

**Analysis of Electronic Waste Management Practices in the Mining
Industry of Zambia (Case Study of First Quantum Minerals
Limited and Dangote Cement Zambia Limited)**

By

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**A dissertation submitted to the University of Zambia
in partial fulfilment of the requirements for the award of the degree of Master
of Science in Sustainable Mineral Resource Development**

**UNIVERSITY OF ZAMBIA
LUSAKA, ZAMBIA**

2022

DECLARATION

I, **Namatama Kamutumwa**, declare that to the best of my knowledge this dissertation contains no material previously published by any other person except where due acknowledgement has been made. This dissertation contains no material that has been accepted for the award of any other degree or diploma in any other University.

Signed: Date.....

APPROVAL

The University of Zambia, School of Mines approves this Dissertation by NAMATAMA KAMUTUMWA titled “Analysis of Electronic Waste Management Practices in the Mining Industry of Zambia” in partial fulfilment of the requirements of a Masters of Science degree in Sustainable Mineral Resource Development.

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ABSTRACT

The mining industry in Zambia is one of the sectors that contributes greatly to the country's economy by contributing greatly to the Gross Domestic Product and according to the latest EITI report, the extractive sector accounts directly for 9.9% of GDP and 78.4% of exports in Zambia. With this at play, there has been a demand to high productivity and this has led to the use of electric equipment such as Computers, printers, electrical lightings and mostly Electronic, remote controlled and computerised heavy equipment machinery during production. Although the use of electronic appliances has great benefit to development of the economy, there has been a great impact on the amount of e-waste being generated as the components in e-waste are toxic and hazardous. This waste has been identified as a problem not just in Zambia but worldwide making the development of an e-waste management system cardinal in any industry. This study employed qualitative methods, purposive sampling techniques and two mining companies First Quantum Minerals Limited (FQML) Kansanshi site and Dangote Cement Zambia Limited (DCZL) were selected as case studies. A regulatory agency Zambia Environmental Management Agency (ZEMA) was also selected. The research methods were used to analyse the management practices of e-waste in the mining industry of Zambia and it was found that the two mining companies were struggling to manage the e-waste generated as there are no e-waste policies or legislation to give guidance on e-waste management practices and they relied on acts such as the Environmental Management Act of 2011 that address hazardous waste management. This study showed that the regulatory agency ZEMA had challenges in conducting sensitization and awareness campaigns and developing of e-waste technical guidelines due to lack of funding. The study concluded that the implementation of e-waste management practices can only be improved through the development of sustainable environmental strategies such as formulation, implementation and enforcement of e-waste management policies and development of e-waste technical guidelines that stress more on handling, storage, collection, sorting, dismantling, transportation in the country. Allocation of funds is needed to develop e-waste technical guidelines and support e-waste management programs such as sensitization and awareness, which have to be implemented, monitored and evaluated within an agreed time frame in these institutions in order to protect the environment from the pollution that comes with this type of waste. Therefore, the study recommended that ZEMA drives the development and implementation of e-waste management policies and legislation with policy makers and develop environmental strategies involving

recycling of e-waste and for the mining companies, development of a comprehensive organizational e-waste inventory, development of a sustainable e-waste management system and introduction of EPR (Extended Producer Responsibility) and green procurement.

DEDICATION

I humbly dedicate this project to the Lord God Almighty my creator, provider and source of strength, wisdom, knowledge and understanding. The Lord has been my help throughout this entire programme. I also dedicate this work to my parents, my partner Joshua Nsama and sisters who have really encouraged and given me emotional support during this study.

To my friends and workmates, thank you for the support in good and in hard times.

God bless you.

ACKNOWLEDGEMENT

Supervisor

To Dr. Sam Kangwa my supervisor who has guided me during this study and whose help has made sure that I give it all it takes to finish that which I have started.

Participants

I offer my deep and sincere gratitude to all the participants and the organisations they represented during this study. I extend my gratitude to the Zambia Environmental Management Agency, Dangote Cement Zambia Limited and First Quantum Minerals Limited management for the help rendered during data collection.

My Family and loved ones

My deep and sincere gratitude to my family and loved ones for their great support, encouragement and love during this study, I am forever indebted to you for the opportunities you have given me which have resulted into me becoming the woman I am today. To my friends, may God richly bless you for the support given during this time.

The University of Zambia, School of Mines

I would like to offer my gratitude to the entire School of Mines staff at the University of Zambia for helping me to achieve my goal of becoming a successful graduate.

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ACRONYMS/ ABBREVIATIONS

Abbreviations	Description
CPU	Central Processing Unit
DCZL	Dangote Cement Zambia Limited
DOE	Department of Environment
EEE	Electrical and Electronic Equipment
EMA	Environmental Management Act
EPA	Environmental Protection Agency
EPR	Extended Producer Responsibility
EU	European Union
FQML	First Quantum Minerals Limited
ICT	Information and Communication Technology
IQ	Intelligence Quotient
IT	Information Technology
NEQA	National Environmental Quality Act
OECD	Organisation for Economic Cooperation and Development
PACE	Partnership for Action on Compiling Equipment
PCB	Polychlorinated Biphenyl
PEPA	Pakistan Environmental Protection Act
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act
ROHS	Restriction on the use of certain Hazardous Substances
SADC	Southern African Development Community
SHARL	Specified Home Appliance Recycling Law
StEP	Solving the e-waste problem (StEP)
UNZA	University of Zambia
USA	United States of America
VCR	Video Cassette Recorder

WEEE	Waste from Electrical and Electronic Equipment
WSR	Waste Shipment Regulation
ZEMA	Zambia Environmental Management Agency

CHAPTER 1: INTRODUCTION

1.0 Introduction

Electronic and electrical waste (e-waste) is a name given to electronic products nearing the end of their ‘useful life’. In the context of the mining industry, these embody electronic heavy equipment machinery, computerized machinery, remote controlled heavy equipment, printers, computers, paper shredders, projectors, telephones, lighting tubes, toners e.tc. (Kiddee et al., 2013).

If this waste is not properly managed, it might end up polluting the environment since most electronic equipment contains varied types of potentially toxic elements e.g. chromium, cadmium, lead, mercury, copper and manganese which can be harmful to public health and the surroundings as alluded by Kiddee et al. (2013).

Over the past years, the global market of electrical and electronic equipment (EEE) continues to grow gradually as shown in Figure 1.1, whereas the lifespan of these products decreases. This has resulted in large quantities of e-waste being produced (Khurram et al., 2011).

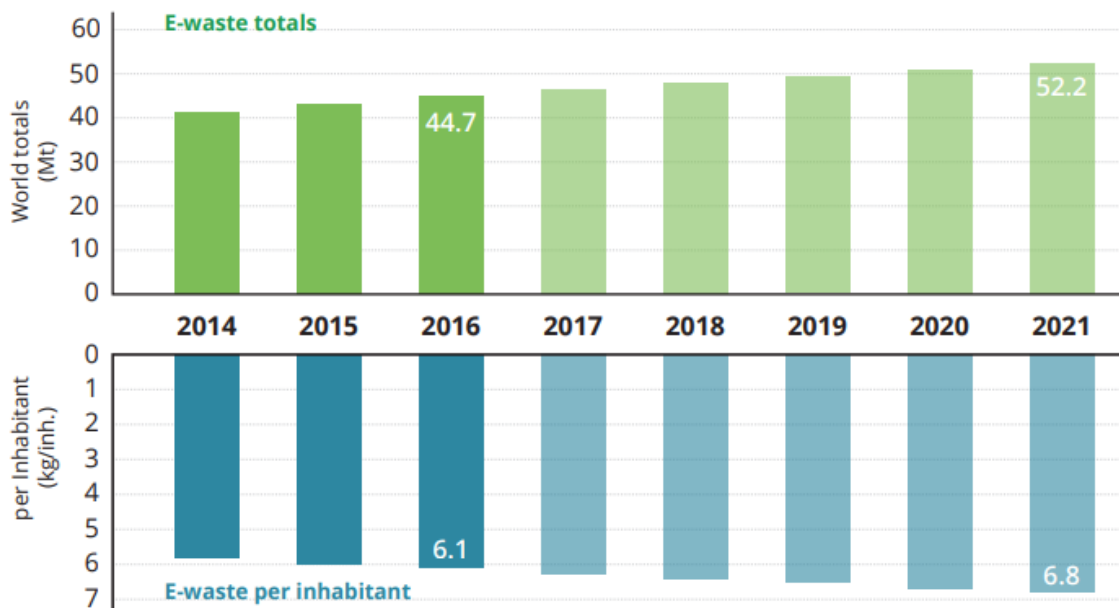


Figure 1.1: Global e-waste Generated (Baldé et al., 2017)

Kangwa and Mutambo (2018) noted that in 2016, the world figure on the amount of e-waste generated was about 45 million tonnes and which was alleged to increase to 50 million tonnes by year 2021. The problem of e-waste has been recognized by various nations, that the speedy

economic progress and also the ever-increasing transboundary movement of secondary resources will increasingly require both 3R endeavors (reduce, reuse, recycle) in every country and the applicable management of international material cycles (Terazono et al., 2006). In order to address this problem, a minimum of four international workshops were held between developed and developing countries to discuss the way forward in dealing with e-waste management states Terazono et al. (2006). Components in e-waste contain substances that might be harmful to the well-being of living organisms and the environment at large. The nature age project (2006) states that within the USA, the Department of Toxic Substances Control has determined that the majority of electronic devices are toxic, these toxic substances include lead, cadmium, mercury, plastics, etc.

Unlike developed countries such as Netherlands and Switzerland which have enforced and e-waste management practices such as recycling and energy recovery, African countries are badly plagued by e-waste due to poor e-waste management. The nature age project (2006) states that, instead of having to face the matter, countries with rich economies that use most of the world's electronic products and generate most of the e-waste, have made use of a convenient, and until now, hidden escape valve – exporting the e-waste crisis to the developing countries of Asia and Africa.

The Basel convention, an international accord has banned the export of hazardous waste to poorer countries since 1992. This was created to “counter the unsustainable and unjust effects of free trade in toxic wastes” (Puckett et al., 2002). With such bans, the European Union (EU) has developed its own means of e-waste management through reuse, recycle and alternative types of waste recovery as outlined in the project age project (2006).

The mining industry in Zambia covers production of different mineral raw materials, which include Copper, Cobalt, Gold, Limestone, etc. The mining investment and governance review of 2016 states that Mining has long been a significant primary sector industry and contributor to the Zambian Economy by providing export income, royalty payments and employment and a study conducted by Sikamo et al. (2016) also contributes that though Zambia desires to diversify its economy, the Zambian copper mining industry will remain one of the biggest contributors to the economy.

The mining industry has high operational and production costs as processes such as Drilling, blasting, loading, hauling and processing demand for the use of specialized and unique equipment i.e. Drill rigs, heavy machinery equipment, control rooms etc. which are expensive and high

maintenance. With this at hand, the use of electronic equipment such as remote controlled heavy machinery equipment, computerized control rooms, two way radios have cushioned the production and operational costs making electronic equipment common in the mining industry. Consequently, this positive change in technology has yielded the generation of e-waste.

1.1 Problem Statement

Electronic and electrical equipment plays a major role in everyday activities to achieve targets and goals. Electronic equipment such as electronic heavy machinery equipment is being used in the mining industry on daily basis as they help in reducing the amount of fumes and noise generated and also help in the reduction of production and energy costs. The continuous use of electronic equipment during production sequentially results into the generation of e-waste. E-waste is of concern in that the components found in it contain toxic and hazardous substances such as Lead, Mercury, Cadmium and Hexavalent Chromium. These substances if not properly managed or disposed of are likely to leach into the water system contaminating both ground and surface water systems, diffuse into air resulting into air pollution, contaminate the soil thereby causing environmental degradation. In addition, when exposed to them, they can result into impaired cognitive function, behavioral disturbances, attention deficits, hyperactivity, conduct problems, lower IQ sensory impairment, dermatitis, memory loss, and muscle weakness as stated in a study conducted by Chen et al. (2011). On the other hand, in Zambia, it was revealed by Gweme et al. (2016) that e-waste is handled by persons who do most of the repairing and reusing of electronic equipment and their simple processing of electronic waste involves serious health and pollution risks. E-waste has raised concern on a global level and the World Economic Forum (2019) states that e-waste is considered the fastest-growing waste stream in the world as rapid changes in technology are happening on a global scale. Africa has not been spared in that, electronic equipment nearing their end of life are shipped in as second hand electronic equipment which end up as e-waste in dumpsites in a short period of time, this claim was also supported by Gweme et al. (2016) stating that second-hand computers received in Zambia and Zimbabwe are often not fit for purpose. Even if second-hand electronic goods are usable, their limited lifespan accelerates their descend into e-waste.

In recent years, Legislative frameworks on e-waste have been formed. The European Union (EU) addressed the e-waste issue by introducing two pieces of legislation. The first being the Waste

Electrical and Electronic Equipment Directive (WEEE Directive) which came into effect in 2003 and its aim was to regulate and motivate e-waste recycling and re-use in member states of the EU, it was later revised and came into effect in 2014 as stated in a study conducted by Sakar (2016). Furthermore, the EU implemented the Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment in 2003. An initiative called Solving the e-waste problem (StEP) which is a membership organization that forms part of United Nations University and was created to develop solutions addressing e-waste. StEP focusses on encouraging the collaboration of all stakeholders connected with e-waste, emphasizing more on developing a holistic, scientific yet applicable approach to the issue Ruediger (2018). This approach to form legislations and initiatives shows that e-waste has raised global concern.

The researcher noted that during their course of employment in the mining industry of Zambia, the management of e-waste generated was difficult as there are no guidelines from the regulatory agency ZEMA that give guidance on how to manage e-waste and this led to it being stock piled within the plant. The regulations that are currently being used for hazardous waste management do not explicitly give guidance on how best to manage e-waste generated. Without proper guidance, there can be serious negative impacts on the environment in years to come as environmental issues are complex and wide. E-waste management cannot be left to chance as it is a fundamental component of developing a sustainable environment thereby making effective e-waste management of utmost importance. This study was centered on analysis of e-waste management practices in two mining companies in Zambia and the regulatory agency ZEMA in order to evaluate the effectiveness of e-waste management systems and identify areas of improvement.

1.2 Study Objectives

1.2.1 Main Objective

To analyze the management practices of electronic waste in the mining industries of Zambia.

1.2.2 Sub Objectives

1. To review the current policies and regulations governing the management of e-waste in Zambia.
2. To determine the current practices of electronic waste management in the mining industry.

1.3 Research Questions

1. What laws are currently in place concerning the management of e-waste?
2. What are the current e-waste practices that are being used in the mining industry?

1.4 Significance of the Study

This study is of significance in that analyzing and assessing the effectiveness of e-waste management practices in these two mining companies in Zambia and the regulatory agency ZEMA will help evaluate the effectiveness of e-waste management systems in this industry and identify areas of improvement.

1.5 Scope of the Study

The study focused on the current state of e-waste management in the Zambian mining industry (Copper and limestone). This was done by gathering information in the North-Western, Lusaka and Copperbelt provinces of the country, limitation on the number of provinces was due to the Covid 19 pandemic and measures that some organizations had put in place to limit the number of interactions with non-employees. The study centered on collecting data from environmental representatives from two mining companies and Zambia Environmental Management Agency (ZEMA) to provide an overview of the environmental challenges they faced in the management of e-waste and determine e-waste management practices that they had employed.

1.6 Study Area or Site

The study was conducted in three provinces in Zambia, the North Western for First Quantum Minerals Limited (FQML) Kansanshi mine, Lusaka for Zambia Environmental Management Agency (ZEMA) and the Copperbelt for Dangote Cement Zambia Limited (DCZL).

1.6.1 Dangote Cement Zambia Limited

DCZL is a mining company located in Ndola and deals in the production of cement. As any other modern mine in Zambia, the organization applies technology as most mining companies in its production through the use of electronics and electrical appliances. Dangote Cement was used as a case study as it is a modern mine with state of the art equipment that are electronic.

1.6.2 First Quantum Minerals Limited (Kansanshi Mine Site)

First Quantum Minerals Limited is a global mining company that produces copper concentrates, cathodes and anodes, and has inventories of nickel, gold and cobalt. It operates mines in several countries and Zambia being one. Kansanshi mine is a large mine located in Solwezi in the North-western Province of Zambia. Kansanshi is one of the most important copper reserves in Zambia, with estimated reserves of 727 million a lot of ore graded at 0.86% copper as stated by the Project - Kansanshi Copper Mine report of (2014). Kansanshi mine was used as a case study area because it is one of the biggest copper producing mines in Zambia.

1.6.3 Zambia Environmental Management Agency (ZEMA)

This is an independent environmental regulator and coordinating agency, established through the Environmental Management Act No. 12 of 2011. It is mandated to protect the environment and control pollution in Zambia through the Environmental Management Act and also the Environmental Management (Licensing) Regulations. It provides for integrated environmental management and also the proper management and use of the environment and natural resources, ensures preparation of the environment report and conducts environmental education and public awareness. The agency has its headquarters in Lusaka, the capital of Zambia.

1.7 Ethical Considerations

Ethics were considered at every stage of the research especially during data collection from the participating organizations which was sort through written requests. Identification codes or numbers were used to protect the anonymity and confidentiality of all individuals that were participating in interviews. Additional ethics considered involved informing the participants about the title of the research, the purpose of the study and why the study is of importance to the body of knowledge in order to have an informed consent before conducting any interview. In order to confirm their voluntary participation in the study, the participants were required to fill in a consent form. The research proposal was also submitted to the University of Zambia ethics committee for thorough scrutiny to ensure all the required ethical matters were taken into consideration.

1.8 Dissertation Structure

The outline of the dissertation is as outlined below:

Chapter 1: This is the ‘Introductory’ chapter to the research study. It details the statement of the problem, study objectives, research questions, significance of the study, scope of the study. The chapter is concluded by highlighting the study area or site and ethical considerations.

Chapter 2: This is the chapter that addresses Literature review. This chapter opens with probing deeper into the back ground of e-waste by categorizing it according to the WEEE directive, it further dives into reviewing why e-waste is a major concern. The section reviews Legislation governing e-waste disposal at global level, reviews the relationship between Africa and e-waste and lastly addresses the Zambian mining industry and local legislation on e-waste.

Chapter 3: This is the chapter that addresses the materials and methods used during the research study. This begins by introducing the methods used and goes further to explain the study population, study sample and sampling techniques used. The chapter goes into detail to explain the instruments of data collection used which were interview guides and addresses the data collection and analysis procedures employed.

Chapter 4: This is the chapter that addresses results and discussion. This chapter is for the sole purpose of analyzing and discussing the raw data of the research. It begins with the analysis of data obtained during data collection in order to answer the research questions formulated in chapter one which further address the objectives developed. This is then followed with a discussion of the analyzed data to give a distinct picture of the findings.

Chapter 5: This chapter focusses on the conclusion of the study and the recommendations developed after the findings and the suggestions for further work in that there are areas that are worth studying in the future.

CHAPTER 2: LITERATURE REVIEW

2.0 E-waste Background

“The introduction of better and improved electronic equipment coupled with reduced prices has contributed to the present growth of e-waste: (Khetriwal, 2009). A number of companies believe that utilization of advanced electronics in their day to day activities contributes to high productivity. Consequently, this has resulted into large volumes of electronic waste being generated in the mining industry.

Electronic waste (e-waste), which is any electrical or electronic equipment that is discarded after reaching its end of life has been classified into ten categories by the EU as outlined in the Table 2.1 and Figure 2.1.

Table 2.1: Categories of e-waste (WEEE Directive, 2012/19 EU)

Category	e- waste
1	Large Household Appliances
2	Small Household Appliances
3	IT and Telecommunications Equipment
4	Consumer Equipment
5	Lighting Equipment
6	Electrical and Electronic Tools
7	Toys, Leisure and Sports Equipment
8	Medical Devices
9	Monitoring and Control Instruments
10	Automatic Dispensers

Electronic waste that is generated from the mining industry, falls into categories 3, 5, 6, 9 and 10 (Table 2.1). These types of electronic equipment contain components that can be hazardous to health and the environment, and if not properly managed can find their way into landfills or/ and incinerators. This information has also been supported by the US Environmental Protection Agency EPA and according to Khurram et al. (2011), it is stated that more than 4.6 million tonnes of e-waste ended up in landfills in 2009.

The toxic chemicals and substances which form major components of electronics or electric products have a high possibility of leaching into the land or water over time or be released into the atmosphere, affecting nearby communities and therefore the surrounding environment adds Khurram et al. (2011).



Figure 2.1: Discarded e-waste (Malakatata, 2019)

2.1 Why e-waste is of Major Concern

“E-waste consists of a large variety of materials of which contain a range of toxic substance that can contaminate the environment and threaten human health if not appropriately manage” (Kiddee et al., 2013).

Table 2.2: Toxic substances found in e- waste and their adverse health effects (Kiddee et al., 2013)

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

2.2 Laws Governing e-waste Disposal

Due to the rapid growth in the amount of e-waste that is being generated worldwide, the Basel Convention in the year 2002 began curbing the production of this kind of waste. The problems that required major attention were environmentally sound management, prevention of illegal traffic to developing countries and building capabilities around the globe to better manage e-waste as stated in the Basel Convention on the control of transboundary movements of hazardous wastes and their disposal.

During its ninth conference of the Basel Convention, the programmers developed were;

- Environmentally sound management of e-waste in Africa, in Asia Pacific and in South America;
- Partnership for Action on Computing Equipment (PACE)
- Follow up Partnership to PACE
- Preparation of technical guidelines on transboundary movements of e-waste, in particular regarding the distinction between waste and non-waste.

The problem of e-waste attracted many policy makers and regulators such as the European Union around the globe. A number of nations such as the USA, Thailand and China have developed policies and laws to curb the matter to which a number are outlined below;

2.2.1 Waste Regulation in the European Union

According to Khetriwal (2011), the European Union (EU) Waste Electrical and Electronic Equipment (WEEE) directive was formulated as a response to the amount and toxicity levels imposed by e-waste. The directive sets a common legislative standard for all EU member countries.

Khetriwal (2011) noted that the process of developing a legislative frame work for waste management commenced in 1991 but it was not until 2003 that the WEEE directive came into play with varying timeframes for member states. This directive has provided stakeholders, several regulators and legislators a better way to manage e-waste through the experience they have attained. Umesh and Singh (2014) stated that the EU has addressed e-waste problems that date as far back as the 1990s. The main approaches are the-waste shipment regulation (WSR) that came

into effect in 1993 and was amended in 2007. This law states that no EU member state is allowed to export e-waste that is classified as hazardous to non-OECD (Organization for Economic Cooperation & Development) countries, However, it has been claimed that e- waste continues to be exported to non-OECD countries. This practice also influenced the development of the restriction on the use of certain hazardous substances (RoHS) in 2003 which focusses more on product designs and increasing recycling rates.

The WEEE Directive focuses on the end of life cycle of electronics and electrical appliances which includes recycling, repairing, disabling, reuse of e-waste and the concept of Extended Producer Responsibility (EPR). While the other puts more emphasis on the concept of product design. Umesh and Singh (2014) explained that the rationale behind this concept is the polluter pays principle which aims at including the disposal and waste treatment costs into the product pricing. The directive was further reviewed in 2008 and this has reduced the amount of e-waste exported to non-OECD countries.

2.2.2 Waste Regulations in the USA

The US has developed and enacted directives and legislations on the management and export of e-waste. There are currently two federal regulations that do address e-waste i.e. the Resource Conservation and Recovery Act of 1976 (RCRA) and The Environmental Protection Agency (EPA) 's CRT Rule. The Resource Conservation and Recovery Act is the principle federal law that addresses the disposal of solid and hazardous waste in the United States and it RCRA, 1976 was enacted in 1976. The RCRA act has listed substances deemed hazardous under title 40, chapter 1, sub-chapter 1, part 261, subpart D and components found in e-waste such as Polychlorinated Biphenyls make the list. The Environmental Protection Agency (EPA) is an independent executive agency of the United States federal government tasked with environmental protection matters patterning to air, health, soil and water as stated by the EPA's Budget and Spending (2022).

2.2.3 Waste Regulations in China

China is one of the Asian countries that has also introduced a number of regulations. The first policy that was put in place is the Catalogue for managing the import of waste which came into effect in 2000 and its goal was centered on banning the importation of waste, second hand electronic equipment inclusive. This policy was then followed by the Technical policy on pollution prevention and the control e-waste in 2006, this policy sets the 3R and the polluter pays principle

which stipulates eco-design and makes provision for environmentally sound e-waste disposal methods. In 2007, the Ordinance on management of prevention and control of pollution from electronics and information control was enacted, this law brought in restrictions on the use of hazardous waste and for producers to produce information about their products. The Administrative measure on pollution prevention from WEEE followed afterwards and came into effect in 2008, this standard addressed licensing scheme for managing e-waste recycling companies as stated in a study conducted by Wang et al. (2021). The study states further that the policy also calls for pollution prevention that results from dismantling, collection and transportation of e-waste. 2011 was the year in which the regulation on Management of the recycling and disposal of WEEE came into effect. This law makes e-waste recycling mandatory, implements extended producer responsibility and establishes a special fund to subsidize e-waste recycling.

2.2.4 Waste Regulations in Thailand

Thailand is also among the countries that have taken a step to curb the harmful effects of e-waste and have initiated better ways to manage it. Umesh and Singh (2014) states that Thailand has the industrial Standards Act 1998 that aims at setting industrial standards useful in promoting and preventing the nation's economy from harm. This act has undergone a number of amendments since it came into effect in order for it to conform to foreign or international standards. The other legislation put in place is the Export and Import of Goods Act of 1979 that addresses issues to do with the importation and exportation of goods.

The Enhancement and Conservation of the National Environmental Quality Act (NEQA) of 1992 looks at the environment and any degradation as a result of pollution. Umesh and Singh (2014) explained that this is achieved by the participation of different stakeholders such as government, people and private non-governmental organizations in environmental promotion. The other legislation mentioned by Umesh and Singh (2014) is the Factory Act of 1992 that focuses on better supervision of factory activities in order to manufacture goods in an acceptable manner. The Substance Act of 1992 is another law that was enacted to deal with e substances used in different everyday activities in order to prevent harm on humans, animal life, plants and the environment in general.

2.2.5 Waste Regulation in Japan

“In the late 1990s, Japan began its efforts to improve legislation concerning various kinds of waste and their recycling. These efforts were prompted by increases in the types and quantities of waste, which were driven by the increase in consumption and the permeation of the throwaway culture” (Hotta, 2014). These changes were triggered by rapid economic growth and life changes in the country. Japan enacted the Specified Home Appliance Recycling Law (SHARL) or usually referred to as the Japanese Recycling Law for Electrical Home Appliances in June 1998 and it came into effect in April, 2001 as claimed by Tasaki (2016), this was prior to the EU directive on WEEE. The main objective of the law states that this legislation shall have the objective of contributing to the maintenance of the living environment and the healthy development of the national economy, by taking steps to secure the environmentally sound disposal of waste and effective utilization of resources through the introduction of measures for proper and smooth collection, transportation, and recycling of specific household appliance waste by retail traders or manufacturers of specific household appliances, with the aim of achieving a reduction in the volume of general waste and sufficient utilization of recycled resources (Hotta, 2014). This law requires recycling rates to be in the range of 50% to 60% by weight as claimed by Umesh and Singh (2014). The other law that was enacted to address e-waste is the Waste Treatment Law which directly points at the management of e-waste that contains substances that are hazardous.

2.2.6 Waste Regulations in Korea

The government of the country of Korea has consistently responded to the changing landscape of e-waste management and had continuously expanded relevant legislation as stated by Yoo et al. (2019). Korea had its Producer Deposit-Refund system introduced in 1992, the law provides for the deposit to be levied on the products destined for collection and recycling. Other programs were also introduced and these included the Producer Recycling System which placed the responsibility of recycling e-waste on the manufacture. The guidelines for the improvement of material and structure of products for stimulating recycling came into effect in 1993, this policy addressed restriction of use of hazardous substances and recyclability rate. Extended Producer Responsibility System EPR was later introduced in the country in 2003, the new system became a success as it focused on lowering the recycling costs for producers and consequently increasing the amount of e-waste that was recycled. From 2014, “Korea once again redefined recycling criteria and created the Electrical and Electronic Product Eco-Guarantee system, this system broadened the

responsibility of e-waste recycling from the manufacturers to a nationwide endeavor” (Yoo et al., 2019).

2.2.7 Waste Regulations in Bangladesh

Bangladesh has developed with increasing use of technology but sustainable and safe use of this technology is a big challenge for the country, a study by Alam and Bahauddin 2015 further states that in Bangladesh, almost 2.7 million metric tonnes of e-waste is generated per year. The country enacted its National Environmental Policy in 1992 which highlights the regulating of all activities that pollute and destroy the environment Hossain et al. 2010. In the National Environmental Policy there is provision for banning the use of heavy metals in industrial production, west permit/consent order to improve waste management and banning the import of hazardous substances that are hazards for human health as mentioned in the guidelines for e-waste management in Bangladesh that were formulated in 2012. This was followed by the environmental conservation Act of 1995 that targets to maintain the quality of the environment. Medical management rules addressing wastes (including e-waste) came into effect in 2008. The latest regulation is the Electrical and Electronic Waste (Management and Handling) Rules of 2011 which directly addresses issues that deal with the management of e-waste. These rules mainly focus on procedures that involve authorization of dealers to conduct recycling processes in a manner that does not pollute the environment. In 2021, Bangladesh’s Department of Environment (DOE) published the Hazardous Waste (e-waste) Management Rules, 2021 under the Bangladesh Environmental Protection Act, 1995. “The rules state that manufacturers shall also submit WEEE management plan and in addition shall also obtain environmental clearance” (Hazardous rules, 2021).

2.2.8 Waste Regulations in Pakistan

Pakistan like many other countries has faced challenges in the management of e-waste as there is no proper system to recycle and dispose e-waste in the country a claim made in the study conducted by Ilyas et al. (2020). In 1997, Pakistan Environmental Protection Act of 1997(PEPA) came into effect, this is the basic legislative tool that empowers the government of Pakistan to frame regulations that protect and provides basic legal framework for protection, conservation, rehabilitation, and improvement of the environment. The act applies to a wide range of issues and extends to air, water, soil, marine, and noise pollution, and to the handling of hazardous wastes as alluded by the e- waste management plan developed in 2021 in Punjab. The Hazardous Substance

Rules 2003 followed afterwards and these were made under PEPA 1997, which states that “A license will be required for the importation and transportation of hazardous substances from Federal or Provincial agency” (e- waste management plan, 2021). In, 2005, the Punjab e- waste management plan continues that the National Environmental Policy came into effect, this policy provides a framework that addresses the environmental issues being faced in Pakistan, pollution of freshwater bodies and coastal waters, air pollution, lack of proper waste management, deforestation, loss of biodiversity, desertification, natural disasters and climate change in particular. Pakistan like other countries has developed policies and Acts to address management of hazardous waste. “The law in Pakistan aims at prohibiting the importation of hazardous waste and providing guidelines on the proper methods of handling hazardous waste which encompasses e-waste” (Ilyas et al., 2020).

2.2.9 Waste Regulations in India

India is one of the largest waste importing countries in the world and it generates about 350000 tonnes of electronic waste every year and imports another 50000 tonnes as alluded by Das (2014). In India, the Hazardous Wastes Management Handling and Transboundary Movement Rules which are guidelines on e- waste management were released in 2008, these provide for the adoption of producer responsibility and the restriction of substances hazardous to health through the adoption of environmentally friendly e-waste recycling systems. This law was then followed by the E-waste (Management and Handling) Rules in 2011, Umesh and Singh (2014) insist that the rules were aimed at managing the e-waste problem in India. The government of India ministry of Environment, Forest and Climate Change notification was released in 2016 and this has laid down responsibilities for the manufacturer, producer, dealers, refurbisher, consumer or bulk consumer, dismantler and recycler State Government for environmentally sound management of e-waste as stipulated in the government of India ministry of Environment, Forest and Climate Change notification (2016).

2.2.10 Waste Regulations in Zambia

Zambia like any other country dealing with e-waste has a number of laws and regulations that address waste management, the most common being the Environmental Management Act of 2011 (EMA) which is an umbrella and principal law which stands over all other environmental legislation in Zambia, Environmental Management licensing regulations of 2013, the Public

Health Act Cap 295 and Solid Waste Regulation and Management Act of 2018. The Environmental Management Act (2011) states that it is an act to continue the existence of the environmental council and re-name it as the Zambia Environmental Management Agency (ZEMA), provide for integrated environmental management, protection and conservation of the environment, sustainable management and use of natural resources, provide for the preparation of the state of the environment report, environmental management strategies and other plans for environmental management and sustainable development. Provide for the conduct of strategic environmental assessments of proposed policies, plans and programmes likely to have an impact on environmental management, provide for the prevention and control of pollution and environmental degradation, provide for public participation in environmental decision making and access to environmental information, provide for environmental audit and monitoring, facilitate the implementation of international environmental agreements and conventions to which Zambia is a party, repeal and replace the Environmental Protection and Pollution Control Act, 1990. The act addresses waste management under division 4 which details general prohibition and duty of care, waste licenses, the role of local authorities in waste management, designation of waste control areas, extended procedure responsibility, cessation of activity relating to hazardous waste, site restoration orders, emergency situations, responsibilities of agency and regulations relating to waste management. One of the sections used to address e-waste is found in division 4 under regulation 57 of the EMA which states that a person whose activities generate waste with potential to pollute the environment shall employ measures essential to minimize waste through treatment, reclamation, re-use, recovery or recycling. The Environmental Management Licensing Regulations of 2013 also focusses on environmental protection but details the management of air quality, hazardous waste, waste and other substances harmful to the environment such as pesticides and ozone-depleting substances.

The Solid Waste Regulation and Management Act, 2018 is an act that addresses management of solid waste, regulation of solid waste, licenses, permits and registration, solid waste services provision, solid waste tariffs and general provisions. It is stated in the act that it serves to provide sustainable regulation and management of solid waste, general and self-service solid waste services, the incorporation of solid waste management companies and define their statutory functions. Provide licensing and functions of solid waste service providers, operators and self-service solid waste providers and provide for their functions, the regulation, operation,

maintenance and construction of landfills and other disposal facilities, the setting and approval of tariffs for management of solid waste and provision of solid waste services. An additional act that addresses waste is the Public Health Act Cap 295. Under part 9 regulation 64, the act states that No person shall cause a nuisance or shall suffer to exist on any land or premises owned or occupied by him or of which he is in charge any nuisance or other condition liable to be injurious or dangerous to health. “The law is employed by most local authorities to ensure that that disposal of wastes within the Zambian districts is allotted exceedingly in a manner that is not injurious to health” (Kangwa and Mutambo, 2018).

2.3 Africa and e-waste

Developed countries have transferred the responsibilities and risks that arise from e-waste to developing countries by exporting their electronic products nearing their end of life. This undermines the Basel Convention that emphasizes that all exports involving e-waste are illegal. Comprehensive studies on the export and import of electronics and electrical appliances reported that most of the WEEE that is exported to African countries is almost worn out and usually at the end of its product life cycle. According to Osibanjo (2007b), Nigeria is one example in which only about 25-75 percent of the computer equipment brought into the country is in good condition, can be repaired or sold, the rest is usually dumped or burnt. In developing countries, Africa in this context, “e-waste is the fastest growing component of municipal trash by a factor of three” (Schmidt, 2002).

Khalema (2015) explained the current stance of some African countries on e-waste management by 2015 most governments in the SADC region recognized the health and environmental issues posed by e-waste, the table below outlines the overview of baseline scenarios.

Table 2.3: The status of e-waste management of the SADC region as of 2015 (Khalema, 2015)

COUNTRY	STATUS OF E-WASTE MANAGEMENT	EXISTING INITIATIVES
<p>Lesotho Botswana Mauritius Mozambique</p> <p>Namibia</p> <p>Swaziland Tanzania Zambia Zimbabwe</p>	<p>There is no accurate data for planning, allocation of human, financial and technical resources for integrated waste management.</p> <p>Collection is generally informal and a few exporters have emerged.</p>	<p>Smaller initiatives to establish some formal collection are in their infant stages.</p> <p>An assessment of the sources, amount and geographical spread of e-waste was undertaken and model regulations developed in Lesotho.</p> <p>The Southern African Telecommunications Association has drafted guidelines for e-waste disposal. These guidelines allow for identification of various sources of e-waste and prescribe procedures for e-waste handling. The guidelines also call for establishment of SADC e-waste in an environmentally sound manner.</p>
<p>South Africa</p>	<p>Waste management legislation in South Africa does not require landfill site owners and recyclers to keep accurate records regarding e-waste volumes and recycling of e-waste are currently unknown. There are several recyclers who still export the valuable components. Collection is still formal and informal</p>	<p>Several studies have been undertaken which culminate in development of plans and guidelines. These are mostly driven by industry. There exists a waste act 59 of 2008 but is still inadequate to regulate the industry. Industry association such as EWASA, e-waste alliance, ITA, are very active in engaging in government to adopt a comprehensive regulatory framework.</p>

2.4 Overview of Zambia on e-waste

The Zambian economy has been based on the mining industry for a number of years. The Zambian government has granted licenses to international resource companies to prospect for minerals such as nickel, tin, copper, and uranium as articulated by an agreement between Albidon and the Zambian government (2006). The fair pricing and new age in the usage of new technology in production has added to the increase in e-waste. Zambia like other African developing countries, has not been spared from the burden of e-waste. Kangwa and Mutambo (2018) stated that there has been a rapid growth in the usage of electronic and electrical appliances. The author continued by stating that the growth can be linked to the period in which there was an influx in the export and import of both new and old electronic goods due to the liberation of the economy.

The literature review has shown that e-waste is a problem at global level and this has driven a number of countries into developing policies, laws and guidelines to curb the management of e-waste. In these countries, law enforcers, policy makers and innovators have been attracted from different sectors and one of them being the introduction of the extended producer responsibility (EPR) concept assets Khetriwal (2009) and further states that when it comes to the recycling of e-waste, most successful countries have adopted the EPR.

Innovative ideas have also been suggested due to the large quantities of e-waste accumulated. Townsend (2011) stated that the end life of electronic appliances can be tackled through the strategic and economic value of WEEE. The author suggested that some elements found in WEEE can be used in energy supply and other advanced technology in that there are many countries which have high demand for these elements but have no suppliers. Kangwa and Mutambo (2018) also added that the metal fractions separated from e-waste can be further processed using hydrometallurgical, pyro metallurgical, electrometallurgical, bio metallurgical processes, and their combinations (Khaliq et al, 2014). With this in place, e-waste can actually be used to benefit the users.

In Zambia, the quantity of e-waste being generated in the mining industry could not be estimated as there was no data on the quantification of e-waste during literature review, this was also noted in the study conducted by Nalwamba (2016) where it is stated that the “Absence of clear figures on the amount of EEEs on the market as well as the quantity of generated e-waste remains a clear indication of the e-waste crisis in Zambia”. The management practices or mitigation measures that

have been employed to manage e-waste in this industry are also not known as such information could not be found during literature review. This indifference between Zambia and other countries that have gone a step further to enact laws and develop policies regarding the management of e-waste point to a gap present in the management of e-waste in Zambia. Thus this clearly shows that there is lack of information on quantification, mitigation measures and the disposal or end use of e-waste generated in the mining industry, therefore, this makes the study cardinal as the analysis of the management practices of electronic waste in these two mining companies will assist in answering the questions raised and find solutions to the concerns identified.

CHAPTER 3: MATERIALS AND METHODS

3.0 Introduction

The research employed qualitative methods to collect data through expert interviews. The sampling techniques used were purposive. Interview guides with semi structured questions (Appendix II) were used when conducting interviews.

3.1 Study Population and Sample

The study population and sample was made up of;

- Environmental experts from two mining companies i.e. Dangote Cement Zambia Limited (DCZL) and First Quantum Minerals Limited (FQML) Kansanshi mine site. For FQML, the team had one senior and two environmental officers and all were present during the site visit and interview session. For DCZL interview session, the team was made up of an Environmental Coordinator and one Environmental officer.
- For the Zambia Environmental Management Agency (ZEMA), the team had two principle inspectors (one from Solwezi and the other from Lusaka) and one Environmental Officer.

The participants were grouped into two categories such that five participants represented the first category from the two mining companies and the other category with three Environmental experts represented a regulatory body (ZEMA). The interviews conducted were one-on-one for FQML and through zoom meeting for DCZL and via phone calls for ZEMA. The participants from both FQML and DCZL were environmental experts that manage all environmental issues of the organizations, hazardous waste inclusive.

3.2 Sampling Techniques

The sampling technique that was employed in the study was purposive sampling. The Environmental experts provided the data by answering the questions in the interview guide on the management practices of e-waste.

3.3 Instruments for Data Collection

Expert interviews were conducted using interview guides (Appendix II). These questions were, precise, specific and completed and all conversations recorded for effective data interpretation with prior consent. Participant observation, analysis of pictures, photos and governmental documents were also used for data collection.

3.4 Data Collection Procedure

The study contacted institutions and stakeholders that are involved in the management on e-waste in Zambia.

1. Objective 1: Information about the current policies and regulations governing the management of e-waste in Zambia. Data was obtained from ZEMA, which is the regulatory agency that deals with the management of all types of waste in Zambia. The information was obtained by using an interview guide (appendix II) specifically formulated for the regulatory agency. The collected data obtained was analyzed using Microsoft word and excel (2010) to assess the current policies and regulations that govern the management of e-waste in the mining industry of Zambia.

2. Objective 2: Information on the current practices of electronic waste management in the mining industry. The data was obtained by firstly communicating with management of the mining companies on the purpose of the research and also to get permission to conduct the research on their mine sites. This was followed by briefing the participants from the environmental departments on the study and the questions in the interview guides. The interview process involved site tours at both mining organizations, followed by an interview session with the selected participant from the company. The collected data was later analyzed using Microsoft word and excel (2010) to determine the current practices of electronic waste in the mining industry. Finally, all data collected was analyzed through the descriptive research analysis method to answer the research questions, draw conclusions and offer recommendations.

3.5 Data Analysis

This being a qualitative study, codes were created to help organize the data by identifying relationships between the answers given for each question in the interview guide. Later the identical and similar data were grouped together in Microsoft word to form themes that helped to answer the research questions and meet the objectives formulated. The three themes that were created and their respective questions and question numbers from the interview guide that was used in their creation is outlined in Table 3.1 and 3.2. Theme one answered the first research question and theme two the second, thereafter, three themes were developed from the answers given during the interviews with the mining companies and the regulatory body and these were called theme 1, theme 2 and theme 3 as outlined below.

Theme 1- **Regulations** that are currently being used in the management of e- waste.

Theme 2- The **Organizational Management** of e- waste in the mining industries.

Theme 3- The Current **Regulatory Standpoint** in the management of e- waste.

To understand how the themes and the questions in the interview guide correlate, two tables (Tables 3.1 and 3.2) were created with 3 columns to represent the themes created, then each column had the specific questions from the specific interview guide (Mining organization or regulatory body interview guide). Then these themes were used to answer the research questions.

Theme 1 was answered by question 11 from the mining organizations interview guide ‘What regulations is this organization using to manage electronic waste?’ and questions 4, 7 and 8 from the regulatory body interview guide i.e. ‘What measures has this regulatory body put in place to manage electronic waste? What regulations is this body using to manage electronic waste? and are there any new regulations on electronic waste or any underway?’. Tables 4.3 to 4.5 represent data obtained for theme 1.

Theme 2 was answered by questions 1,2,3,4,6,7,10 and 12 from the mining organizations interview guide i.e. ‘Discipline of the respondent. How one understands electronic waste? What are the negative impacts of electronic waste on human life and the environment? Does your organization produce any type of e-waste? if yes, state the types produced? What is the total quantification (tonnes) of e-waste that your organization produces in a month? How do you dispose of your e-waste? What management practices of e-waste have you employed in your organization? Are there any challenges this organization is facing in the management of electronic waste? Is there anything you would like to mention on the future plans of electronic waste management in your organization?’ Questions 5, 6, 9 and 10 were answered from the Regulatory body interview guide ‘Are there any challenges this body is facing in the management of electronic waste? What has hindered this regulatory body when it comes to the management of e-waste? Are there any companies registered with you that deal with the final disposal of e-waste? If yes to question 9, what methods are being used?’

Theme 3 was answered by questions 8, 9 and 13 from the mining organizations data i.e. ‘What measures have Regulatory body put in place to manage electronic waste in your organization? Do you receive any help from Regulatory body in the management of e-waste? What changes do you

think should be made in order to improve on the management practices of e-waste in the mining industry?' Questions 1, 2 3 and 11 were answered from the regulatory body data i.e. 'Discipline of the respondent. How one understands electronic waste? What are the negative impacts of electronic waste on human life and the environment? Is there anything you would like to mention on the future plans of electronic waste management in the mining industry or Zambia at large.' (appendix V) represents data collected for theme 3.

Table 3.1: Correlation between the themes created and the questions from the ‘Mining Organizations’ interview guide

THEME 1: Regulations	THEME 2: Organizational Management	THEME 3: Regulatory Standpoint
<p>1.What regulations is this organization using to manage electronic waste?</p>	<ol style="list-style-type: none"> 1. Discipline of the respondent. 2. How one understands electronic waste? 3. What are the negative impacts of electronic waste on human life and the environment? 4. Does your organization produce any type of e-waste? if yes state the types produced 5. What is the total quantification (tonnes) of e-waste that your organization produces in a month? 6. How do you dispose of your e-waste? 7.What management practices of e-waste have you employed in your organization? 8. Are there any challenges this organization is facing in the management of electronic waste? 9. Is there anything you would like to mention on the future plans of electronic waste management in your organization. 	<ol style="list-style-type: none"> 1. What measures have Regulatory body put in place to manage electronic waste in your organization? 2. Do you receive any help from Regulatory body in the management of e-waste? 3. What changes do you think should be made in order to improve on the management practices of e-waste in the mining industry?

Table 3.2: Outlining the correlation between the created themes and questions from the "Regulatory Agencies" interview guide

THEME 1: Regulations	THEME 2: Organizational Management	THEME 3: Regulatory Standpoint
<p>1. What measures has this regulatory body put in place to manage electronic waste?</p> <p>2. What regulations is this body using to manage electronic waste?</p> <p>3. Are there any new regulations on electronic waste or any underway?</p>	<p>1. Are there any challenges this body is facing in the management of electronic waste?</p> <p>2. What has hindered this regulatory body when it comes to the management of e-waste?</p> <p>3. Are there any companies registered with you that deal with the final disposal of e-waste?</p> <p>4. If yes to question 9, what methods are being used?</p>	<p>1. Discipline of the respondent.</p> <p>2. How do you understand electronic waste?</p> <p>3. What are the negative impacts of electronic waste on human life and the environment?</p> <p>4. Is there anything you would like to mention on the future plans of electronic waste management in the mining industry or Zambia at large.</p>

CHAPTER 4: RESULTS AND DISCUSSION

4.0 Introduction

This Chapter presents an analysis of the data collected, discusses the research findings and answers the research questions posed in Chapter 1 which includes the analyzed interview guides after the creation of codes and development of themes. This section outlines the types, classification and quantities of e-waste generated in these two mining companies, the current legislation, policies and guidelines that are being used in the management of e-waste. The section further outlines the e-waste management practices that are being used to manage e- waste generated and the impacts of e-waste on these two mining companies.

4.1 Types quantities and classification of e-waste

During the study, it was found that e-waste was being generated in the two mining organizations that were sampled and this was categorized as out lined in the tables 4.1 and 4.2 below.

Table 4.1: Types of e-waste generated at FQML Kansanshi Mine Site

Type of E-waste Generated	Classification	Quantity
Heavy Machinery Equipment	Category 1 (Electrical and electronic tools) and Category 9 (Monitoring and Control Instruments)	Not Quantified
Printed Circuit Boards	Category 3 (IT and Telecommunication Equipment)	Not Quantified
Metal Frames	Category 5 (Lighting Equipment)	Not Quantified
Power Supplies	Category 5 (Lighting Equipment)	Not Quantified
Computers	Category 3 (IT and Telecommunication Equipment)	Not Quantified
Telephones	Category 3 (IT and Telecommunication Equipment)	Not Quantified
Printer Toner Cartridges	Category 3 (IT and Telecommunication Equipment)	Not Quantified
Printers	Category 3 (IT and Telecommunication Equipment)	Not Quantified
Keyboards	Category 3 (IT and Telecommunication Equipment)	Not Quantified

Table 4.2: Types of e-waste produced at Dangote Cement Zambia Limited

Type of E-waste	Classification	Quantity
Metal Frames	Category 5 (Lighting Equipment)	Not Quantified
Electric Lamps	Category 5 (Lighting Equipment)	Not Quantified
Fluorescent Tubes	Category 5 (Lighting Equipment)	Not Quantified
Power Supplies	Category 5 (Lighting Equipment)	Not Quantified
Computers	Category 3 (IT and Telecommunication Equipment)	Not Quantified
Printer Toner Cartridges	Category 3 (IT and Telecommunication Equipment)	Not Quantified

At FQML, nine types of e-waste were generated and these were classified according to the WEEE Directive, 2012/19 EU. Although the heavy machinery equipment generated was classified as e-waste, it was not regarded as such at the mine site but categorized as scrap metal that was usually recycled and used as spare parts for other machinery. The e-waste generated was not quantified because quantification of this type of waste was difficult as the process involved a number of processes and procedures. At DCZL, six types of e-waste were produced, this waste was not quantified and was directly taken to the stock pile. This showed that the mining organizations had a challenge when it came to the quantification of this type of waste. The absence of quantification procedures and processes in these two mining companies can be attributed to the unavailability of e-waste technical guidelines and a well-structured environmental management plan system to act as a guide in the management of e-waste. At global level, it can be noted in the literature reviewed that for global law enforcers and policy makers to come up with legislation, the e-waste generated was quantified and this assisted in realizing the magnitude of the problem. Baldé et al. (2017) supports this claim by stating that over the past years, the global market of electrical and electronic equipment (EEE) continues to grow gradually, whereas the lifespan of these products decreases. This has resulted in large quantities of e-waste being produced and further reveals that 44.7Mt of e-waste was produced in 2016.

4.2 Current Legislation and Policies

The Zambia Environmental Management Agency (ZEMA) formerly called the Environmental Council of Zambia is the agency in Zambia that provides integrated environmental protection, conservation, sustainability and management. The existence of this agency is through the Environmental Management Act of 2011. The findings indicated that the agency is using four different regulations namely the Environmental Management Act No 12 of 2011 which is the mother act of all environmental regulations, Environmental Impact Assessment Regulations, Environmental Management (licensing regulations) Statutory Instrument No 112 of 2013 and the Extended Producer Responsibility 2018, Regulations (SI No. 65 of 2018) to manage e- waste generated in the mining industry and the country at large. It was also found that there were no specific guidelines to address the management of e-waste and the two mining companies interviewed were using the Environmental Management (licensing regulations) Statutory Instrument No 112 of 2013 to manage the e-waste generated. To cushion the problem of e-waste on the environment, the agency had increased awareness and sensitization on the dangers of handling e-waste, had initiated programmes to encourage people to take precautions when handling e-waste and had put emphasize on taking e-waste to licensed companies that are specialized in handling such waste. During the interview session, the issues that had negatively contributed to the management of e-waste were also brought to light. The lack of infrastructure to support e-waste management such as an engineered dumpsite and recycling and dismantling equipment being one of them. Other contributing factors being lack of adequate funding to carry out sensitization and awareness campaigns and lack of funding to develop e-waste technical guidelines on the management of e-waste. it was also found that there are no companies that deal in the final disposal of e-waste in Zambia and the companies present are those that deal in the collection and exportation of e-waste to other countries for recycling purposes. Unlike other countries such China and member countries of the EU that have developed policies and directives to address e-waste, Zambia has no direct e-waste guidelines, but has regulations such as the Environmental Management Licensing Regulations Statutory Instrument No 112 of 2013 that address hazardous waste which can be compared to the Resource Conservation and Recovery Act in the USA, the principle federal law that addresses the disposal of solid and hazardous waste.

4.3 E-waste Management Practices

It was discovered that at FQML, an e-waste management system had been implemented. Firstly, e-waste was stored at the FQML hazardous waste management storage shed in different containers, when the containers were full, the environmental department through management would engage a third-party licensed dealer to collect the e-waste at a fee. The organization later purchased a shredder as a way of recycling and reusing the e-waste generated. The implementation process that had been put in place involves five general stages namely, collecting, sorting, dismantling, shredding and metal recovery at the smelter. The e-waste is collected from points of generation (departments) and stored in what is referred to as an IT container, from there, it is transported to the hazardous storage area where it is sorted, dismantled (separation of PVC from metal) the PVC is stored separately while the metal casings is then shredded into smaller parts and these are taken to the smelter for metal recovery, a process called pyrometallurgy as shown in diagram 4.1. At DCZL, it was found that the e-waste generated in the organization is stored in containers and also stockpiled at the storage site and only one type (which are fluorescent tubes) are being used for energy recovery. At the time of the interview, DCZL was in the process of engaging licensed third-party dealers specialized in e-waste collection. The management practice in place involves collection and stock piling of e-waste as shown in diagram 4.2.

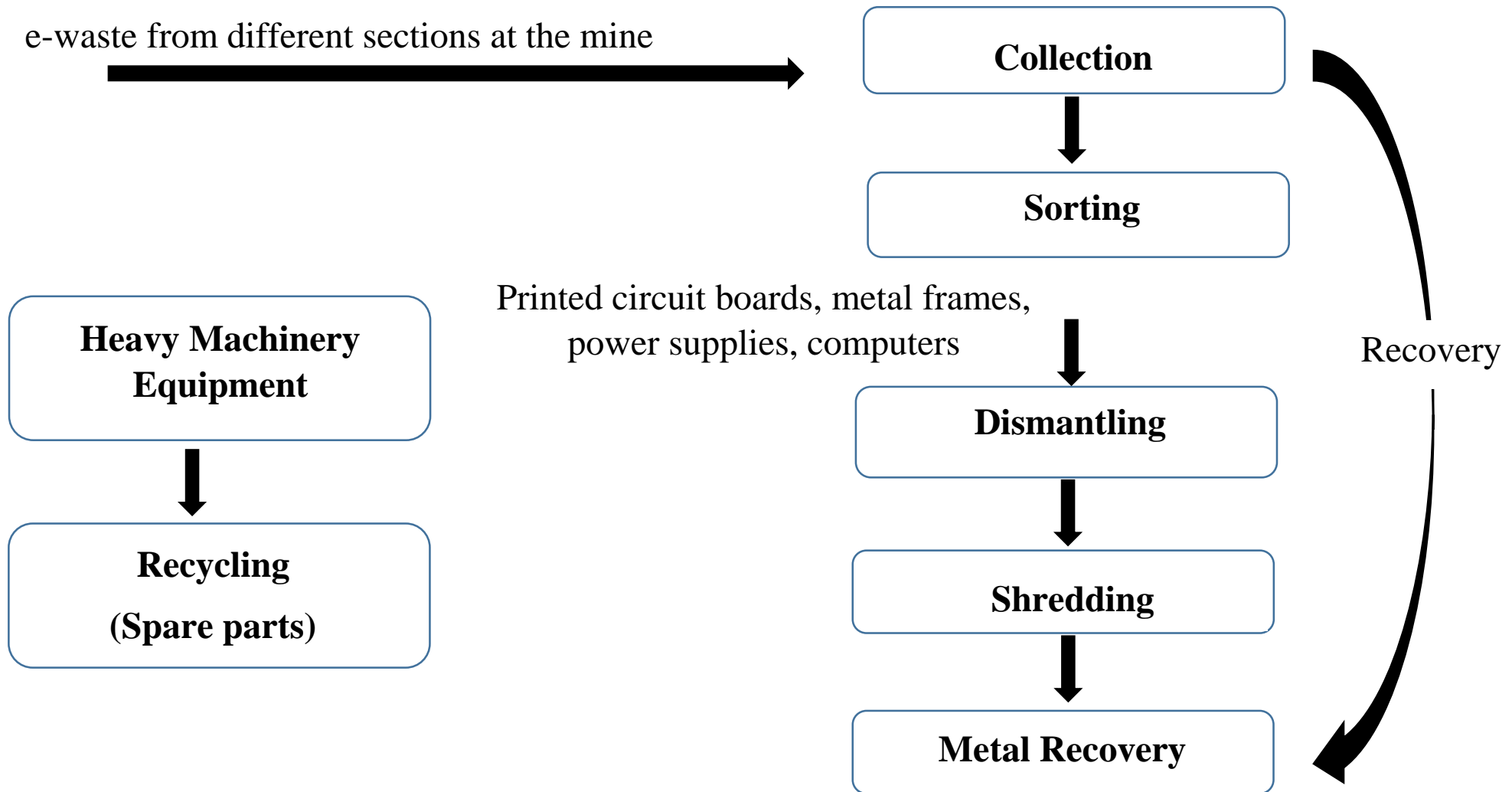


Figure 4.1: The management system of e- waste at Kansanshi mine site of First Quantum Minerals Limited

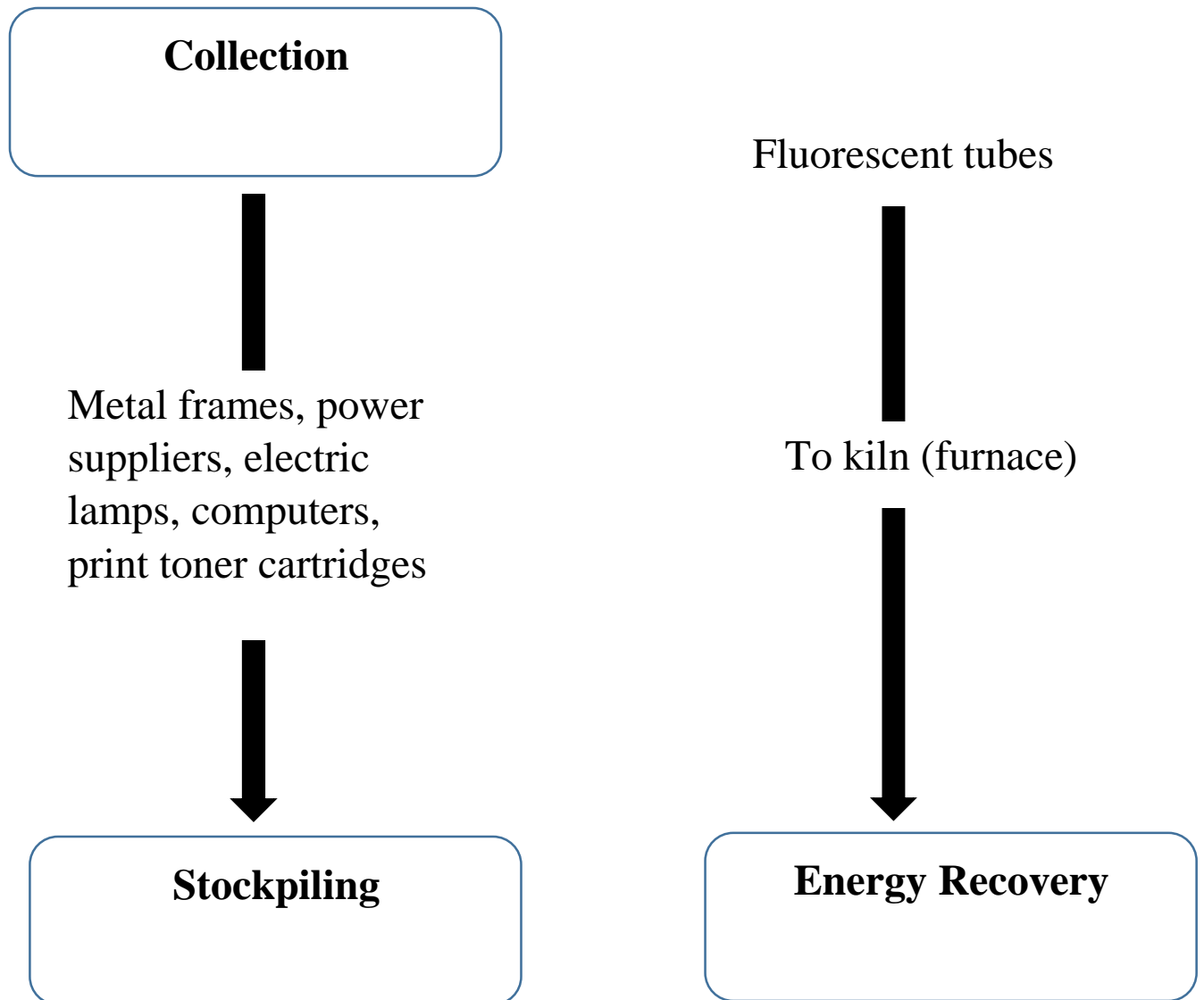


Figure 4.2: The management system of e-waste at Dangote Cement Zambia Limited

FQML has implemented e-waste recycling processes in form of metal recovery in its environmental management plan which is one of the approaches to reduce the amount of e-waste generated a claim supported by Hidy et al. (2011) which states that electronic products will require not only increased recycling rates, but also improved recycling. DCZL has also shown interest in recycling process by engaging third party dealers. From the analysis, FQML seems to have an advanced e-waste management system as most of its e-waste is recycled than DCZL. Although DCZL is stockpiling most of its e-waste on site, it is also showing interest in improving its management system by considering to engage third party licensed dealers.

4.4 Impacts of e-waste

There were no visible environmental impacts of e-waste on the two companies during the research period and what was noted are challenges being faced by the companies which would give way to environmental impacts in the future. It was found that FQML was facing e-waste management challenges as some of the e-waste generated was disposed of in general waste bins by employees and not the allocated e-waste containers. Another challenge faced by FQML was the proper management of the PVC recovered after sorting and dismantling the e-waste, this was because the company had no information on how best to manage this type of e-waste due to lack of specific e-waste guidelines. In addition, DCZL had a challenge managing the growing e-waste stock pile. In order to prevent the environmental impacts of e-waste from the stock pile, the organization was sourcing for data on sorting and dismantling of the e-waste generated so as to properly separate the components as there were plans that additional components might be considered as alternative fuel in the kiln (furnace) in order to reduce on stockpiling. Managing e-waste before the effects begin to surface is of utmost importance as it prevents any environmental degradation. Though the companies had no visible environment impacts of e-waste during the research period, the effects of e-waste on the environment are likely to grow due to stock piling and mishandling of e-waste within the years to come. Countries such as Bangladesh and Thailand can be referred to as examples as the impacts of e-waste manifested after a longer period of poor management practices.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In order to improve the e-waste management practices in the mining industry, there is need for sufficient government involvement and control of this sector through formulation, implementation and enforcement of e-waste management policies and legislation in the country. Policy makers will need to formulate policies and legislation so as to give guidance and direction on e-waste management as the findings revealed that the two companies had no guidelines to assist in managing e-waste. The policies and legislation developed will have to be implemented in the country in order to be recognized and observed by the companies and then enforcement of these policies and legislation has to follow as it will play a role in ensuring that every company abides to the stipulated law in order to improve the management practices in the mining companies. Allocation of funds is needed to develop e-waste technical guidelines and support e-waste management programs such as sensitization and awareness which are cardinal in changing the mindset of people towards e-waste, this will create trust in the regulatory body (ZEMA) and prevent environmental pollution and degradation.

The study has addressed the first objective by examining the current policies and regulations governing the management of e-waste in Zambia. The findings indicated that only four regulations namely the Environmental Management Act No 12 of 2011, Environmental Impact Assessment Regulations, Environmental Management (Licensing Regulation) Statutory Instrument No 112 of 2013 and the Extended Producer Responsibility 2018, Regulations (SI No. 65 of 2018) are being used in the management of e-waste. The main justification for this by the regulatory agency was lack of monetary funds to develop e-waste technical guidelines. The study addressed the second objective by determining the management practices of electronic waste management in the two selected mining companies. The e-waste management processes were not fully implemented and monitored for FQML and not implemented for DCZL showing that ZEMA needs to step in and give guidance in the management of e-waste even before the e-waste guidelines are implemented to stop future environmental pollution and degradation.

Therefore, the implementation of e-waste management practices can only be improved through the development of sustainable environmental management strategies by ZEMA and the mining organizations, which have to be implemented, monitored and evaluated to protect the environment.

5.2 Recommendations

The study established various issues surrounding the management of e-waste in the mining industry and the challenges faced by the mining organizations and regulatory body. Below are the research recommendations given on the management of this type of waste;

5.2.1 To the Regulatory Body

ZEMA needs to:

1. Arrange workshops to engage policy makers, regulators and waste experts to discuss the development and implementation of e-waste management policies and legislation.
2. Develop sustainable environmental strategies such as one involving recycling to manage e-waste in the mining industry and the country at large in order to achieve a circular economy;
3. Develop e-waste technical guidelines that address handling, storage, collection, sorting, dismantling, transportation and treatment options.
4. Engage with organizations in the mining industry to discuss sensitization and awareness programs, challenges faced in these organizations and recommendations that environmental experts have in the management of this waste.
5. Source for funding in order to raise awareness and capacity building through training programs on sensitization.

5.2.2 To the Mining Organizations

In order to properly manage and reduce the amount of e-waste produced in an organization, the recommendations given are:

- Development of an organizational e-waste management strategy which should be implemented, monitored and evaluated within an agreed time frame.
- Development of a comprehensive organizational e-waste inventory using the categories of EEE in the WEEE 2012/19 EU directive (appendix III) as a guide. This involves identifying and classifying the-waste generated by each company and help to identify the type of e-waste generated and make quantification of the-waste possible.

- Development of a sustainable e-waste management system. This can be done by first of all following the hierarchy of waste reduction.
- Introduction of EPR (Extended Producer Responsibility) and green procurement that contributes to a sustainable e-waste management system.
- Careful outlining of needs for implementing successful waste programs. Organizations should engage with other stakeholders and Regulatory body in order to implement waste programs through raising awareness and ensuring capacity building. This can also be strengthened by ensuring the strategy implemented are monitored.

5.3 Suggestions for Further Work

After carrying out the study, it was discovered that there are areas that are worth studying in the future such as:

- The enforcement of the extended producer responsibility in Zambia.
- Progress on the development of the e-waste technical guidelines.

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Appendix I: Informed Consent Form

Part I: Information Sheet

Dear participant,

I am Namatama Kamutumwa a post graduate student in the School of Mines, Department of Metallurgy and Mineral processing at the University of Zambia pursuing a Master of Science in Sustainable Mineral Resources Development. I am conducting a research titled the Analysis of Electronic Waste Management Practices in the Mining Industry of Zambia.

You invited to participate in this research because you are subject matter experts due to the environmental duties you perform in your organizations. This research study will involve your participation through individual interview sessions that will take 45 minutes to 1 hour each.

The purpose of this study is to understand e-waste, the current challenges being faced in the mining industry and Regulatory body, thereby, adding more information to the body of knowledge on how this type of waste can be managed. Your participation in this research study is entirely voluntary. If at all you feel uncomfortable with a question, you have the right not to answer it or cut the interview process but my hope is that you will be willing to participate in this interview as this study will help know more about the management practices of e-waste in this industry. The interview sessions and follow ups will be conducted within a week at each organization. There are risks due to invasion of privacy & breach of confidentiality or, loss of confidentiality and risks to releasing confidential organizational information. This will be reduced by ensuring that all participants are kept anonymous and confidentiality is maintained and secondly, obtaining permission from the organizations prior to data collection.

Your participation and cooperation will be highly appreciated

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact any of the following:

Namatama Kamutumwa

Researcher

namatamakamutumwa@yahoo.com

This research has been reviewed and approved by NASREC which is a committee whose task it is to make sure that research participants are protected from harm. If you wish to find about more about the IRB, contact:

Dr. Erasmus Mwanaumo, Chairperson, Natural and Applied Sciences, Research Ethics Committee,
University of Zambia

P O Box 32379

Lusaka

or

Professor. Henry M. Sichingabula Director, Directorate of Research and Graduate Studies

University of Zambia

P O Box 32379

Lusaka

Appendix II: Interview Guides

Part 1: For Mining Companies

I am Namatama Kamutumwa, a post graduate student Pursuing a Master of Mineral Science, degree in Sustainable Mineral Resource Development. I am conducting a research on analysis of electronic waste management practices in the mining industry of Zambia. Voluntarily kindly answer these questions freely in this interview. The information you are going to provide will be purely for academic purpose and will be used as such, meaning confidentiality shall be exercised seriously. Your cooperation will be appreciated.

1. Discipline of the respondent.
2. How do you understand electronic waste?
3. What are the negative impacts of electronic waste on human life and the environment?
4. Does your organization produce any type of e-waste? if yes state the types produced
5. What is the total quantification (tonnes) of e-waste that your organization produces in a month?
6. How do you dispose of your e-waste?
7. What management practices of e-waste have you employed in your organization?
8. What measures have Regulatory body put in place to manage electronic waste in your organization?
9. Do you receive any help from Regulatory body in the management of e-waste?
10. Are there any challenges this organisation is facing in the management of electronic waste?
11. What regulations is this organisation using to manage electronic waste?
12. Is there anything you would like to mention on the future plans of electronic waste management in your organisation.
13. What changes do you think should be made in order to improve on the management practices of e-waste in the mining industry?

Part 2: Interview Guide for Regulatory body

I am Namatama Kamutumwa, a post graduate student Pursuing a Master of Mineral Science, degree in Sustainable Mineral Resource Development. I am conducting a research on analysis of electronic waste management practices in the mining industry of Zambia. Voluntarily kindly answer these questions freely in this interview. The information you are going to provide will be purely for academic purpose and will be used as such, meaning confidentiality shall be exercised seriously. Your cooperation will be appreciated.

1. Discipline of the respondent.
2. How do you understand electronic waste?
3. What are the negative impacts of electronic waste on human life and the environment?
4. What measures has this regulatory body put in place to manage electronic waste?
5. Are there any challenges this body is facing in the management of electronic waste?
6. What has hindered this regulatory body when it comes to the management of e-waste?
7. What regulations is this body using to manage electronic waste?
8. Are there any new regulations on electronic waste or any underway?
9. Are there any companies registered with you that deal with the final disposal of e-waste?
10. If yes to question 9, what methods are being used?
11. Is there anything you would like to mention on the future plans of electronic waste management in the mining industry or Zambia at large.

Appendix III: WEEE 2012/19 EU Directives

ANNEX I

Categories of EEE covered by this Directive during the transitional period as provided for in Article 2(1)(a)

CATEGORY	E-WASTE
3	IT and telecommunications equipment
5	Lighting equipment
6	Electrical and electronic tools
9	Monitoring and control instruments
10	Automatic dispensers

Appendix IV: Sample of Signed Consent Forms

Part II: Certificate of Informed Consent

Title: Analysis of Electronic Waste Management Practices in the Mining Industry of Zambia

I the undersigned confirm that; voluntarily agree to participate in this research study

- I understand that even if an agreement to participate in this research has been made, withdrawal can be done at any time.
- I understand that the purpose and nature of the study has been explained to me by the researcher and I have had opportunities to ask questions about the study.
- I fully understand that participation involves: being interviewed by the researcher using an interview guide and recordings might be taken
- I understand that there will be no direct benefit from participating in this research study
- I understand that all information I provide in for this study will be treated confidentially
- I understand that withdrawal to use any data collected within two weeks of the interview can be done.
- I understand that disguised extracts from my interview may be quoted in the researcher's final thesis for the purpose of this study.

Print Name of Participant M Pando Victor
Signature of Participant 
Date 30/06/21
Day/month/year


Part II: Certificate of Informed Consent

Title: Analysis of Electronic Waste Management Practices in the Mining Industry of Zambia

I the undersigned confirm that; voluntarily agree to participate in this research study

- I understand that even if an agreement to participate in this research has been made, withdrawal can be done at any time.
- I understand that the purpose and nature of the study has been explained to me by the researcher and I have had opportunities to ask questions about the study.
- I fully understand that participation involves: being interviewed by the researcher using an interview guide and recordings might be taken
- I understand that there will be no direct benefit from participating in this research study
- I understand that all information I provide in for this study will be treated confidentially
- I understand that withdrawal to use any data collected within two weeks of the interview can be done.
- I understand that disguised extracts from my interview may be quoted in the researcher's final thesis for the purpose of this study.

Print Name of Participant ALVIN MAKASA

Signature of Participant 

Date 02/06/2017

Day/month/year


Part II: Certificate of Informed Consent

Title: Analysis of Electronic Waste Management Practices in the Mining Industry of Zambia

I the undersigned confirm that: voluntarily agree to participate in this research study

- I understand that even if an agreement to participate in this research has been made, withdrawal can be done at any time.
- I understand that the purpose and nature of the study has been explained to me by the researcher and I have had opportunities to ask questions about the study.
- I fully understand that participation involves: being interviewed by the researcher using an interview guide and recordings might be taken
- I understand that there will be no direct benefit from participating in this research study
- I understand that all information I provide in for this study will be treated confidentially
- I understand that withdrawal to use any data collected within two weeks of the interview can be done.
- I understand that disguised extracts from my interview may be quoted in the researcher's final thesis for the purpose of this study.

Print Name of Participant CARDLINE CHILY

Signature of Participant 

Date 16/06/2021

Day/month/year

Appendix V: Interview Guides Answers

I. Responses from the Interview Guides

Table 1: The responses for question 11 from the ‘Mining organization’ interview guide

	Mining Organization	11.What regulations is this organization using to manage electronic waste?	FQM (Kansanshi Site)	Zambia Environmental Management Agency (ZEMA) licensing regulations are being used with the mother Act being the Environmental Management Act, 2011
			Dangote	At the moment, the only regulations our organization is using to manage the e-waste generated here is the Environmental management (licensing regulations 2013)

Table 2: The responses for question 4 from the ‘Regulatory body’ interview guide

	Regulatory Body	4.What measures has this regulatory body put in place to manage electronic waste?	ZEMA	<ul style="list-style-type: none"> • Increasing awareness and sensitization on the dangers of handling e-waste by the people. •Encouraging people to be taking precautions when handling e-waste. •Encouraging people to be taking e-waste to licensed companies that are specialized in handling such type of waste.

Table 3: The responses for question 7 from the ‘Regulatory body’ interview guide

	Regulatory Body	7. What regulations is this body using to manage electronic waste?	ZEMA	The agency is currently using four different regulations namely the Environmental Management Act No 12 of 2011, Environmental Impact Assessment Regulations, Environmental Management Licensing Regulation Statutory Instrument No 112 of 2013 and the Extended Producer Responsibility 2018, Regulations (SI No. 65 of 2018).

Table 4: The responses for question 2 from the ‘Mining organization’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Organizational Management	Mining Organization	2.How do you understand electronic waste?	FQM (Kansanshi Site)	It is the management of electronic equipment or electronics like circuit boards, metal frames, power supplies computers, CPUs, printers, keyboards etc. that have reached the end of their life cycle
			Dangote	It is the management of electronic waste such as toners, computers, cables anything electronic that is fit for disposal

Table 5: The responses for question 3 from the ‘Mining organization’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Organizational Management	Mining Organization	3.What are the negative impacts of electronic waste on human life and the environment?	FQM (Kansanshi Site)	The-waste is non-biodegradable, landfilling will waste space, biodegradable materials have potential to leach into ground water systems of the nearby rivers, streams, wells and plastic component leachate is toxic to soils due to its carcinogenic properties. Due to heavy metals contained in the-waste, toxins that are released when it is burnt are a threat to human and animal life because this contributes to air pollution
			Dangote	There are a number of negative impacts and this depends on the types of electronic waste generated, non-biodegradable-waste bringing a lot of electronic leaching

Table 6: The responses for question 4 from the ‘Mining organization’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Organizational Management	Mining Organization	4.Does your organization produce any type of e-waste? if yes state the types produced	FQM (Kansanshi Site)	Yes, we do, Printed circuit boards, metal frames, power supplies, Computers, telephones, printers, printer toner cartridges, keyboards. Heavy Machinery Equipment is among them only that the parts are recycled as spare parts for other machinery before they are classified as e-waste
			Dangote	Yes, we do, metal frames, power supplies, Fluorescent tubes, electric lamps, Computers, Printer toner cartridges,

Table 7: The responses for question 5 from the 'Mining organization' interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Regulations	Mining Organization	5.What is the total quantification (tonnes) of e-waste that your organization produces in a month?	FQM (Kansanshi Site)	The quantification of the electronic waste is difficult as it is just stored in the IT containers. Quantification was only done when the-waste was being transferred to the third-party licensed dealers
			Dangote	No quantification is being done at the moment as all the e-waste generated is currently being stock piled

Table 8: The responses for question 6 from the 'Mining organization' interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Regulations	Mining Organization	6.How do you dispose of your e-waste?	FQM (Kansanshi Site)	When we began the management of e-waste, it was first stored at our hazardous waste management storage shed in different containers, when the containers were full the environmental department through management would engage a third-party licensed dealer to collect the-waste at a fee. As an organization we managed to purchase a shredder as a way of recycling and reusing our e-waste. The process involves five general stages namely collecting, sorting, dismantling, shredding and metal recovery at the smelter. The e- waste is collected from points of generation and stored in what we call an IT container, from there, it is transported to the hazardous storage area where it is sorted, dismantled (separation of PVC from metal) the PVC is stored separately while the metal casings is then shredded into smaller parts and these are taken to the smelter for metal recovery. The organization is currently exploring whether the PVC can also be shredded or a licensed waste collector can be engaged
			Dangote	The e-waste generated in the organization is being stored in containers and only one type (which are fluorescent tubes) are being used for energy recovery. The organization is in the process of engaging licensed third-party dealers specialized in e-waste collection at the time of the interview

Table 9: The responses for question 7 from the ‘Mining organization’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Regulations	Mining Organization	7.What management practices of e-waste have you employed in your organization?	FQM (Kansanshi Site)	The organization has implemented the process of metal recovery in the management of e-waste that involves collecting, sorting, dismantling, shredding and metal recovery.
			Dangote	At the moment, the e-waste generated is only being collection and stock piled.

Table 10: The responses for question 10 from the ‘Mining organization’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Regulations	Mining Organization	10.Are there any challenges this organization is facing in the management of electronic waste?	FQM (Kansanshi Site)	The proper quantification of the-waste generated is difficult as some departments in the organization are disposing of the e- waste in general waste bins. The other challenge being the proper management of the PVC recovered after sorting and dismantling the e- waste.
			Dangote	The increasing in the quantity of the e- waste stock pile is becoming a challenge and not having enough information on how best to manage this type of waste from the Regulatory body is contributing.

Table 11: The responses for question 12 from the ‘Mining organization’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Regulations	Mining Organization	12. Is there anything you would like to mention on the future plans of electronic waste management in your organization.	FQM (Kansanshi Site)	Having an opportunity to have PVC casings recovered from the dismantling process recycled through a licensed recycling company or dealer is one of the future plans for the organization,
			Dangote	At the moment the organization is in the process of engaging a third party licensed dealer. The organization seeks to attain enough knowledge in the sorting and dismantling of the e- waste generated and to properly separate the components as there are plans that some components might be considered as alternative fuel in the kiln (furnace).

Table 12: The responses for question 5 from the ‘Regulatory body’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Regulations	Regulatory Body	5.Are there any challenges this body is facing in the management of electronic waste?	ZEMA	The lack of infrastructure to support e-waste management such as an engineered dumpsite and recycling and dismantling equipment has been a major challenge. Other contributing factors being lack of adequate funding to carry out sensitization and awareness campaigns and lack of e-waste Technical Guidelines on the management of this type of waste.

Table 13: The responses for question 6 from the ‘Regulatory body’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Regulations	Regulatory Body	6.What has hindered this regulatory body when it comes to the management of e-waste?	ZEMA	The major hindrance in the implementation of better management practices has been the lack of proper funding on e- waste sensitization programs and development of e-waste Technical Guidelines.

Table 14: The responses for question 9 from the ‘Regulatory body’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Regulations	Regulatory Body	9.Are there any companies registered with you that deal with the final disposal of e-waste?	ZEMA	Currently there are no companies that deal in the final disposal of e-waste but only those that collect it and export it to other countries for recycling.

Table 15: The responses for question 10 from the ‘Regulatory body’ interview guide

Theme 2	Interview Guide	Question Number	Institution	Answer Given
Regulations	Regulatory Body	10.If yes to question 9, what methods are being used?	ZEMA	The only method being used is the transboundary movement of the-waste to other countries for recycling.

Table 16: The responses for question 8 from the ‘Mining organization’ interview guide

Theme 3	Interview Guide	Question Number	Institution	Answer Given
Regulatory Standpoint	Mining Organization	8.What measures have Regulatory body put in place to manage electronic waste in your organization?	FQM (Kansanshi Site)	Conducting at least two compliance inspections/ audits and offering help with regards environmental management.
			Dangote	Provide help with contacts e-waste third party licensed dealers and conducting compliance inspections.

Table 17: The responses for question 9 from the ‘Mining organization’ interview guide

Theme 3	Interview Guide	Question Number	Institution	Answer Given
Regulatory Standpoint	Mining Organization	9.Do you receive any help from Regulatory body in the management of e-waste?	FQM (Kansanshi Site)	The organization is receiving help from ZEMA such as licensing and environmental monitoring through inspection of sites within the organization and the agency offers advice on which recycling facilities are functional in the country
			Dangote	Not enough help is received from Regulatory body but ZEMA does help in engagement with different recycling companies but much improvement is needed

Table 18: The responses for question 13 from the ‘Mining organization’ interview guide

Theme 3	Interview Guide	Question Number	Institution	Answer Given
Regulatory Standpoint	Mining Organization	13.What changes do you think should be made in order to improve on the management practices of e-waste in the mining industry?	FQM (Kansanshi Site)	There’s need for more awareness on e-waste and its harmful effects on the environment because not enough people know the toxicity of this waste and challenges that are involved in its management, that is why people end up throwing them in any bin and secondly there is need to Support local recyclers. She continued that regulators can empower local recyclers instead of having to transport e- waste to other countries such as South Africa
			Dangote	The agency needs an act of guidance and licensing regulations for the management of electronic waste to guide the industry on the best way to manage this type of waste.

Table 19: The responses for question 1 from the ‘Regulatory body ‘interview guide

THEME 3	INTERVIEW GUIDE	QUESTION NUMBER	INSTITUTION	ANSWER GIVEN
Regulatory Standpoint	Regulatory Body	1.Discipline of the respondent.	ZEMA	Environmental Inspector

Table 20: The responses for question 2 from the ‘Regulatory body ‘interview guide

Theme 3	Interview Guide	Question Number	Institution	Answer Given
Regulatory Standpoint	Regulatory Body	2.How do you understand electronic waste?	ZEMA	Electronic waste or e-waste describes discarded electrical or electronic devices. E-waste is a popular, informal name for electronic products nearing the end of their "useful life." Computers, copiers, and fax machines are common electronic products. Many of these products can be reused, refurbished, or recycled.

Table 21: The responses for question 3 from the ‘Regulatory body’ interview guide

Theme 3	Interview Guide	Question Number	Institution	Answer Given
Regulatory Standpoint	Regulatory Body	3.What are the negative impacts of electronic waste on human life and the environment?	ZEMA	Some of the characteristics of e-waste are: ignitable, or something flammable; corrosive, or something that can rust or decompose; reactive, or explosive; carcinogenic, may cause cancer and toxic, or poisonous.

Table 22: The responses for question 11 from the ‘Regulatory body’ interview guide

Theme 3	Interview Guide	Question Number	Institution	Answer Given
Regulatory Standpoint	Regulatory Body	11.Is there anything you would like to mention on the future plans of electronic waste management in the mining industry or Zambia at large.	ZEMA	The Agency has been engaging key stakeholders (companies that deal with e-waste) in order to come up with a national e-waste inventory which would help in establishing the hazardous waste (e-waste) hierarchy. This is done in order to provide a platform or basis in which to open up a recycling or processing plant for e-waste by the prospective investors.