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Management of Municipal Electronic Waste (e-waste): A Focus on Environmental Pollution in Gwanda Urban

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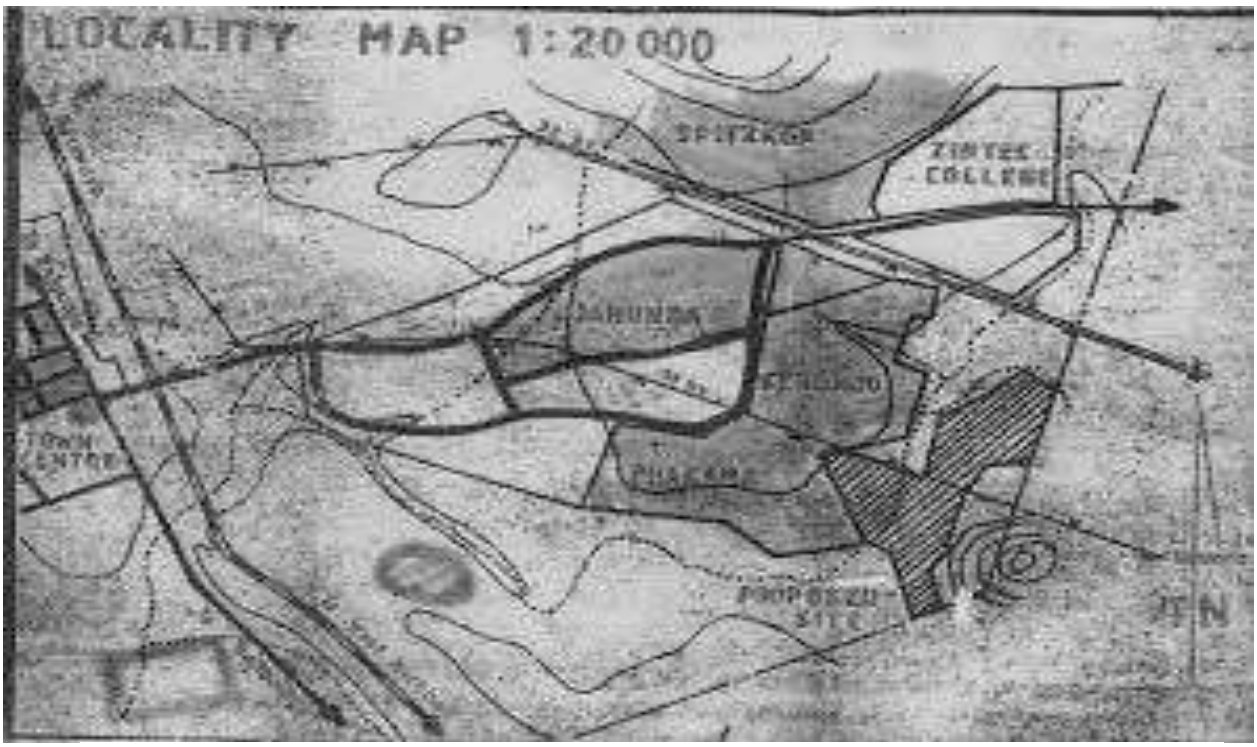
ABSTRACT

The purpose of this study was to establish how the municipality attends to electronic waste in Gwanda town. Electronic waste is a type of waste that is usually not thought of by municipalities in most developing countries. There is little provision for its collection and sustainable disposal and consequently leading to adverse human health and environmental hazards. Generators of electronic waste include users in homes, manufacturing industries, teaching and learning institutions, and various industrial places. Both qualitative and quantitative methods were used in data collection. The researcher spent one month (July) in the year 2017 with the respondents interacting and living among them to enable effective rapport development while collecting data. Observation, unstructured interviews and closed ended questionnaires were used in generating data. Remote sensing techniques (Camera) were also used during the collection data. Purposive sampling technique was used to select some research participants in generating qualitative data and random sampling was used to collect quantitative data. Findings suggest that electronic waste is not well taken care of by the municipality and hence lead to environmental and health hazards in both children and adults. The Municipality Waste Collecting Department was not doing well on the collection and disposal of electronic waste. In the adjacent forests of Gwanda town, residents disposed broken electronic gadgets; thus, littering and polluting the environment. The study recommends that for effective management of e-waste, the Municipality need to educate the residents of Gwanda and involve them in managing e-waste to reduce environmental pollution.

Keywords: Management, Electronic waste, Gwanda, Environmental Pollution

INTRODUCTION

Municipal solid waste is so wide such that if one is to look at it from the broad spectrum it would be difficulty to fully address each of them. Mathe and Phiri (2015), classified municipal solid waste into two categories which were industrial waste and domestic waste but in this study the researcher concentrated on electronic waste and which is waste generated in industry and at residential areas. Still on that it was also made clear that solid waste can also be looked at from the dimension that some of it is biodegradable while some is not. "Biodegradable waste such as the leftover of food, decays and has a positive impact on the ecosystem," (Mathe and Phiri, 2015: 1557). This is because decayed matter improves the soil structure and the nutrient value of the soil. Solid waste is a form waste which is solid. In this study, the solid waste focused on is the electronic waste. Electronic waste means electronic gadgets that have broken down in such a way that they cannot be repaired and the only option would be that of throwing them away the way other waste is discarded. Fig.1: The map of Gwanda showing the site studied study area



Source: Adapted from Department of Physical Planning Matabeleland South Province Gwanda

The map is drawn to scale and shows the area covered by the Municipality of Gwanda. The southern part of the map shows the proposed site just next to Phakama residential area. On the Northern part, is Spitzkop residential area and as one moves north is a bush. The same with the east and western parts and in the periphery of the Municipality area are the bushes which were also within the study site. The town center is on the extreme west across the railway line.

The Nature of electronic waste

The electronic waste can be put into many groups. The first group consists of temperature regulating equipment such as fridges, air corn and ferns. It was observed that the named items are common in most homes, institutions and in industries. Other examples of electronic waste are television screens, computer monitors and computer processors, electric bulbs, radio components, electric pressing irons, and other small equipment such as cell phones, small information technology gadgets and other communication equipment. At times the electrical goods get to a point when they cannot be resuscitated which lead to the disposal of these items. The municipalities seem not talk about e-waste in developing countries, and one wonders if they are not considering the e-waste as a solid waste, and their impact on the environment.

The Composition of Electronic Waste

Electrical gadgets metals, plastic, chemicals such as those found in cumulative cells, glass and another substance that is flexible Polychlorinated Biphenyl (PCB). Some of these substances are not biodegradable and they are chemical in nature. The chemical substances in electrical gadgets can be traced to the elements of the periodic table.

Problem Statement

Gwanda is a town in a developing country and the electronic waste has been a big challenge to the environment and other living things. The municipality seem not to be doing much to reduce individuals and companies from disposing electrical waste in near-by bushes. The rate at which e-waste is disposed in undesignated areas is on the rise and that need an urgent action to stop the act. Electronic waste has rare metals from the periodic table and these are

dangerous to plant and animal life. The situation needed to be controlled hence the need of exploring the management of e-waste.

Research Objectives

The objectives of the study are to:

1. Establish the perceptions of residents regarding management of electronic waste.
2. Investigate what motivates residents to dispose electronic waste in the bushes.
3. Establish the impact of electronic waste on the environment.
4. Explore the extent on which the environment is littered with e-waste

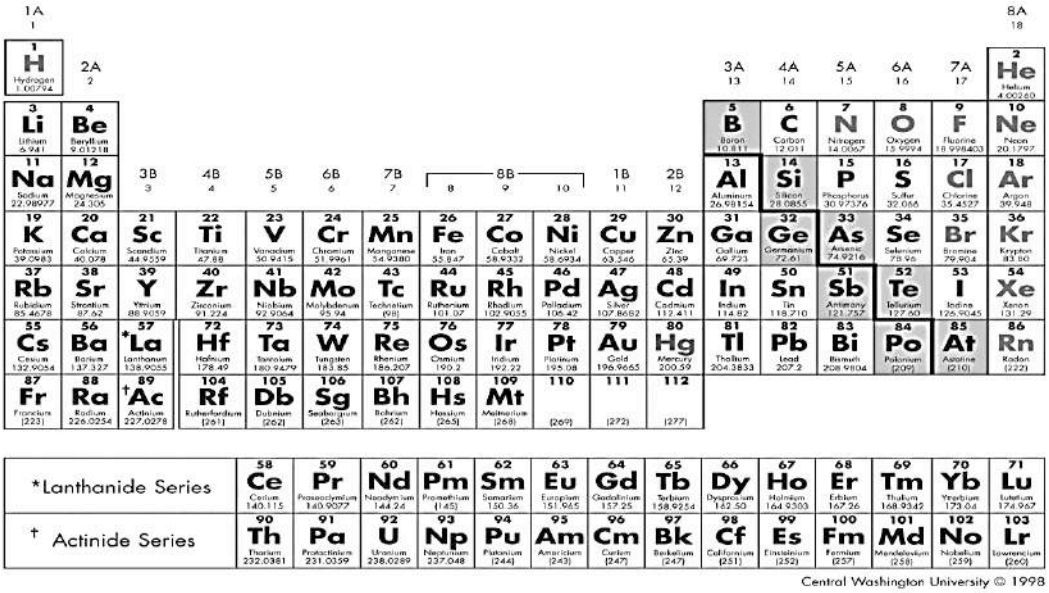
Research Questions

The research questions that guided the study are:

1. What are the perceptions of residents regarding management of electronic waste?
2. Why are the residents using nearby bushes for disposing electronic waste?
3. What is the impact of electronic waste on the environment?
4. To what extent is the environment littered with e-waste?

REVIEW OF RELATED LITERATURE

Electronic waste consists of some chemical substances found in the periodic table of elements. Literature helped in locating these chemical substances on the periodic table (Fig 2) below.



The periodic table of elements:
Fig.2 Periodic table of elements
Source: (Central Washington University, 1998)

Electronic waste consists of household, office and industrial dysfunctional electrical goods such as computers, television and many others which are discussed in subsequent sections of the study. In making and assembling electrical gadgets, there are chemical substances used and are the rare earth metals such as, Lanthanum (La); Cerrum (Ce) and Praseodymium (Pr). Some precious metals such as Lead (Pd); Silver (Ag) and Gold (Au), are used. It was also found that other metals such as iron (Fe); Copper (Cu) & Aluminum (Al) are also used in the making components of electronic devices, (Earl and Wilford, 2004). Hazardous materials such as heavy metals are also used and examples are Chromium (Cr); As; Mercury (Hg) & Pb in the

manufacturing of the electrical goods that are found in every home worldwide, (Bark and Knapp, 1978). In the light of this it, becomes evident that what we call electrical waste is more than just being electronic waste but a wide range of chemical substances that are found in the periodic table. E-waste is transformed into chemical waste because the different substances react with water and moisture and pollutes the environment. In this study, the researcher looked at impact of the e-waste pollution on the environment. Chemical substances used in electrical gadgets are traced to the periodic table of elements in Fig.1: From the transition elements, Chromium (Cr); Iron (Fe); Copper (Cu); Palladium/Lead(Pd); Silver (Ag); Cadimium (Cd); Gold (Au); and Mercury (Hg) are used as components in electrical gadgets,(Earl and Wilford, 2004). These substances are used because they allow electrical energy to pass through them.

Most of the lead found in the atmosphere is from the emissions from vehicles, paint chips, paint chips, from ammunition products, inorganic fertilizers, pesticides and batteries of varying sizes and from other products from industry. The transportation and distribution of lead from the point sources of pollution, are both fixed and mobile, the air is the medium, (UNEP, 1991). This was supported by (UNEP, 1991) who reported that about 20% is mostly dispersed which can be interpreted as having about 80% close to the source. Studies have shown that measuring so to quantify lead in Greenland oscillated with the demand of leaded petrol usage in the developed world other parts of the globe over the past decade, (UNEP, 1991). Isotopes provided evidence for the source of lead in Greenland snow since the late 1960s; (Rosman; Chisholm; Boutron; Candelone and Gorlach, 1993). The particle sizes of the chemical substance varied with distance from the source. The particles found near the source were much bigger compared to those found further away.

Cerium (Ce) can be hammered into thin sheet; it is soft and can be drawn into thin wire. Its other property is that it is grey iron metal, and is a bit harder compared to lead. Cerium is highly reactive in air, it tarnishes readily when exposed to air. When in cold water it oxidizes slowly but when exposed to hot water it oxidizes fast. It dissolves in acids and can burn when exposed to heat or scratched with a blade. Cerium (Ce) is a rare chemicals substance which is used in the production stage of colour televisions, fluorescent lamps, energy-saving lamps and glasses, (Bark and Knapp, 1978). This substance is dangerous in that the gas it produces can cause lung embolisms, if one is exposed to it for a long time. It can also affect other body organs such as the liver. At domestic level Cerium find its way into the environment when electrical gadgets are thrown away into the environment and should be noted that it would get contact with water and soil which are livelihood resources. When it is in water and soil its concentration build up in all living beings. Aquatic organisms' cell membranes get damaged which lead to a drop-in reproduction hence reduction in population.

Praseodymium is a soft and can be hammered to a thin sheet and its colour is silver yellowish. It is in the lanthanide group which is also in the periodic table of elements, (Central Washington University, 1998). It reacts slowly with oxygen but when exposed to the air it reacts to form oxides which is green in colour and the formed oxide which does not form a protective layer that can protect it from oxidation. It is resistant to corrosion in the air just like the other rare metals, but it still needs to be stored under oil or coated with plastic to protect from oxidation, (Balde; Wang; Kuehlr and Huisman, 2015). When stored under oil or coated with grease it gets protected from being in contact with water that would make it react rapidly.

Praseodymium is one of the rare chemical substances that are also found in household equipment such as colour televisions, fluorescent tubes, energy-saving lamps and specialized glasses. Some of it properties are like those of cerium and this is because in the periodic table

they are found within the lanthanide series hence they have a lot in common, (Bark and Knapp, 1978). The use of praseodymium in the twentieth century is still growing, because it is suitable in producing catalyzers and polishes glass.

Its toxicity is quite low when compared the other substances in the Lanthanide Series, very soluble in water and is a mildly toxic when swallowed, and its insoluble salts are not toxic. They irritate the skin and eyes of living beings. At the work environment, it produces damps and gasses that are inhaled when animals breathe in, (Balde; Wang; Kuehlr and Huisman, 2015). When this substance is inhaled it can cause lung embolisms, especially if the animal is exposed to it for a long time. It disrupts the nervous system and the cell membrane of marine organisms. Worldwide findings of Electronic waste generation according to (Balde; Wang; Kuehlr and Huisman, 2015), in 2010, a 33.8 megaton of electronic waste was generated; in 2014; 41.8 megaton of electronic waste was generated. Electronic waste was 2% of global MSW and findings showed that there was an increase of 25% of electronic waste in the world.

METHODOLOGY AND METHOD THAT GUIDED THE STUDY

The study used a Mixed Design. Ethnography method of generating data was used. This was appropriate because the researcher spent some time with the respondents in the field, interacting, staying with them while collecting data. The researcher sought for permission so that the ethical and legal considerations were respected and adhered to. The techniques used that fell under ethnography were observation, open and closed interviews in generating data.

Remote sensing was also used in collecting data and this was good because it provided evidence of what was observed. Purposive sampling was used because it enabled the identification of key informants who could give credible data because of their area of specialization and experience and random sampling was used for collecting quantitative data. The idea was to generate data from members of the community who would have certain characteristics in the knowledge domain. Such individuals were residents, environmental scientists, and waste collectors. Closed ended questionnaires were used in collecting quantitative data.

Qualitative Data Analysis

This section of the study discusses the findings from different respondents and is guided by the research questions.

Table. 1: The population of the study as per qualification was tabulated below:

	Frequency	Percent	Valid Percent	Cumulative Percent
JC	2	2.8	2.8	2.8
Form 5	6	8.3	8.3	11.1
Certificate	21	29.2	29.2	40.3
Diploma	28	38.9	38.9	79.2
Degree	11	15.3	15.3	94.4
Master's Degree	2	2.8	2.8	97.2
Other Qualification	2	2.8	2.8	100.0
Total	72	100.0	100.0	

Source: Researcher

The respondents were drawn from a wide range of educational background. This was done because pollution is not selective so it affects all. The assumption was that generating of data from a wide spectrum may lead to data that is representative. The data was collected from

residents, environmental science students, waste collectors and Environmental Health Technician students (EHT). It was analyzed qualitatively and quantitatively. Both qualitative and quantitative data was collected for analysis.

Data generated and guided by Research question 1.

Respondent A: said, 'the municipality has a mandate of collecting solid waste from both domestic and commercial stands which they are not doing effectively.

The issue raised by the respondent is in congruence with what was documented in the UNICEF report on the Assessment of Gwanda water Supply and Sewage Systems which was conducted in 2010, where the responsibilities of the Municipality was highlighted. Several other respondents were of the perception that electronic waste is a type of waste that was not thought much by the municipality as the town council has nothing in place for the collection of large electronic waste such as televisions and even fridges.

The other respondent said: 'we do not have other options besides taking large electrical waste to any undesignated dumping site at night.'

The researcher asked: "why is the dumping of such waste done at night?"

Respondent: Some of us we understand that the environment need to be protected and environmental agencies are on the lookout for the polluters. The act of littering is bad such that we would not want to be associated with polluting the environment.

It becomes evident that the residents of Spitzkop are aware of the repercussions of polluting the surroundings but circumstances may have forced them to act otherwise. They may need assistance on issues regarding electronic waste handling and disposing the waste.

During a focus group discussion, it came out that the municipality has a mandate they fail to accomplish but it also surfaced that management of electronic waste should be a responsibility of the municipality and all stakeholders such as the residents and industry. Leaving the responsibility to the municipality may not reflect responsibility to the residents and the business community.

Respondent B: "I do not know what you are talking about when you say electronic waste, may you explain that."

This shows that some respondents had no idea of electronic waste even though these are the type of waste they see in the suburb time and again. The researcher clarified electronic waste and even gave examples then the respondent got clear on the concept. The perceptions of the respondents were mixed up as others pointed to the municipality while others indicated that there was also part of the equation in the quest for a sustainable solution regarding managing the collection and disposal of electronic waste.

A respondent who has relatives at Hlalanikahle township said, 'it is unfortunate that the municipality has failed in managing electronic waste because in some township there is no infrastructure put in place for managing solid waste. How can the municipality claim to be well prepared in managing waste while some people in Hlalanikahle Township are less than 500 meters from the land fill yet in the UNICEF (2010) report talks of 1500 meters, which was measured from the municipality offices not from the residential areas. Management of

electronic waste need a proper planning that is guided by ethical standards so that information disseminated does not misrepresent reality on the ground

Data generated and guided by Research question 2

EHT students: pointed that, pre-positioning of many 200-liter oil drums for waste disposal at the CBD of Gwanda is fine but we suggest that it is not enough because at the residential area such initiatives are not in places in public gathering places such as the tax pickup points.

Source: Mathe

Plate 1: A 200-liter drum used as temporary rubbish dumping point in Gwanda Urban.

An environmental science student said, 'The town council has failed to enforce that every residential area should have a bin and probably the municipality can place large containers at particular points at the township so that residents can dispose their electronic waste.

Another Environmental science student: pointed that what motivates people in disposing their electronic waste in the bush is lack of proper infrastructure for use by residents.

A resident also, indicated that the municipality has done nothing to resolve littering in the nearby bushes because they failed to put in place facilities that can be used by anyone one who need to.

Another resident said: the bush around Spitzkop is littered not only with e-waste but with any solid waste that cannot fit in a standard bin. Lack of proper facilities has made residents to litter the environment with e-waste and other type of waste.

From the various responses it shows that e-waste is not thought of in Gwanda urban. There are no logistics put in place to handle such type of waste. Some of the respondents seemed to have an idea of this type of waste such that if in the management of e-waste, residents are involved the situation could change as the suggestions from the grassroots people could inform the municipal authorities and change their approach towards handling of solid waste particularly e-waste.

Data generated and guided by Research question 3

In the environment, there are different type of substances, those that are biodegradable and those that are not. Substances that are not biodegradable tend to build up in the environment and lead behaves like those that are not biodegradable because it accumulates in the soil, especial the soil which is reach in organic material, (US EPA 1986). Lead is not lost through leaching so when deposited in the soil it can percolate into the top layer of the soil. While at the upper layers of the soil, it remains there over a long period of several years for example about 2000 years or so. The organic matter on the environment that has not been disturbed retains the lead from the atmosphere. In soils that have been cultivated the lead gets mixed with the soil to a root zone depth. Environmental science students said: 'It was noted that the lead in the soil find its way into plants and soil organism and this enables it to filter into the food chain, while in the food chain it accumulates fast to lethal level in higher order consumers.' With the nature of the chemical nature of lead in the soil, it displaces other chemical substances, (US EPA 1986). Another Environmental Science Student said, 'It hinders the chemical breakdown of inorganic components of the soil and plants may absorb it when it is in a soluble state.

Plants take in lead from the soil and keep most of it within their roots. There is evidence that plant foliage also takes up lead from the soil and this is the same substance taken in by plants. EHT student said, 'Once it is within the plant it gets passed on to the plant eaters through the food chain. When the substance accumulates in the soil and some plant species have been found to have a capacity of accumulating high concentration of lead substance, (UNEP, WHO AND ILO, 1991). The stomata on the lower part of plant leaves are a sight for gaseous exchange as they allow carbon dioxide which is a raw material essential for photosynthesis to take place and they allow oxygen to be emitted. Environmental science students said: 'Lead pollutant usually forms a layer on the leaves and reduces the amount and intensity of light in reaching it. This situation makes plants not to grow well leading to stunted growth of plants.' The stunted plant might succumb to death because the layer of lead formed on the leaves reduce photosynthesis, respiration and promote the cells of the plant to become long and makes plants age fast. "All these effects have been observed in isolated cells or in hydroponically grown plants in solutions of around 1-2 ppm of lead in soil moisture for example the lead levels experienced by ecosystems near smelters or roadsides," (Rosman; Chisholm; Bouton; Candelone and Gorlach, 1993:333).

Evidence exist to show that lead high concentrations are occasionally found near roadsides (i.e., 10,000 - 40,000 ppm dry weight)," (UNEP, WHO and ILO, 1991) and this magnitude of lead is lethal to a large population of microorganisms such as bacteria and fungi on the leaf and in the soil. Once the micro-organisms are poisoned they die and at times they fail to do their function such as decomposing organic material. A respondent said, '…this can have a significant impact, given that many of these micro-organisms are an essential part of the decomposing food chain.' The micro-organisms that may have died because of lead poisoning can be replaced buy a new strain of bacteria of same species but the strain of bacteria may not be as efficient as the one that existed before it. The decomposition of organic material may be reduced. The other responded quoted (UNEP, 1991) that, "Evidence also suggests that micro-

organisms can make lead more soluble and hence more easily absorbed by plants. That is, bacteria exude organic acids that lower the pH in the immediate vicinity of the plant root."

An EHT student, held that, in animals,' lead substance disrupts the normal functioning of the central nervous system (CNS) and reduces their ability in synthesizing red blood cells.' By the reduction on the synthesis of red blood cells that lead to a negative effect on the functions of the red blood cells such as the transportation of oxygen to the rest of the body as well as that of carbon dioxide from the cells to the lungs for expulsion from the body. The two residents with medical background were emphatic when they were deliberating on the effects of lead. They went on to say, '… if the concentrations of lead in the blood is above 40 µg/dl it triggers overt signs and symptoms in animals.' The argument was supported by a study which was conducted by US EPA, in 1986. A responded reported that, '…calcium and phosphorus in the diet of animals can reduce the absorption of lead through the walls of the intestines.' The US EPA, (1986) report postulated that a diet of 2-8 mg of lead per kilogram of body mass in a day, over period, may increase the mortality rate in many different animals.

A respondent from the agricultural field said, '…grazers are directly affected during the consumption of forage and feed contaminated by airborne lead and somewhat indirectly by the up-take of lead through plant roots. Invertebrates may also accumulate lead to toxic levels to their predators.' It was reported that lead shot and lead increase in concentration may severely affect individual organisms and threaten their survival in the environment, (WHO, 1989). The perceptions of the respondent were supported by some studies, (Hill, &Holman, 1987 and Balde, Wang, Kuehlr & Huisman, 2015), which reported that after a few days of waterfowl taking in of lead shot, the substance reaches the blood system and at that point it is transported and reaches major life supporting organs, such as the heart, the liver and the kidneys. In another study that was conducted in 1993 by OECD it was reported that by the 17th to 21st day after taking in lead, the bird fell into coma and later died. Following the ingestion of lead shot, lead toxins was observed in Magpie geese, swans, and other species of duck, (Hill and Holman, 1987, and Balde; Wang, Kuehlr & Huisman, 2015). This concretizes the negative effect of lead on birds. A respondent said, 'Praseodymium can be a threat to the liver when it accumulates in the human body.' Praseodymium enters the environment when electrical items are dumped away and this makes the substance to accumulate in the soil and bodies of water.

The lead which is organic is more readily ingested by different species of birds and fish (WHO, 1989). Water dwelling organisms take up the inorganic lead through a transfer of lead from water and sediments but the process is substantially slow. The organic lead is taken in by water dwelling living beings fast through water and sediments. The aquatic organisms get affected by lead at water concentrations much lower when compared the quantities deemed safer for other wild beings. The concentration occurs more often and the effects of lead from the atmosphere places that have levels of aquatic lead may not easily be noticed (US EPA, 1986).

Copper finds its way into the soil and at that point it attaches itself to organic matter and other minerals because of this it does not spread fast when released into the environment which makes it hardly find its way into groundwater. On surface waters copper travels large distances, suspended on sludge at times as free copper ions. A responded reported said, 'copper is not biodegradable and because of that it can accumulate in plant and animal when it is transferred from the soil.' The soils that are rich in copper are inhabited by very few plants that can tolerate the toxic environment. An environmentalist pointed that, 'most plants and soil organisms cannot survive in toxic soils and because copper is toxic to plants and other living

beings.' The toxic of copper products become a threat to crop land and pasture as plant diversity is reduced, depending on the pH of the soil and the abundance of organic material. Even though copper is toxic manure which contains copper is used but will work well when soil pH is low and when there is a lot of organic matter.

Most of the respondents concurred in that, copper substance interrupts the activities of soil microorganisms and earthworms. The soil microorganisms and earthworms decompose organic matter and improve the soil texture and these processes get hampered. When the soil is copper polluted animals and plants take in concentrations that damage their health. Lanthanum is a rare chemical substance that is found in most houses hold electrical gadgets and examples are colour televisions, computers monitors, fluorescent tubes, the current energy-saving lamps and other glasses. All rare elements seem to have similar properties. LA2O2 is used in making specialized optical lenses such as the infrared adsorbing glass, camera lenses and telescope lenses

A respondent from a chemical plant pointed that Lanthanum is used as the core material in carbon arc electrodes. Lanthanum salts are found in zeolite a catalyst which is used in the refining of crude oil products because it stabilizes the zeolite when it is at high temperatures. A respondent from the medical perspective, said, 'Lanthanum is a dangerous substance because damps and gasses associated with it when inhaled may cause lung embolisms, particularly if exposed to the substance for a long time. It is also known that it can cause cancer to human beings and increases the chances of lung cancer when breathed in.' Studies have also indicated that when Lanthanum accumulates in the body it affects the normal functioning of the lever. Lanthanum is found in electronic waste and is dumped when the irreparable electrical items are thrown away in the neighborhood. Household equipment such as old colour televisions has traces of this substance so when they are dumped this substance finds its way into the soil and water. The other respondent said, '…the concentration of lanthanum builds up in the soil, water and eventually enters the food chain.' Aquatic organisms get exposed to Lanthanum in water and may experience damage to their cell membranes and the substance eventually disrupts their reproductive processes.

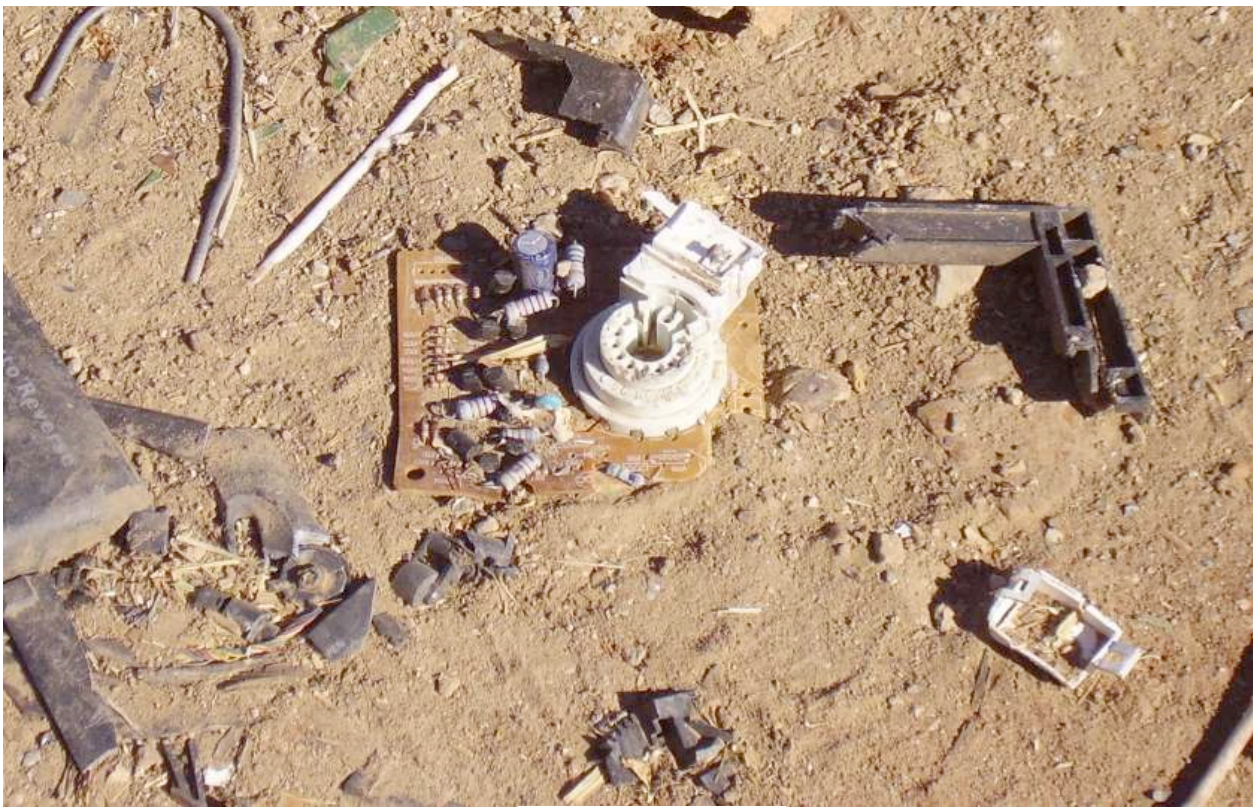
Data generated and guided by Research question 4

Observation method was used complimented by a remote sensing tool in capturing observation in the bushes around Spitzkop residential area. It was observed that the area was littered with electronic waste in the form of broken televisions as well as other forms of solid waste.

Source: Mathe 2017

Plate 2: The physical pollution of the environment by none biodegradable remains of television set. The items were found dumped in a bush a few meters from Spitzkop residential area.

With the advent change in technology some electronic gadgets cannot be repaired as the service parts have changed and no longer available in the market. Examples are VCR machines, and VCR films the turntables have been replaced by (Compact Disc) CD-players and overhead projectors have been replaced by multi-media projectors. A lot of changes have taken place in the electronic industry. There are no longer common and spare parts for such gadgets are no longer available in the market.



Source: Mathe 2017

Plate 3: Shows the internal electronic components such as diodes and circuit board. These are some of the components that have chemical and none chemical substances.

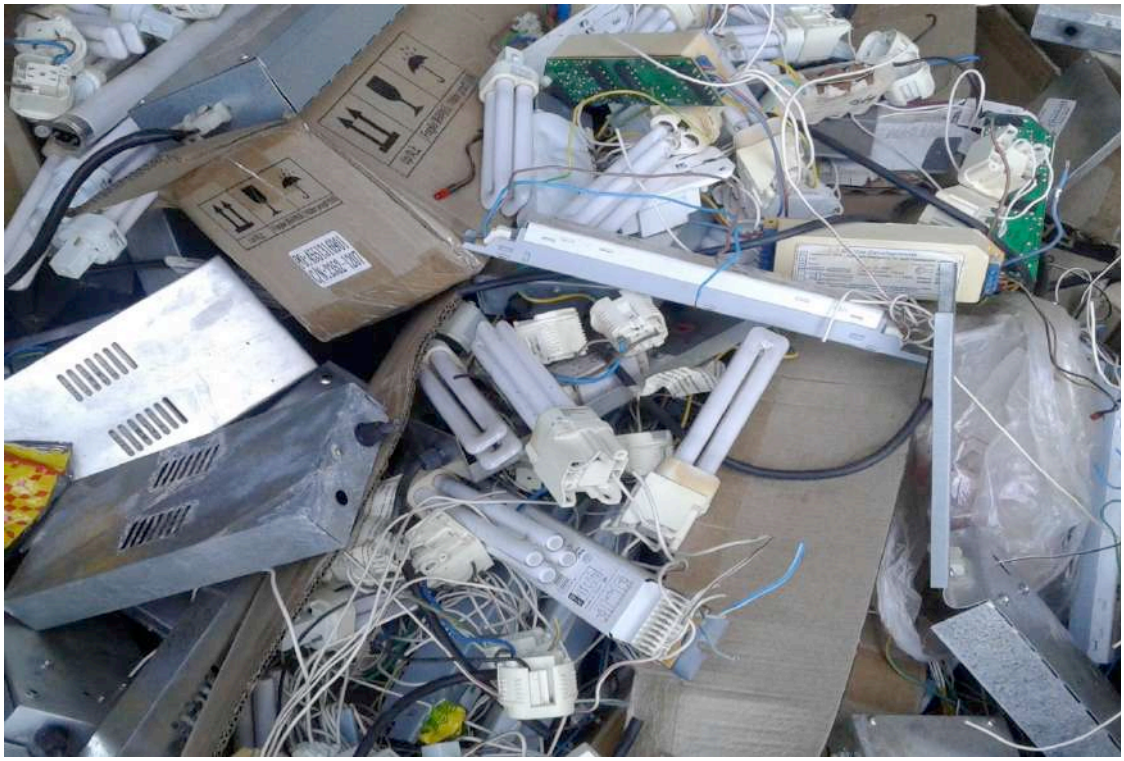


Plate 4(a)

Plate 4(b)

Source: Mathe 2019

Plate 4: Shows the internal electronic components such as florescent tubes and other electrical components. These are some of the components that have chemical and none chemical impact on the environment.

Disposal of e-waste in a mixed residual waste system such as in bins is common throughout the world. The bin becomes the first point of waste disposal. In this case small items such as bulbs, broken cell phones are usually thrown into dust bins. The amount of e-waste disposed in this manner cannot be quantified because there are no records kept. They are items that cannot fit in the normal dust bin and such electronic waste is tempting to the residents to come up with an illegal way of disposing it, hence the bush becomes the nearest option.

The collection of electronic waste outside take-back system is not accounted for because when it happens it is not recorded or reported. The waste collected might not be treated well as environmental issues are ignored or because of not knowing the possible danger to the environment. It was found that waste is not properly treated as some of the processes used harm the environment. In Gwanda, e-waste is also collected by individuals or companies and taken through various channels but such e-waste cannot be quantified as there are not recorded because people move to a near-by bush and dispose it. Their impact is that they pollute the land, and poison plants. Backyard recycling of substances contributes to huge scale pollution of the environment, (soil, air and water bodies).

Quantitative Data Analysis

Table. 1: Gender

		Strongly Agree	Agree	Not Sure	Strongly Disagree	Disagree	Total
e-waste challenges in GDA	Male	15.4	53.8	30.8	-	-	100
	Female	28.8	54.2	16.9	-	-	100
Separating waste	Male	23.1	15.4	0.0	15.4	46.2	100
	Female	35.6	0.5	3.5	45.8	6.8	100
Collection & disposal of e-waste	Male	0	0	-	15.4	84.6	100
	Female	15.3	18.6	-	54.2	11.9	100
Educating residents on e-waste	Male	23.1	14.4	15.4	46.2	0	100
	Female	42.4	18.6	3.4	32.2	3.4	100

Table 1: According to the survey, more females (54.2%) agreed that there was a challenge in managing e-waste in Gwanda urban. It therefore indicates that more females observed the challenges and these were drawn from various sectors of the economy. On the issue of separating e-waste from other type of solid waste, it was observed that most male respondents (46.2%) raised that the municipality was not involved in separating e-waste from other waste. One other issue from the analysis was that the male respondents (84.6%) pointed that the municipality was not taking part in the collection and disposal of e-waste. This could have been a major contributing factor for residents to dispose e-waste behind bushes. The table further highlights that the municipality (46.2%) does not provide education to the local community on the management of e-waste.

Table: 2 Age group and e-waste management in Gwanda

Table. 2	Age-group	Strongly Agree	Agree	Not Sure	Strongly Disagree	Disagree	Total
e-waste in GDA	18-25	100	0.0	0.0	0.0	0.0	100
	26-33	14.3	68.6	17.1	0.0	0.0	100
	34-41	10.5	68.4	21.1	0.0	0.0	100
	42+	53.8	15.4	30.8	0.0	0.0	100
Separate e-waste	18-25	0.0	100	0.0	0.0	0.0	100
	26-33	48.6	14.3	5.7	0.0	31.4	100
	34-41	0.0	0.0	0.0	57.9	42.1	100
	42+	53.8	0.0	0.0	30.8	15.4	100
Provide Collection & Disposal	18-25	0	0	0	0	100	100
	26-33	17.1	20.0	0.0	45.7	17.1	100
	34-41	0.0	0.0	0.0	57.9	42.1	100
	42+	23.1	30.8	0.0	30.8	15.4	100
Educating on e-waste	18-25	0.0	100	0.0	0.0	0.0	100
	26-33	54.3	20.0	5.7	20.0	0.0	100
	34-41	0.0	0.0	0.0	0.0	100	100
	42+	69.2	15.4	0.0	0.0	15.4	100
Integrated e-waste management	18-25	100	0.0	0.0	0.0	0.0	100
	26-33	71.4	20.0	0.0	8.6	0.0	100
	34-41	0.0	0.0	0.0	100.0	0.0	100
	42	69.2	30.8	0.0	0.0	0.0	100

There was a variation regarding age and challenges on waste management. The age-group 18-25 (100%) strongly expressed that there were challenges of e-waste management in Gwanda town. On the separating of e-waste those aged 34-41 strongly suggested that there was not separation of e-waste from other waste. One can even make a claim that the municipality is not having a facility that enables the separation of e-waste from on their type of waste. On the provision and collection of e-waste, those aged 18-25, (100%) pointed that there was no collection and disposal of e-waste. This concretized by the age group 34-41 (100%) who suggested that the municipality was not providing environmental education to the residents. Provision of Environmental Education to the community may reduce the burden of handling e-waste in the town. The same age group 100% (34-41) observed that there was no integrated e-waste management in Gwanda town. The integrated e-waste management system is ideal as it allows the involvement of e-waste generators in managing the e-waste. It implies a bottom up approaches.

Table 3: Qualification and Management of e-waste in Gwanda town

Table. 3	Qualification	Strongly Agree	Agree	Not Sure	Strongly Disagree	Disagree	Total
e-waste in GDA	Ordinary Level	0.0	66.7	33.3	0.0	0.0	100
	Diploma	42.9	35.7	21.4	0.0	0.0	100
	Bachelor's Degree	18.2	45.5	36.4	0.0	0.0	100
	Master's Degree	45.5	54.5	0.0	0.0	0.0	100
Separate e-waste	Ordinary Level	0.0	0.0	0.0	33.3	66.7	100
	Diploma	53.6	0.0	0.0	39.3	7.1	100
	Bachelor's Degree	23.3	0.0	0.0	54.5	18.2	100
	Master's Degree	0.0	0.0	0.0	100	0.0	100
Provide Collection & Disposal	Ordinary Level	0.0	0.0	0.0	33.3	66.7	100
	Diploma	21.4	14.3	0.0	39.3	7.1	100
	Bachelor's Degree	45.5	54.5	0.0	0.0	0.0	100
	Master's Degree	0.0	0.0	0.0	100	0.0	100
Educating on e-waste	Ordinary Level	0.0	100	0.0	0.0	0.0	100
	Diploma	20.0	20.0	5.7	54.3	0.0	100
	Bachelor's Degree	0.0	0.0	0.0	0.0	100	100
	Master's Degree	69.2	15.4	0.0	0.0	15.4	100
Integrated e-waste management	Ordinary Level	0.0	0.0	0.0	56.2	43.8	100
	Diploma	0.0	20.0	0.0	8.6	71.4	100
	Bachelor's Degree	0.0	0.0	0.0	100.0	0.0	100
	Master's Degree	0.0	0.0	0.0	69.2	30.8	100

**** X2 is the Pearson Chi-square value

** Significant at < 0.05

According to the survey, most respondents had ordinary Level holders (66.7%) showed that there were challenges on e-waste management in Gwanda. It was also observed that 66.75% pointed that there was no separation of e-waste and at the same time there was no collection and disposal of e-waste by the municipality of Gwanda. While those with Master degree were 100% who disagreed that e-waste is collected in the municipality area. For the Education on e-waste, it was observed that those Bachelor's degree did not agree with the supposition as they held that there was no environmental education offered by the municipality. These are likely to

have influenced the sporadic disposal of e-waste in and around Gwanda town. Data was drawn from different academic participants and that enabled the collection of none biased data.

Table 4: Pearson Chi-square value

	e-waste is a challenge in Gwanda town	Separating waste	Collection of e-waste for disposal	Educating the community on e-waste	Integrated e-waste management
Gender	X2 =33.765 df= 12 Sign.0.001	X2 =15.796 df= 4 Sign.0.003	X2 =30.365 df= 3 Sign.0.000	X2 =8.667 df= 4 Sign.0.070	X2 =16.413 df= 3 Sign.0.001
Age Group	X2 =28.05 df= 8 Sign.0.000	X2 =57.478 df= 16 Sign.0.000	X2 =40.671 df= 12 Sign.0.000	X2 =48.116 df= 16 Sign.0.000	X2 =40.672 df= 12 Sign.0.000
Qualification	X2 =28.057 df= 8 Sign.0.000	X2 =57.478 df= 16 Sign.0.000	X2 =23.740 df= 12 Sign.0.022	X2 =48.116 df= 16 Sign.0.000	X2 =51.708 df= 18 Sign.0.000

The value of test statistic is 33.765. The p-value is 0.001 is less than the chosen significant level of 0.05. it means that there is enough evidence which suggest that there is an association between gender and e-waste challenges in Gwanda.

The statistic value is 15.796, df= 4 and the significant level is 0.003. The p-value is 0.003 which is well below the significant level of 0.005. As a result of the significant level being lower than 0.05 indicates that there is an association between gender and the separation of e-waste. Most findings linking gender and separation of e-waste shows that based on gender. Respondents should advocated for the separation of e-waste before disposal.

The statistical value is 30.365 df =3 and the significant level is 0.000 which is lower than the significant level of 0.05. This means there is an association between gender and the collection and disposal of e-waste.

The value of statistic test is 8.667, df=4 and the significant value of 0.070. This shows that the p value is greater than the chosen significant level of 0.005. Therefore it was concluded that there is not enough evidence to suggest that there was an association between gender and the Municipality educating the community on e-waste management.

The value of the test statistic is 16.413, the df= 3 and p value is 0.001. The expected count is less than 5 which suggest that some of the cells had an expected count less than 5 so some of the assumptions were not met. The p value is less than the significant level of 0.05, the hypothesis was accepted. It was therefore concluded that there was enough evidence to suggest an association between gender and integrated e-waste management. The integrated e-waste management called for all stakeholders to be involved in the management of e-waste, however the bottom up approach would be ideal for the situation.

CONTRIBUTIONS OF THE STUDY

The study is of beneficial to the policy makers regarding the policies drafted on the management of electronic waste. It encourages the town authorities to mobilize in the management of electronic waste. Management of electronic waste cannot be a responsibility of the Municipality alone but residents need to be involved as they are also the generators of the

waste. The study aims at bridging the gap so that the management of electronic waste is bottom up and all stakeholders participate in proper disposal of electronic waste. The environmental implication brings on board the public health department and the public as certain health standards are easily realized if all stakeholders are aware of the implications of their actions. The aim of the study is to make stakeholders aware of the environmental implications of electronic waste.

RECOMMENDATIONS

SDG s are a great idea because there is a belief that global goal is a guide to enable the world, countries to get somewhere they want to go. Municipalities are also guided by the same SDGs as their mandate is that of realizing them. SDGs can bring huge change and help in pointing a direction and the municipalities should strive to realize them because by realizing them sustainable development would take place.

SDGs are important for economic growth, social growth and environmental sustainable activities on urban environment management become important but that cannot be achieved if municipalities do not take them seriously. The three elements are integrated as they cannot be looked at in isolation with the other. Municipalities do not want to end up over a cliff in terms of climate change, loss of biodiversity and environmental disasters. Some initiatives of realizing the MDGs can be put in place even if municipalities are financial hard hit, for example, environmental education, and waste management education can be initiated at ward level by councilors, and that would create a difference from the current situation. Environmental crises are on the rise, for example, e-waste pollution and other forms of pollution in urban areas

Municipalities need a sound understanding of electronic waste which would enable them to handle such type of waste. Good policies need to be developed so that proper infrastructure for handling of such waste is put in place. The collection and treatment of e-waste need also to be put in place so that members of the community know where to dispose electronic waste. Above all other initiatives that can be put in place by Municipalities, educational campaigns on how best electronic waste should be disposed can be conducted in the town. This can be done by councilors at ward level and even the collection of such waste to a single collection point. That would lead to a sustainable, and a collective management of solid waste.

CONCLUSION

The removal and disposal of electronic waste depended on the legislature in different countries, however many developing countries lack in that legislature at times they have fine policies in place but nothing works as politics overrides the policies. Example: Zimbabwe has fine environmental protection policies, and public health policies but the implementation is not effective. Some say is a result of the economic meltdown and lack of legislature to enforce and legalize the policies. The infrastructure for holding the e-waste, treatment stands, which lead to improper handling of e-waste. E-waste legislation, the Basel Convention (1992) Depending on the composition of e-waste- it can be categorized as hazardous waste.

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