in the garbage bin (which ultimately ends up in the landfill sites). This could be the consequence of:

- ☐ A lack of awareness of e-waste management and a system for e-waste disposal
- ☐ A lack of infrastructure for the collection and responsible disposal of e- waste
- ☐ Ignorance on the part of the respondents who should be following a structured process

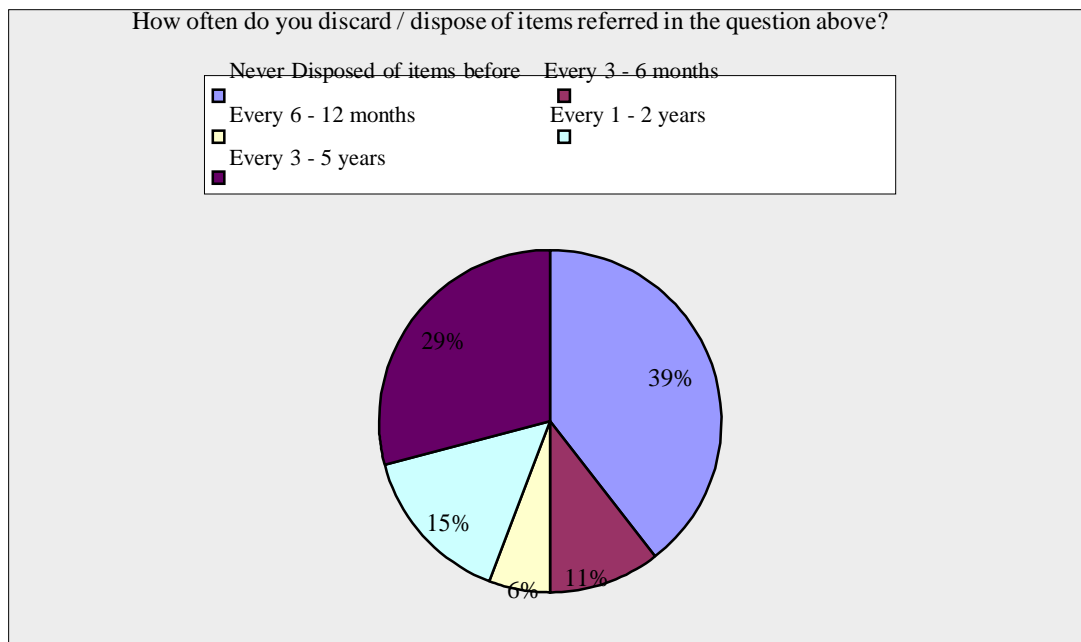
The remaining respondents at 31.40% and 5.81% respectively, either donated the old equipment to a person/organization or traded it in for a new device. In these

instances, it is unknown what becomes of the equipment after passing to the second user or organization.

Question 17: How often do you discard / dispose of items referred in the question above?

This question added a time frame to the discarding of old equipment. The aim is to deduce the frequency of disposal. Figure 15 below illustrates that 39% of respondents have never disposed of items before, while 29.1% disposed of items every 3 to 5 years. This shows that disposal of items takes place very infrequently or in most cases, never. This could also point to opportunities for the improvement for awareness and e-waste system infrastructure.

Figure 15. Timeframe of disposal of items



Question 18: Have you taken recyclables to a collection point before?

This question was probing the awareness of collection points for recyclables such as paper, glass, cans, garden waste, batteries and CFL Bulbs. The information received could possibly assist in identifying possible collection points for e-waste that is currently utilized for other recyclable items. Figure 16 below explains the results.

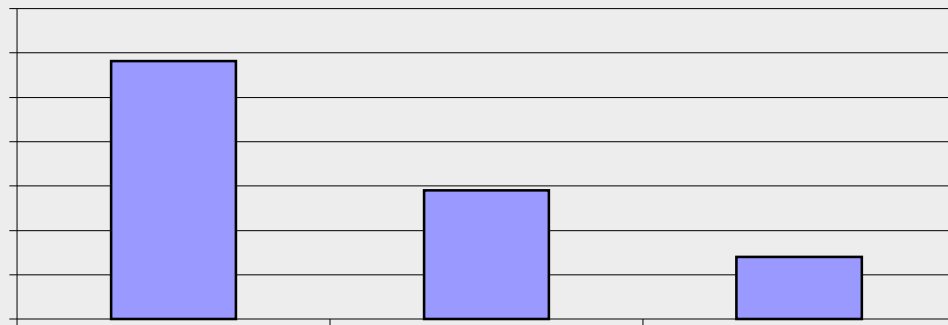


Figure16. Collection points for other recyclables

Have you taken recyclables to a collection point before (paper, glass, plastics, cans, garden waste, batteries, CFL Bulbs), If so, please specify?

70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%

No I have not taken
recyclables to a collection
point before

Yes, to a premises of a
business or organisation
other than my workplace

Yes, Premises of my
employer / own business

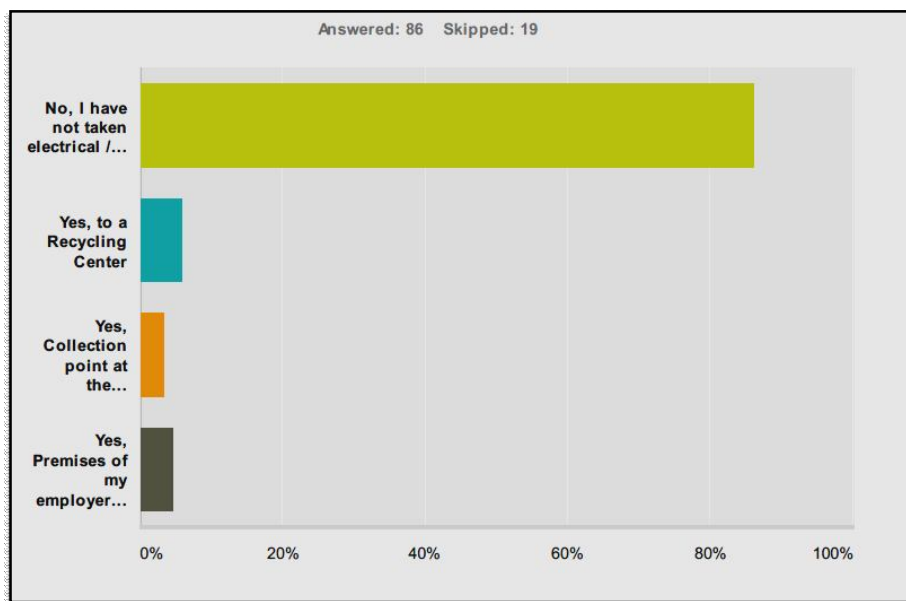
From the results 58.1% of respondents do not take recyclables to a collection point, while 29.1% take their recyclables to premises of a business or organisation. The remaining 14% take their recyclables to their employer or place of business. This illustrates that the majority of respondents in MMM are not actively involved in recycling practices.

Question 19: Have you taken e-waste for recycling before?

This question now changes the focus to the recycling of e-waste, as opposed to all recyclables in the previous question. Figure 17 below illustrates the results of the responses to this question. The outright majority of 86% of respondents have not taken e-waste for recycling previously. A marginal 5.8% state that they have taken

e-waste to a recycling centre, while 3.5% and 4.7% have taken e-waste to a collection point at a business premises and to a place of employment respectively. The significance of these responses is also valuable to an e-waste management system, where the identified collection points can be incorporated into the system.

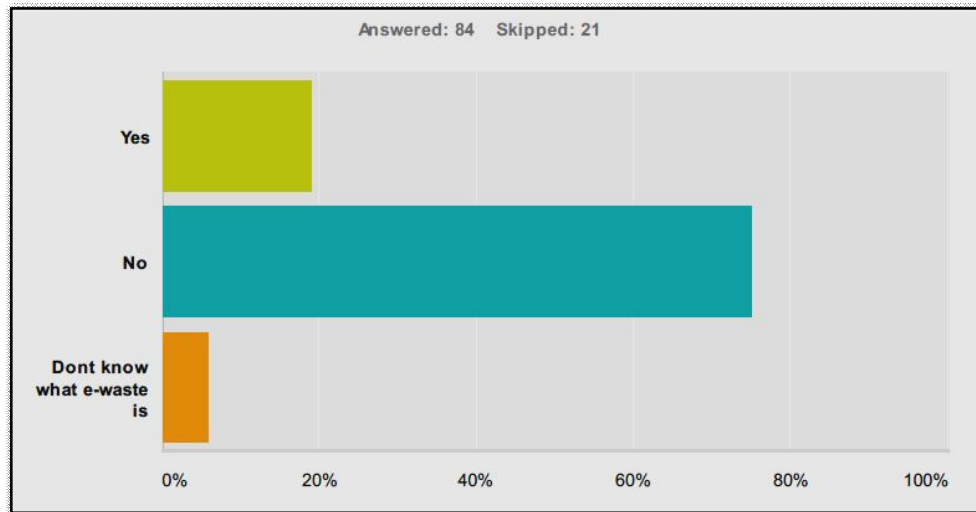
Figure 17. E-waste recycling points



Question 20: Do you know of e-waste drop-off sites in the Mangaung Metropolitan Municipality?

This question aimed to explicitly enquire if respondents were aware of e-waste drop-off sites. The results of this question would clearly illustrate if there is awareness of e-waste collection sites. Figure 18 illustrates the outcomes of the responses.

Figure 18. Awareness of e-waste collection sites in MMM



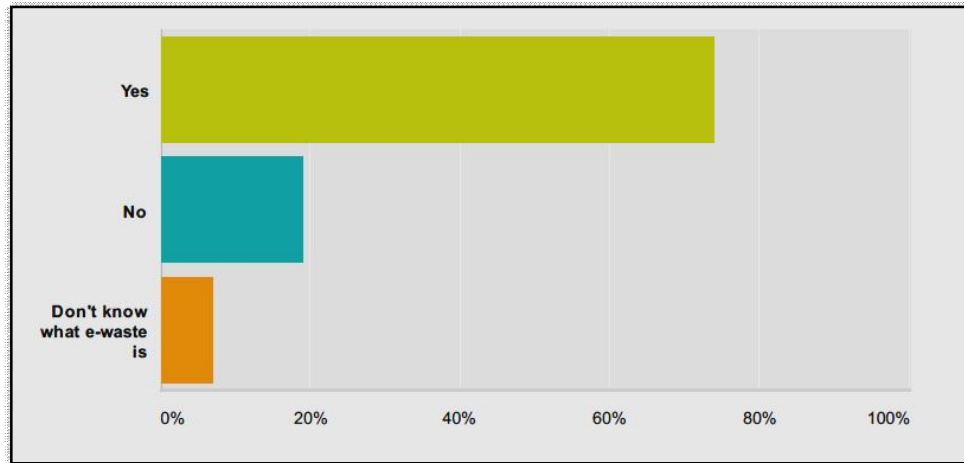
From Figure 18 above 75% of all respondents' state that they are unaware of e- waste drop-off sites within the Mangaung Metropolitan Municipality. Alternatively, 19.05% are aware of such a collection site, while 5.95% are unaware of what e- waste is.

Question 21: If there were/are sites that receive e-waste, would you drop off your e-waste there?

This question was aimed at measuring the willingness of respondents to participate in environmentally responsible e-waste practices. Figure 19 below shows the graphical responses to this question.

The results of this question illustrates that a 74.1% majority of respondents are willing and able to take e-waste at drop-off sites if they are aware of such collection points. A minority of 18.8% of respondents answered "No" to the question posed. This response could be due to the lack of information on the hazards of e-waste and the laws which govern e-waste that are not adequately enforced.

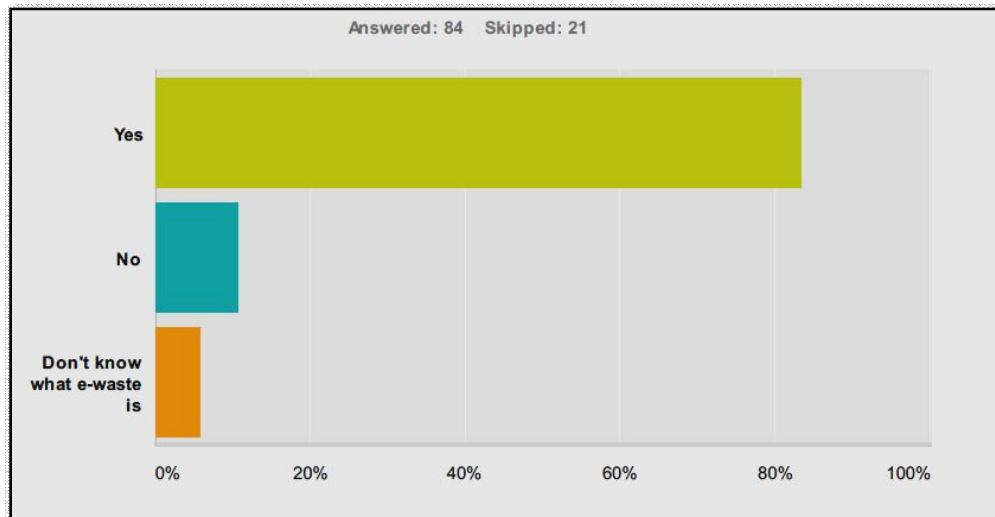
Figure 19. Willingness to drop-off e-waste



Question 22: If there are collection services that picked up e-waste for free from your residence / employer / business, would you or do you use such services?

The question posed to respondents was aimed at measuring the willingness of citizens to use free e-waste collection services. Majority of responses at 83.33% stated that they will use such services if they were available. Figure 20 below illustrates the responses graphically.

Figure 20. Willingness to utilize free pickup services

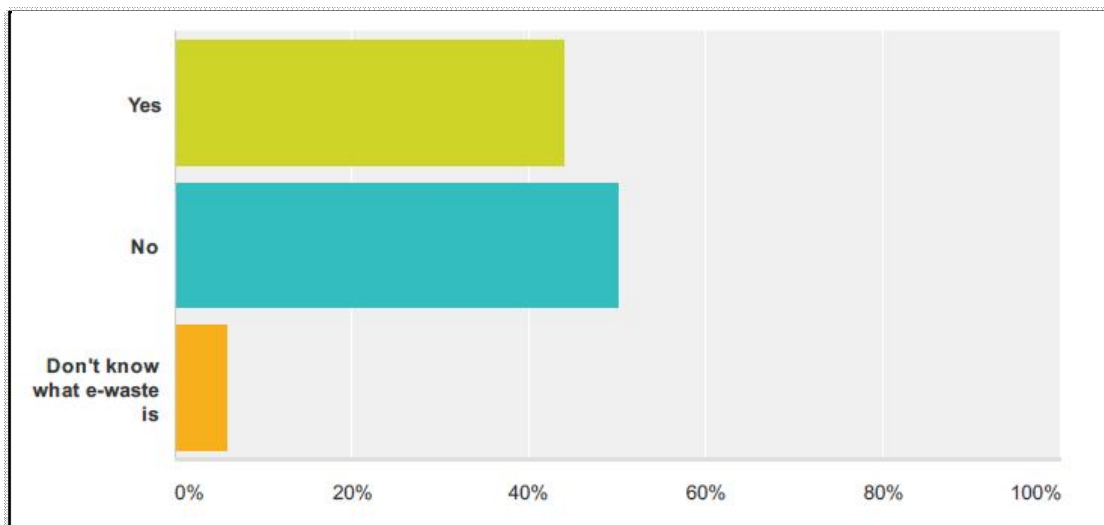


Question 23: If there are collection services that picked up e-waste for approximately R100 per month, from you residence / employer / business, would you consider / are you making use of such services?

The aim of this question was to deduce if respondents were willing to pay for e- waste collection services. Figure 21 below show the graphical responses to this question.

Interestingly, 50% of the respondents stated that they would not want to pay for the service. The remaining 44.05% of respondents stated that they would be willing to pay for the service.

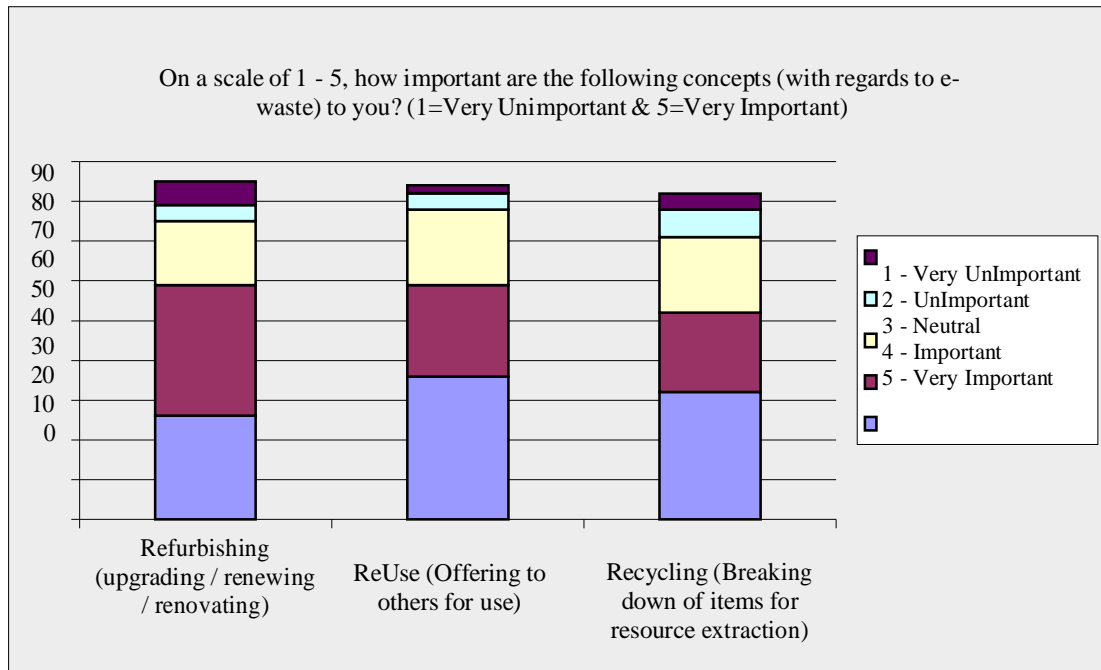
Figure 21. Willingness to pay for a collection service



Question 24: On a scale of 1-5, how important are the following concepts to you?

This question was aimed at deducing how important refurbishing, reuse and recycling were to respondents. The options were weighed on a Lickert scale of 1 to 5, with 1 being very unimportant while 5 was very important. Figure 22 below shows the responses to the various concepts.

Figure 22. Importance of e-waste concepts

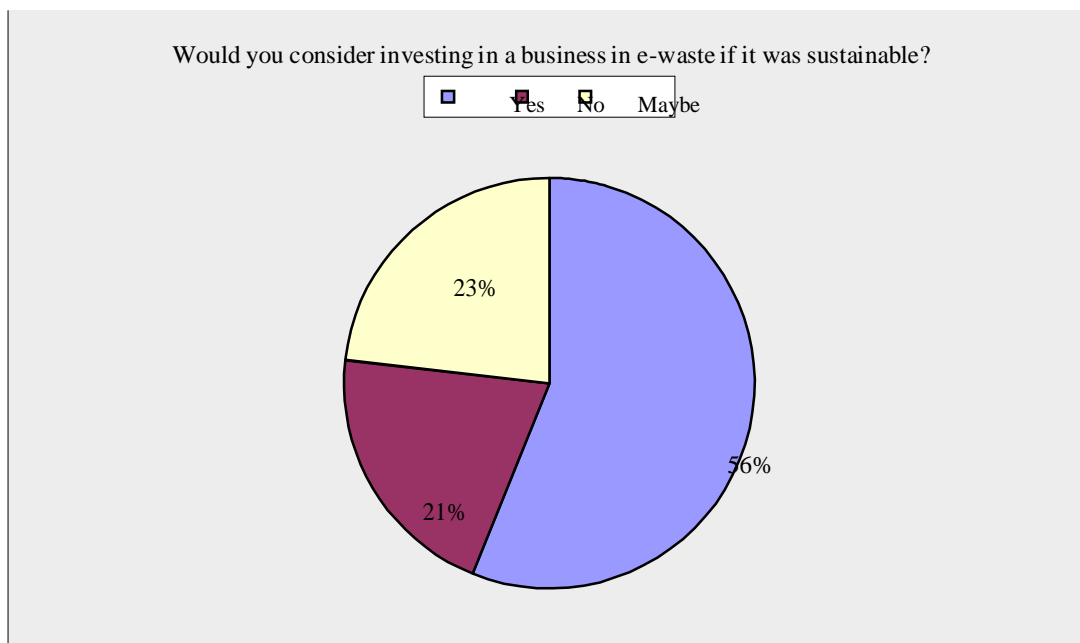


The responses show that the majority of respondents find all three concepts as either important or very important. The significance of this finding shows that with an effective e-waste management system, the respondents would support the initiatives.

Question 25: Would you consider investing in a business in e-waste if it was sustainable?

This question was posed to respondents to measure the willingness to enter e- waste as a business if the opportunity arose. The responses show that 56% of respondents will be willing to invest in a sustainable business in e-waste. The remaining 21% and 23% of the respondents, answered “No” and “Maybe” respectively. The findings show that should e-waste management be sustainable within the MMM, entrepreneurs will definitely consider venturing into the field. Figure 23 below illustrates the responses graphically.

Figure 23. E-waste as a sustainable business



From the primary research conducted, it can be concluded that e-waste is not being managed in an environmentally sustainable manner within MMM. From the best practices outlined in the literature review, it can be concluded that MMM is not conforming to national or international standards. The primary research has revealed the following information of how e-waste is being managed in MMM:

- E-waste is a new waste stream and lack of knowledge or awareness of the endemic issue is of concern in MMM.
- The citizens of MMM need more information and guidance with regard to recycling practices and e-waste responsible practices specifically.
- The advertising of e-waste recycling companies needs to be improved and the possible funding of the current e-waste recycling company will assist in building an e-waste management system or recycling centre. The Waste Act of 2008 makes reference to clearly marked drop-off centres at well- advertised locations (the detea, 2013:1).

- An effective e-waste take-back system will simplify the responsible disposal of e-waste.
- Residents and businesses are willing to be more responsible in e-waste management if more information on what is required is provided.
- Citizens of MMM have a high regard for the concepts of refurbishment, reuse, or recycling, but initiatives in the matter are very limited.
- There is a lack of laws or regulations that specifically govern e-waste in MMM.

- The disposal of e-waste into landfill sites in MMM is a concern as wastes entering the facilities are mixed and no active monitoring, measuring or enforcement occurs to prevent the dumping of e-waste.
- There are currently informal collectors at landfill sites who salvage e-waste for recyclers, however, crude dismantling practices are used to extract only valuable recyclable materials. The remaining “non-recyclable” toxic and non-toxic materials are compacted into the landfill site.
- There are current formal and informal recyclers in MMM who collect recyclables for recycling centres.
- Current initiatives are starting to raise awareness and to collect e-waste, but this needs to be expanded to a larger scale.

The findings of the Literature Review as well as the Primary research indicate that e-waste is a global and local concern. There have been initiatives in other provinces in South Africa to implement e-waste management but nothing has been introduced in the Free State province or MMM in particular. Therefore a need exists to expedite the introduction of these initiatives in MMM to ensure better control and management of the problem.

The findings have answered the following research questions:

What are the levels of awareness of e-waste management within the MMM?

The findings have led to the conclusion that the awareness of e-waste management in Bloemfontein is very low. All stakeholders need to be made more aware of the consequences of irresponsible e-waste disposal. The residents need to be more aware of e-waste in general and then to become more active in responsible recycling activities. The management authorities of MMM need to enforce regulations that govern e-waste disposal so that illegal dumping can be eradicated.

Would there be more responsibility from residents and businesses with heightened awareness, and if the facilities for disposal of e-waste were more convenient?

The residents and businesses have indicated that they will be willing to drop off e-waste at a recycling centre if the facilities were available. There was also a positive response to e-waste concepts such as refurbishing and recycling, which illustrates the willingness to be more environmentally responsible.

Based on best practices, what recommendations can be made to MMM or interested parties to heighten awareness and responsibility regarding e-waste management?

8. Recommendations

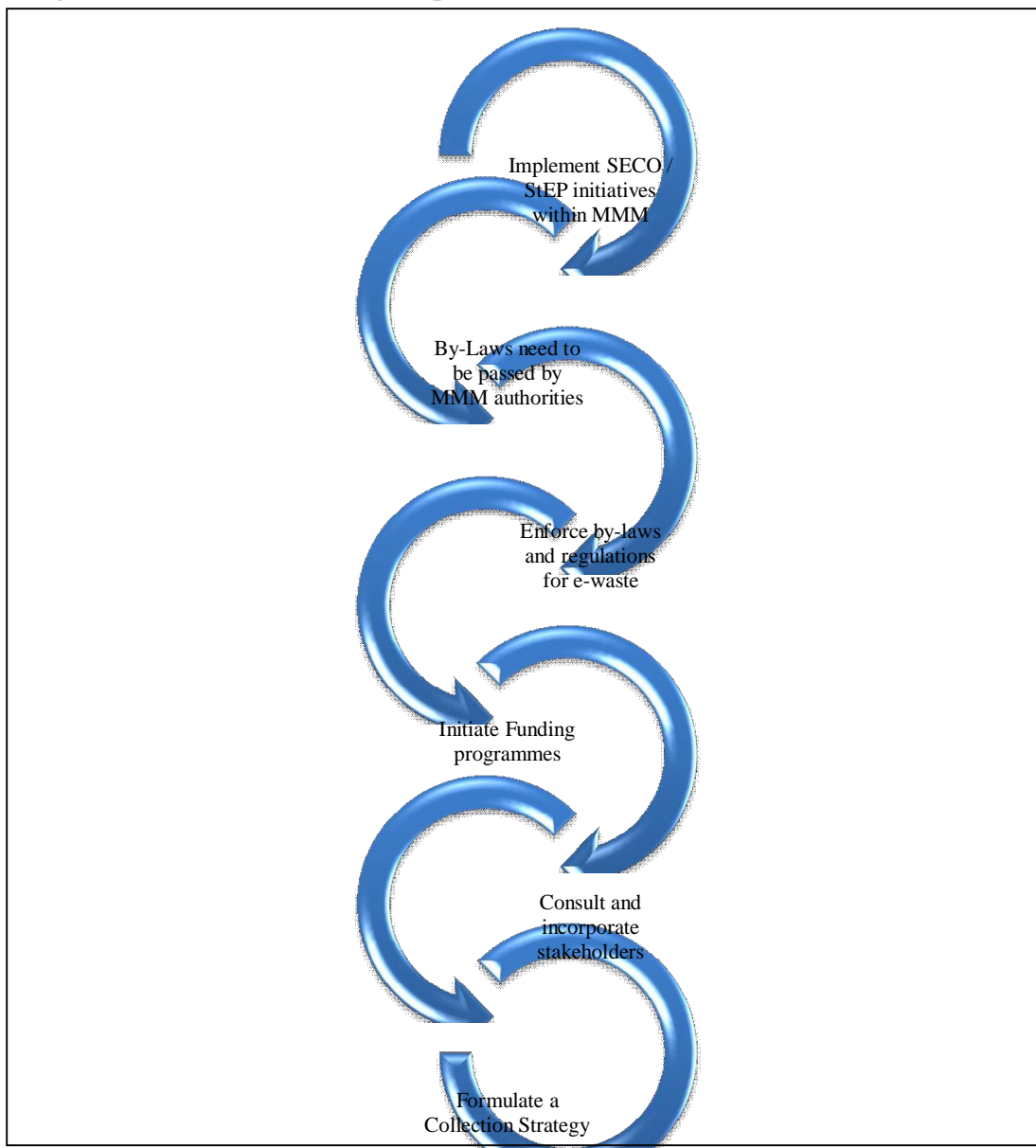
The following recommendations can be made to MMM or interested parties in order that e-waste can be better managed within the metropolitan:

- ☐ The SECO pilot initiatives and StEP guidelines that have been introduced in other South African provinces would need to be implemented in MMM.
- ☐ MMM should pass detailed by-laws that specifically govern the disposal of e-waste.
- ☐ There must be stringent enforcement of those laws to ensure compliance.
- ☐ The take-back system needs to be funded to be successful. This should be incorporated into the Section 21 companies that the detea have already been proactively proposing. This will have to be included in the e-waste collection strategy.
- ☐ For the initiatives to be successful all stakeholders must be consulted and included into the system.
- ☐ More awareness campaigns regarding responsible e-waste disposal are required.

- An e-waste collection strategy should be implemented throughout MMM which incorporates a permanent drop-off facility (similar to Refurb Warehouse), special drop-off events (similar to the FNA event) and door-to- door / curb side pickups which can incorporate the formal and informal collectors.
- Effective awareness campaigns ought to be implemented. Awareness initiatives should also incorporate the concepts of reuse and refurbishment to minimize disposals in the first place.

The plan is outlined in Figure 24 below:

Figure 24. MMM E-waste action plan



Initiate awareness
campaigns

9. Conclusions

In conclusion this study has achieved the aims and objectives that were initially set out. As this study concentrated on the Mangaung Metropolitan Municipality, there is scope for further studies to be conducted in the remaining municipalities in the Free State and other provinces in South Africa where e-waste is possibly not being managed. The study can also be further explored in terms of the exact quantities of the e-waste flow once an e-waste management system is implemented. The initiatives of manufacturers in producing green electronics, as well as the participation of consumers in purchasing environmentally friendly electronics can be a scope of further study. The employment or business opportunities created by e-waste disposal can be studied to quantify socio-economic development within the MMM area.

There is a need for the Mangaung Metropolitan Municipality to respond to the emerging e-waste problem, through developing new regional by-laws, building partnerships with all stakeholders in the current system and incorporate all of this into an integrated e-waste management system for MMM. This can be achieved by implementing the proposed MMM e-waste action plan, for a brighter and more environmentally sustainable future for MMM.

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