Exploring E-waste Management Practices in South African Organisations

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Abstract

The previous studies have delineated the weakness and drawbacks of e-waste practices in various organisations. However, these studies failed to address major issues relating to effective e-waste management, hence the high rate of obsolescence of electronic equipment continues to grow becoming the fastest growing waste stream in the world. Organisations are paying little attention to the environmental aspects, and there is limited research surrounding e-waste in South African organisations. The primary motivation of the study was to determine the current e-waste practices in the South African organisations to contribute to sustainable e-waste management. The sample was drawn from ten South African organisations from the viewpoint of Information Technology (IT) professionals and managers through semi-structured interviews. The findings of the study revealed that there is a lack of environmental awareness programme in South African organisations, research is not conducted during the procurement process and there is no procurement strategy, limited budget is provided to purchase electronic equipment, hardware’s and software’s are not upgraded to extend the life span of electronic equipment, and data is not managed appropriately, there is lack of recycling capacity, obsolete electronic is not properly disposed of, and there is non-conformance to environmental legislations due to lack of enforcement. The study recommends an increased environmental awareness programme in South African organisations, research to be conducted prior purchasing, develop procurement strategy, provide sufficient budget and purchase environmentally friendly electronic equipment that are less harmful to the environment. The hardware’s and software’s should be upgraded to extend the life span of electronic equipment, and recycling of e-waste should be conducted to reduce and manage e-waste. To some extent, obsolete electronic equipment should be returned to the supplier to ensure safe disposal, and effort should be made to ensure regulatory compliance with the environmental legislations.

Keywords: electronic equipment, e-waste management, environnmental sustainability

1. Introduction

Globally, technological innovation, increased use of internet, universal availability of electronic equipment and changing preferences of consumers is creating a daunting challenge for electronic waste (e-waste) management (Samarakoon, 2014; Kumar and Bhaskar, 2016; World Economic Forum, 2019:6). The result of this technological advancement, upgrading and demand of electrical and electronic equipment (EEE) has contributed to the drop of the average life cycles of new computers resulting in substantial reduction of their lifespan (Perkins et al., 2014; Moyo et al., 2019; Ichikowwitz and Hattingh, 2020:44). Empirical evidence indicates that the high rate of obsolescence of electronic equipment has caused organisations to replace their EEE frequently and discarding obsolete electronic equipment. As a result, e-waste is becoming the fastest growing waste stream in the world (Lundgren, 2012:12; Borthakur and Sinha, 2013; Jayapradha, 2015; Kumar and Bhaskar, 2016:2).

In the past, organisations paid littlle attention to environmental aspects; hence, a huge growth of e-waste over the past decade (Heacock et al., 2016:3). Therefore, the importance of finding solution for effective e-waste management has become urgent to contribute to environmental sustainability. The purpose of the study is to explore the current e-waste practices in South African organisations to contribute to sustainable e-waste management. This paper proposes new approaches that can be used to reduce the growing accumulation of e-waste, improve sustainability and economic growth through effective management systems.

2. Background and Context of E-waste Generation

EEE has become an essential part of everyday life in enhancing the living standard of the modern society, globally (Lundgren, 2012:23; Kumar and Bhaskar, 2016; Torres et al., 2016). Electronic waste is comprised of numerous forms of electrical or electronic equipment that have reached end of use (i.e., obsolete) in their life cycle, and therefore are no longer needed by the owners (Begum, 2013:47; Shagun, Kush and Arora, 2013; Moyo et al., 2019). It is estimated that during 2016, approximately 44.7 million tons (Mt) of e-waste was generated internationally. This pattern of high volume of e-waste generation increased substantially to 53.3 Mt during 2019 and translated to an average of 7.3 kg per capita (Forti et al., 2020). Without concerted action, this waste stream will continue to grow exponentially reaching a high level of 74.7 Mt (about three to four percent growth annually) by 2050 (Forti et al., 2020; Ichikowitz and Hattingh, 2020).

The statistical analysis of the quantity of e-waste generated during 2019 in various continents show that Asia generated 24.9 Mt (5.6 per capita), America 13.1 Mt, Europe 12 Mt (16.2 per capita), Africa 2.9 Mt (2.5 kg per capita) and Oceania 0.7 Mt (16.1 kg per capita) (Forti et al., 2020). From this theoretical lens, it is explicit that the phenomenon of e-waste is growing at an alarming rate of almost 2 Mt annually, globally, and this threatens the planet's ecosystems (Ichikowitz and Hattingh, 2020).

United Nations Environment Programme (UNEP) reports estimate that the annual global e-waste generation is around 20 to 50 million metric tons, which is equivalent to about 5% of the global municipal solid waste production (Shamim, Mursheda and Rafiq, 2015:1). In the same vein, the United States (US) Environmental Protection Agency (EPA) anticipates an increase of global municipal solid waste from 5% to 10% in the coming years due to accelerated population growth and economic activities (Torres et al., 2016:1; World Economic Forum, 2019:14). It is therefore not amazing that approximately 5-8% is still found in municipal waste due to inappropriate disposal. This suggests that e-waste has become almost three times the rate of municipal solid waste, globally (Samarakoon, 2014:1; Ichikowitz and Hattingh, 2020).

In Africa, the continent has approximately 1.2 billion inhabitants which generate an average of 2.5 kg per capita of e-waste (World Economic Forum, 2019:14; Forti et al., 2020). Without any intervention, this exponential increase of e-waste will force the African countries to make unforeseen sacrifices in the future to minimise the amounts of e-waste because it has become a global threat to environmental sustainability (Shamim, Mursheda and Rafiq, 2015:1; Kumar and Bhaskar, 2016:4; Forti et al., 2020).

Despite the low per capita generation of e-waste in poorer developing countries such as South Africa, e-waste is still receiving little attention and improperly managed due to large presence of the informal sector managing e-waste (Kumar and Bhaskar, 2016:3). It is estimated that approximately 80% of e-waste is generated by government and businesses in South Africa (Lawhon, 2012:70). The argument is that this excessive generation of e-waste is posing a threat to the environment and has the potential to impede the sustainable development of the society and compromise the future of the coming generation (Shamim, Mursheda and Rafiq, 2015:10; Kumar and Bhaskar, 2016:4).

3. Statement of the Problem

The phenomenon of e-waste is caused by a lack of adequate public awareness; lack of facilities for e-waste collection; a lack of government policy and legislation; a lack of an effective collection system and logistic infrastructure; the dominance of the recycling sector by an uncontrolled, ill-equipped informal sector that pollutes the environment; a lack of adequate recycling facilities; technical barriers (knowledge of recycling process); poor financing of hazardous waste management activities; and a lack implementation of the extended producer responsibility (EPR) system (Khaliq et al., 2014:174; Perkins et al., 2014; Forti et al., 2020:71).

Moreover, there is limited contribution from research and unavailability of recent e-waste statistics because the current statistics have been overused or obsolete (Forti et al., 2020:73). Therefore, information about the generation, movement and destination of e-waste is lacking. As a result, it is extraordinarily difficult to monitor and track e-waste, hence the loopholes are rampant (Lundgren, 2012:13).

Previous studies have described the weakness and drawbacks of e-waste practices in several organisations. However, the studies failed to address major issues relating to effective e-waste management in organisations. Simply put, there is limited research surrounding e-waste management in South African organisations in terms of its devastating impact to the environment and further research is required on this subject.

4. Research Objectives and Questions

The study seeks to evaluate the e-waste management practices in South African organisations. To achieve this aim, the following objectives are formulated.

- To identify factors that influence the procurement process of electronic equipment in South African organisations.
- To determine the factors that contribute to the generation of e-waste.
- To assess the current e-waste management practices in South African organisations.
- To determine the compliance of South African organisations with relevant environmental legislations pertaining to management of e-waste.

5. Research Questions

- What are the factors that influence the procurement process of electronic equipment in organisations?
- What are the factors contributing to e-waste generation in organisations?
- How do organisations manage e-waste?
- How do organisations ensure compliance with relevant environmental laws in relation to e-waste management?

6. Overview of Literature Review

6.1 The Importance of Green Design in the Production of Electronic Equipment

The Waste Electrical Electronic Equipment Directive of the European Parliament and the Council (2002/96/EC) has directed the promotion, reuse, recycling and reduction of e-waste generation. This directive encourages green design in the production of electronic equipment through collection of e-waste, segregation, recovery and recycling by utilizing the best technology and making the producer responsible for financing the returning back of electronic equipment (Lundgren, 2012:36).

6.2 The Role of Extended Producer Responsibility to Manage E-waste

The primary objective of EPR is to provide economic incentive for producers by considering environmental aspects during the design and manufacturing of the electronic equipment to improve e-waste management. EPR transfers the responsibility to the producer for collection, treatment, reuse, and recycling of e-waste (Torres et al., 2016:25; Miner et al., 2020). Without the implementation of the EPR, the producer is not legally obliged to comply with the effective sustainable e-waste management (Forti et al., 2020). Therefore, a consensus has emerged that e-waste should be properly disposed and managed by means of EPR where organisations are willing to play a meaningful role in its recycling by ensuring protection to human health and the environment (Shamim, Mursheda and Radiq, 2015).

6.3 The Significance of Green Procurement in Promoting Environmental Sustainability

Green procurement means that all purchasing decision and allocation of contracts take into consideration of the environment, including quality, price and delivery. This process or practice has the potential to reduce the deleterious consequence of e-waste and ensure environmental sustainability. The intention of green procurement is to contribute significantly to the protection of the environment by ensuring that the suppliers comply with the environmental standards (Meloni et al., 2018:11). Essentially, green procurement is critical to ensure that the suppliers of electronic equipment conform with the green credentials to promote environmental sustainability. It has the potential to create a solid, healthy society that lives with the environmental limits through the promotion of good governance (Agyepong and Nhamo, 2017).

6.4 The Effects of Short Life Cycle of Electronic Equipment

The technological advancement of electronic equipment has caused the average life cycle of new computers to drop drastically in the recent years by nearly 50%, from five years to two years, with fewer options of repairs, not easy to dissemble or recycle because they are designed for disposal (Perkins et al., 2014; Moyo et al., 2019; Ichikowwitz and Hattingh, 2020:44). This shorter life cycle and replacement of obsolete electronic products has adverse impacts on the environment because of improper disposal in landfill sites (Gaidajis, Angelakoglou and Aktsoglou, 2010; Borthakur and Sinha, 2013; Jayapradha, 2015; Heacock et al., 2016:4; World Economic Forum, 2019:6).

In the next few years, the demand of electronic equipment will continue to increase gradually due to economic growth and high population rates resulting in frequent purchasing of new electronic equipment (Lundgren, 2012:9;

Torres et al., 2016:1; Miner et al., 2020:1). This will inevitably cause many organisations to constantly replace their electronic equipment to ensure effective and efficient business operation by discarding obsolete electronic equipment (Suja et al., 2014; Ichikowitz and Hattingh, 2020). Without intensive action to manage e-waste, the organisations are likely to witness a considerable rise of e-waste in the future (Kumar and Bhaskar, 2016).

6.5 Increasing the Life Span of Electronic Equipment Through Reuse and Refurbishment

The reuse and refurbishment can contribute substantially to the reduction of the growing accumulation of e-waste (Meloni et al., 2018:9). However, the reuse of electronic equipment has some limitations because it can only extend the life of the electronic equipment temporarily. This is the reason that there is a lack of recognition of reuse as an alternative method to manage e-waste, thus posing challenges to the fragility of the planet ecosystem (Torres et al., 2016:7). However, cloud computing has been identified as an alternative solution because it has the potential to increase the life span of electronic equipment since the users are more attached to their data rather than their devices (Meloni et al., 2018:9).

6.6 The Benefits of Using Switzerland Model to Manage E-waste

E-waste is becoming a concern due to the rapid increase in environmental footprint and high volumes of waste generation. The Switzerland model has been used as a good benchmark for efficient and effective e-waste management (Advanced Tropical Environment, 2012:14). This model ensures that the consumer is charged recycling fee in the sale price of the electronic product in advance, and this amount covers the process of safe disposal of the equipment at the end of life cycle. Thus, the consumer can return the obsolete equipment free of charge at any dedicated collection sites in Switzerland to prevent obsolete electronic equipment reaching the landfills (Chowdhury, 2012:4). In principle, this model encourages the retailers, importers, and manufacturers to take back the electronic equipment to ensure that they are managed in an environmentally sustainable manner (Gaidajis, Angelakoglou and Aktsoglou, 2010).

6.7 The Role of Circular Economy

A circular economy is a system that ensures that all the materials and components of the electronic products are kept at the highest value, and waste is designed properly out of the system, which is the opposite of the linear economy (Awasathi et al., 2019). The introduction of the circular economy for electronic equipment has reduced the cost of the consumers by 7 percent during 2020, and is expected to reduce the cost of the consumer by 14 percent in 2040. More importantly, the approach of circular economy encourages the producers of electronics to offer buy-back or return the refurbished obsolete electronic equipment to the producer (World Economic Forum, 2019:18). Scientific studies show that 50 percent of the users are willing to buy used or refurbished electronic equipment under the right condition (Meloni et al., 2018:9).

6.8 The Impacts of E-waste Generation and Inappropriate Disposal to the Environment

Globally, about 82.6% of e-waste was generated during 2019 without any formal collection (De Froberville, 2019). This lack of collection of obsolete and dilapidated electronic equipment from consumers has become a major stumbling block across many countries, globally (Awasathi et al., 2019). On the other hand, the fundamental flaws of e-waste collection and recycling without strategies in organisations will cause the future of the upcoming generation to be grim (Veit and Bernardes, 2015). It is projected that e-waste production will increase substantially by 20 Mt annually, and to the great extent, some of this waste will end up in landfills and impact the ecosystem (Gaidajis, Angelakoglou and Aktsoglou, 2010). It is also estimated that about 5-8% of e-waste continue to be dumped in landfills, hence it is imperative to identify remedial actions to reduce e-waste and preserve the environment (Ichikowitz and Hattingh, 2020).

In South Africa, the handling of e-waste is posing a serious challenge due to unscientific disposal practices and lack of specific legal frameworks around e-waste management (Khaliq et al., 2014:2; Jayapradha, 2015; Torres et al., 2016:37; Moyo et al., 2019). As a result, some organisations continue to stockpile their e-waste because they don't know how to dispose it (Gaidajis, Angelakoglou and Aktsoglou, 2010; Perkins et al., 2014). This lack of awareness or waste information contributes to the illicit practice of disposing of e-waste in landfills or open places by South African organisations (Lundgren, 2012:12; Muzenda, 2013; Veit and Bernardes, 2015:6).

6.9 The Effects of Hazardous Chemical Agents on Human Health and Environment

E-waste is composed of great number of different sizes, shapes and chemistry (Khaliq et al., 2014:2). It contains complicated assembly of 1,000 different substances such as brominated flame retardants, chlorofluorocarbons, beryllium, antimony, phthalates, mercury, arsenic, hexavalent chromium, lead, cadmium, polychlorinated biphenyls, polybrominated diphenyl ether and polybrominated biphenyls which are highly toxic and are a source of pollution and risk to human health and the environment (Lundgren, 2012:12; Borthakur and Sinha, 2013; Samarakoon, 2014:2; Heacock et al., 2016:4; Torres et al., 2016:12; Moyo et al., 2019; World Economic Forum, 2019:13; Forti et al., 2020).

Most of these components are detrimental to the environment and public health because some have been found to be carcinogenic (causing the formation of cancer), teratogenic (causing developmental malformations) and mutagenic (increased alteration of genetic material usually DNA) (Forti et al., 2020). Such harmful substances can bioaccumulate (toxins building up within the tissues of organisms) due to increased exposure (Torres et al., 2016:12). Also, the cocktail effect of interaction of these chemicals are sometimes greater than the effects of chemicals individually (Lundgren, 2012:23).

In a study conducted at Sri Lanka in 2014, approximately 40 percent of heavy metals stemmed from e-waste were found in dumping sites resulting in ground water and soil contamination, land degradation and loss of biodiversity (Khaliq et al., 2014;3; Samarakoon, 2014; Jayapradha, 2015; Veit and Bernades, 2015:5; Torres et al., 2016:12; World Economic Forum, 2019:6). In the same vein, several studies have also discovered that about 50 t and 71 kt of brominated flame retardants plastics globally in undocumented flow of e-waste, and this is attributable to poor handling and unsafe disposal (De Froberville, 2019; Forti et al., 2020). These substances contain toxic materials that are released to the atmosphere during incineration and contributes to an increase environmental footprint (Khaliq et al., 2014:2; Samarakoon, 2014:1; Kumar and Bhaskar, 2016; Fort et al., 2020). Moreover, there is little research on the knowledge and awareness of this waste stream (Miner et al., 2020:2). Therefore, effective handling and disposal methods of e-waste can play a significant role to reduce environmental harm (De Foberville, 2019; Forti et al., 2020).

6.10 The Importance of E-waste Recycling

Switzerland was the first country to implement electronic recycling system in 1991, through the collection of unused and obsolete electronic equipment. It is estimated that the country recycled about 98 percent of all e-waste using advanced technologies that prevented atmospheric pollution and other environmental impact (Shamim, Mursheda and Rafiq, 2015:2).

A review on e-waste recycling shows that Europe is the continent with the highest collection and recycling with approximately (42.5%), followed by Asia (11.7%), United States (9.4%), Oceania (8.8%) and Africa with (0.9%) (Forti et al., 2020). The overall picture of (0.9%) in Africa demonstrates that there are ineffective e-waste recycling and collection efforts in developing countries such as South Africa (De Froberville, 2019). The relative low statistics of e-waste recycling is exacerbated by the absence of accurate data to determine the exact figure of the growing accumulation in developing countries (Forti et al., 2020). However, it is projected that approximately 11% of e-waste is being recycled on annual basis in South Africa (Ichikowwitz and Hattingh, 2020:44).

The most powerful inhibitor of e-waste recycling is caused by the lack of coordinated effort and expertise to extract valuable resources, to meet the social, political, economic and environmental challenges (Khaliq et al., 2014:2; Heacock et al., 2016:8). As such, the country is dominated by informal collectors and recyclers without the necessary technical skills and using rudimentary techniques (Ichikowitz and Hattingh, 2020:44). Little attention has been given by previous studies on appropriate recycling methodologies. Therefore, it strongly recommended that the recycling of e-waste should be conducted by trained workers using technologically advanced facilities (Perkins et al., 2014).

6.11 Recovery of Precious Metals From Electronic Equipment Through Recycling

E-waste is recognised as a resource due to the potential recovery of valuable materials such iron, alluminium, copper, gold, silver, platinum, palladium and rare metals from the 69 elements of the periodic table (Heacock et al., 2016:4; Torres et al., 2016:12; World Economic Forum, 2019:11; Forti et al., 2020:58). The recovery of precious can be done through recycling because 95 percent of useful materials can be recovered through disassembly and destruction of the equipment. In the end, these valuable materials can be sold or reused (De Froberville, 2019). Unfortunately, these valuable resources and materials continue to be unused (World Economic Forum, 2019:6). The critical challenge is that some of this electronic equipment has not been designed efficiently to ensure that the valuable materials can be recovered during their disposal (Heacock et al., 2016:4).

6.12 The Impact of Informal E-waste Recycling

E-waste management in the developing countries is dominated by the informal sector and recyclers. This is despite few countries such as South Africa, Morocco, Egypt, Namibia and Rwanda having recycling facilities that co-exist with the existence of a large informal sector. South Africa is dominated by the informal sector and recyclers that use rudimentary techniques, without appropriate technology, and lacking the capacity to control and manage e-waste (Forti et al., 2020). The poor design and complexity of electronic equipment pose a serious challenge on the recycling industry because different materials are combined, bolted, screwed, snapped, glued and soldered together which makes separation and recovery of materials difficult (Lundgren, 2012:18).

The recycling practice for electronic equipment include manual disassembly, heating printed circuit boards in order to recover solder and chips, acid extraction of metals from complex mixtures, burning plastics to isolate metals and melting and extruding plastics (Forti et al., 2020). This burning and heating (incineration) expose workers to fumes that are harmful to the health of individuals through inhalation (Moyo et al., 2019). This inhalation of fumes cause many people to experience symptoms of headaches, shortness of breath, chest pains, weakness and dizziness (Perkins et al., 2014). It is projected that the carbon emissions associated with the production and use of electronic equipment will reach 14 percent of total emission by 2040. Without any abatement, the volume of e-waste will continue to escalate to more than million tons annually by 2060 (World Economic Forum, 2019:10).

The recycling activities in the informal sector are generally labour intensive and requires sophisticated technologies to seprate materials, involves low income and unregulated work (Lundgren, 2012:25; Heacock et al., 2016:3; Torres et al., 2016). This informal sector is not regulated, lacks structure, is unregistered and illegal, lack workplace health and safety, lack appropriate technical skills and technology, and do not have appropriate facilities to manage e-waste, and is conducted by the poor and marginalised social group for survival (Perkins et al., 2014; Shamim, Mursheda and Rafiq, 2015:3; Heacock et al., 2016:8; Moyo et al., 2019; Ichikowwitz and Hattingh, 2020).

6.13 The Lack of Legislation Enforcement in Controlling E-waste

It estimated that about 1.3 million tonnes of obsolete electronic equipment (70%) are shipped illegally from developed countries to developing countries every year (Ichikowitz and Hattingh, 2020). The rationale according to US Environmental Protection Agency is that it is cheaper to export waste than to process it (Lundgren, 2012:14). These exports take place under the false pretence of donations, repair, refurbishment, direct use, and recycling passing at the ports without the authorities being able to detect this illegal practice (World Economic Forum, 2019:14).

The criminal syndicates disguise the labelling of used electronics and conceal e-waste by mixing waste with legitimate consignments and manipulate the custom declaration to the authorities when the ship carrier is due to leave the port. Consequently, this is contributing to the growing accumulation of e-waste in developing countries (Lundgren, 2012:17; Holmner and Marais, 2013:136; Sthiannopkao and Wong, 2013; Moyo et al., 2019).

The exported electronic equipment constitutes a serious breach of the transboundary shipment framework of the Basel Convention established since 1992. This Convention emphasises that export should only take place with the written consent of the country of import (Heacock et al., 2016:13), and waste should be treated freely like common goods to protect human health and environment (Suja et al., 2014; Forti et al., 2020:54; Ichikowwitz and Hattingh, 2020:44).

It is estimated that the volume of transboundary movement of used electronic equipment is ranging between the 7-20% globally (Moyo et al., 2019; Forti et al., 2020). This is the reason the Rotterdam Convention encourages a shared responsibility between the exporting and importing countries for human health and eco-sustainability. The primary intention is to promote the exchange of information about the toxic chemicals that may be exported and imported (Lundgren, 2012:34).

The International Criminal Police Organisation (INTERPOL) research by Pollution Crime Working Group has discovered that there is a syndicate network of criminals that profit from illegal export of e-waste to the developing countries (Shamim, Mursheda and Rafiq, 2015:5). This illicit practice continues to happen despite the media and environmental groups exposing this “white collar” crime of smuggling e-waste (Lundgren, 2012:17). Regrettably, this undesirable practice has become a burning issue for developing countries such as South Africa because e-waste has become a dumping ground of the developed countries, and the prospects of being caught is very little (Shagun, Kush, and Arora, 2013:490; Forti et al., 2020).

The countries in Africa such as Egypt, Ghana, Madagascar, Nigeria, Rwanda, South Africa, Cameroon and Cote D'Ivoire have developed and published legislations on e-waste. However, these countries are still experiencing a serious challenge on enforcement (Muzenda, 2013:79; Forti et al., 2020). Moreover, the number of illegal shipments of e-waste is gradually increasing annually accounting to about 70% of all e-waste, globally. This illegal shipment is attributed to the lack of effective enforcement of legislations and regulations that are specific to the management of e-waste (Lundgren, 2012:16; World Economic Forum, 2019:13; Miner et al., 2020:1).

The presence of legislation in the world means nothing if it cannot be enforced (Forti et al., 2020). This means without intensive action to manage this practice, the cost of managing e-waste will be soon too great for the society, government, and businesses to ignore. Therefore, finding ways to enforce legislation and combat this illegal shipment of electronic equipment is required (Kumar and Bhaskar, 2016).

6.14 The Challenges of E-waste Management in Organisations and Institutions

E-waste is presenting environmental management challenges across many economic sectors, and organisations and institutions. In a study conducted at University Kebangsaan Malaysia (UKM) in 2011, a myriad of environmental challenges that were identified at organisational level involved inefficient data management, equipment classifications, low awareness of e-waste, collection and disposal problems and lack of specific regulations and policy in the end of life of EEE (e-waste) and poor management practices within the University. Consequently, the study recommended that strategies to collect and record data of e-waste should be developed in holistic manner. This initiative could help strengthen e-waste management at organisation level (Chibunna et al., 2012).

In another study conducted by Kiddee, Naidu and Wong (2013), based on the case studies of e-waste recycling in China, India and Ghana. The study identified that toxic substances from e-waste is impacting the environment and human health through improper disposal. As a result, the study recommended that the life cycle assessment of electronic equipment should be conducted, and extended producer responsibility policy should be developed to resolve the growing accumulation of e-waste. Nagajothi and Felixkala (2015) revealed that e-waste management practices in India continue to suffer drawbacks because of insufficient legislation, poor inventory, health hazards resulting from informal recycling, lack of awareness and reluctance of corporate companies to address the growing accumulation of e-waste.

Whereas e-waste management has been stated at various institutions and organisations there is very scarce literature about some management at organisation level especially in South Africa. This is in stark to the situation in India, where research has been conducted on e-waste disposal, for instance Kishore (2010) found that many organisations lack awareness and appropriate skills to discard electronic waste. To overcome this shortcoming, preventative plan and strategy, training on legislation, safe disposal and proper collection system are needed to reduce the ongoing accumulation of e-waste.

In light of the above-mentioned literature gap, the study seeks to evaluate e-waste management practices amongst several organisations in South Africa. These organisations procure several electronics such as desktops, laptops, printers, scanners, telecommunications devices and others, therefore, the generation of e-waste in such organisations is inevitable. Preliminary studies focused primarily on solid waste without addressing e-waste separately as an independent subject. Therefore, an intense study is required to understand e-waste management practices in South African organisations. The study intends to fill a growing gap that has been identified in literature and find sustainable solutions for managing e-waste effectively in South African organisations.

7. Materials and Methods

7.1 Geographical Charcteristics of the Study Area

The geographical location of the study area was Gauteng, North-West, Free-State and Mpumalanga region in South Africa.

7.2 Research Design and Methodology

Research design is an overall plan of the research and articulates what data will be required, what methods will be used to collect and analyse data, and how the research question will be answered, and the techniques that will be used in reporting and analysing the data (Bless, Smith and Kagee, 2006). For this study, this plan was supported by a detailed understanding of epistemological conventions and explicit articulation of what the study intended to achieve (Sinkovics and Alfodi, 2012). The primary intention of this plan was to discover the content of knowledge that was required for sustainable e-waste management practices, and measures to expose the philosophical concepts that support the research approach. This was to ensure that the evidence that was attained by the researcher was able to answer research questions as ambiguously as possible (Bless, Smith and Kagee, 2006). This research plan required a particular methodology before getting data or analysing the data to determine the responses to questions through the application of scientific measures (Hox and Boeije, 2005:593).

7.3 Population of the Study

The population is any complete group of entities that share some common characteristics. It provides a group of elements from which a researcher samples and likely to generalise (Clarke 2011:102). The population of the sampling method selected for this study was non-probability sampling which had elements identified as known and not zero probability from ten South African organisations. This means that the sample was drawn in a way that does not give every participant of the inhabitants a known chance of being nominated. The selection criteria for inclusion in this study was IT professionals (19) and management (11) who articulated experience as it relates to the e-waste phenomena from ten South African organisations.

7.4 Sampling Framework/Procedure

The method by which the researcher reduces the total population for a research project to a number that is practically realistic and theoretically suitable is called sampling. The identification of the research must depend on the research questions that the researcher wants to be answered (Leedy and Ormrod, 2015:279-284). The sampling strategy, that is design and size, depends on the research paradigm (Leedy and Ormrod, 2005). For this study, sampling was based on qualities rather quantities by using participants who might offer thick descriptions of the phenomena under study (Nicholls, 2009). In utilising this technique, the researcher had no way of predicting or ensuring that each element of the population was represented in the sample through the selection of non-probability sampling. The primary aim of purposive sampling was to construct a sample that is meaningful theoretically, build in certain characteristics or conditions and assist in developing and testing findings and explanations (Hox and Boeije, 2005:595).

The sampling was obtained from each participating organisation in South Africa. The research focused on the following stakeholders as its target population: (i) Information and Technology managers (11), and (ii) IT Specialist/Technicians (19). The researcher carried on developing a sample until saturation of data was reached (when researcher is not producing any significant new insights in relation to the core questions), no new information is coming forward; no new categories are coming considering the selected nonprobability sampling (Leedy and Ormrod, 2015:319).

7.5 Data Collection Methods

The data collection in this study was conducted through semi-structured interviews and both primary and secondary data was used. Primary data was generated through semi structured interviews, while secondary data was obtained from previous studies on e-waste books, journals, articles as well as other documents in government databases. The researcher followed an inflexible procedure that was intended to seek answers in order to set preconceived questions through semi structured interviews (Struwig and Stead, 2010:98). The semi-structured interviews seeked to cover both factual and meaningful information, and the participant had the opportunity to respond more elaboratively and in greater detail (Saunders et al., 2007).

All the interviews were recorded with the permission of the participants. After the interviews the recording was transcribed into computer files. The researcher recorded the information and made use of hand-written notes. In this regard, care was taken to assure the respondents that they will not be identifiable, including their workplace and any subsequent report. The transcript of the interview was sent to the participant to get the participants' written acknowledgement for its accuracy or corrected copy. In the end, the participants were informed that once the final research was written, the recording of the interviews would be destroyed.

7.6 Data Analysis and Interpretation

Primary data collected during interviews was stored in MS Excel (Version 2016) for processing and coding. This data was subjected to both descriptive and inferential statistical analysis by making use of the of soft package of SPSS 25 version. It required several closely related operations such as establishment of categories, application of these categories to raw data through coding and drawing statistical inferences (Greenacre, 2009). The results derived from the analysis was summarised by means of tables, pie charts, bar graphs and other graphical representations. The qualitative data collected from the sampled organisations was transcribed and subjected to content analysis and thematic mapping. Thematic analysis was used to identify themes which emerged from a given episode. The transcriber and the researcher ensured verbatim transcription of all the interviews. The qualitative data was coded using an iterative process of reviewing the transcribed data and codes (Leedy and Ormrod, 2015). The following tests were used in the analysis of the results of the study:

- Descriptive statistics including means and standard deviations, where applicable. Frequencies were represented in tables or graphs.
- Chi-square goodness-of-fit-test: A univariate test, used on a categorical variable to test whether any of the response options were selected significantly more/less often than the others. Under the null hypothesis, it is assumed that all responses are equally selected.
- Binomial test: Tests whether a significant proportion of respondents select one of a possible two responses. This can be extended when data with more than 2 response options is split into two distinct groups.

8. Results and Discussion

8.1 Characteristics of Participants

Out of the 30 IT personnel that were interviewed, 23 (77%) were predominately males while 7(23%) were females. However, preference was not given to gender. Part of this population imbalance is attributable to the IT industry being dominated by males. The underlying reason can be due to the inconsistent application of the employment equity across the industry. The proportion of educational achievement were as follows: about 21 (70%) of them obtained Diploma while 9 (30%) hold university degree. This indicates that the majority of the participants are highly qualified, however, education cannot be used as a differentiating factor, and working in the IT industry requires high level of education.

8.2 Distribution of Time in the Company, Involvement in the Company and in the Position

It was discovered that half of the participants 50% (15) served the company between five to six years, and 23% (7) served between seven to ten years, while the remaining 17% (5) served between 1 to 2 years, and 10% (3) served for three to four years. This result indicates that IT personnel's length of service is sufficient to execute their tasks in their organisations. The majority of the participants 63% (19) occupy non managerial positions while 37% (11) occupy managerial positions. This means that most of the participants are probably field workers. In the same way, the majority of participants 63% (19) are involved in the company IT while the remainder 37% (11) are involved in business.

8.3 Summary of the Research Findings

The main findings of this research in relation to each research question are discussed and each question is followed by a discussion of the findings relating to that question.

8.3.1 What Are the Factors That Influence the Procurement of Electronic Equipment in Your Organisation?

To a large extent, the participant (n = 15, 50%) believe that the *IT product life cycle* should be considered during the buying process for their electronic equipment, while some of the participants (n = 15, 50%) were of the opinion that IT departments were *not considering the IT product life cycle* when procuring electronic equipment. In other words, the buying process was conducted in an unstructured manner. Studies reveal that the shorter life cycle and replacement of obsolete electronic equipment is impacting negatively on the environment (Heacock et al., 2016:4; World Economic Forum, 2019:6).

The participants (n = 17, 57%) mentioned that the *lack of conducting research during procurement* is the constraint in purchasing electronic equipment. According to participants, this is the contributory factor to the failure of e-waste management. As such, the organisations are failing to recognise the importance of research before conducting their purchases. Green procurement takes into consideration of the environment, quality, price and delivery (Melonie et al., 2018:11). However, some participants (n = 13, 43%) felt that their companies were conducting research before procuring electronic equipment. Green procurement is critical to reduce deleterious consequence of e-waste and ensure environmental sustainability (Agyepong and Nhamo, 2017; Melonie et al., 2018:11). It is acknowledged that technology can enable the business to grow in a sustainable manner and safe the planet if it used and designed properly.

The participants (n = 21, 70%) mentioned that their companies were *automatically replacing the computers* every three years because the life span of computers is very short. They felt that most of the computers were becoming obsolete in a very short space of time and those computers should be used for spare parts. The survey conducted by Moyo et al. (2019) revealed that the average life cycles of new computers have dropped drastically in recent years because they are designed for disposal. But, some participants (n = 9, 30%) indicated that their companies were not automatically replacing computers.

Given the drive or impetus to address the growing computing needs, some of the participants (n = 17, 57%) highlighted that their companies did *not have procurement strategy*. Therefore, without procurement strategy, there is uncoordinated implementation of e-waste management that contribute to the generation of e-waste. Green procurement is intended to contribute to the protection of the environment (Melonie et al., 2018:11). In contrast, some of the participants (n = 13, 43%) felt that their companies were having procurement strategies.

Again, the participants (n = 22, 73%) perceived the *quality and reliability* of electronic equipment as a significant element that influences the purchasing of electronic equipment. In their perception, *quality and reliability* is important to ensure good performance of electronic equipment. Whereas, some participants (n = 8, 27%) felt that *quality and reliability* was not a significant factor in the procurement process. The quality and reliability are considered to be critical because many organisations are replacing their electronic equipment every two years as a result of poor quality and unreliability (Ichikowwitz and Hattingh, 2020).

The participants (n = 16, 53%) indicated that *the frequent crashing* of computers is increasing the business operation costs and leading to a decline in performance, while others (n = 14, 47%) mentioned that they did not experience *frequent crashing* of computers. Therefore, their companies purchase computers according to *business needs*. However, some of the participants (n = 14, 47%) were concerned that their *IT system was not matching the business requirements*, thus contributing significantly to e-waste generation. In fact, the electronic equipment should match the business requirements and replaced when they are required. In contrast, the participants (n = 16, 53%) felt that their company IT system was matching the business requirement.

The participants (n = 21, 70%) mentioned that it is not unusual for their companies to *replace old computers* with new ones. This frequent replacement of computers with new ones helps in energy conservation and preservation of the environment. On the other hand, other participants (n = 9, 30%) felt that it was usual for companies to replace old computers. They believe that the use of *task specific requirements* should be conducted to ensure that work is completely successful.

Again, the participants (n = 19, 63%) mentioned that *limited IT budget* was a barrier on their company technology and inhibit the effectiveness of proper e-waste management because their IT operations are not adequately supported in finances. Without finances it is difficult to purchase green products that are energy efficient and *environmentally friendly*. Nevertheless, some of the participants (n = 11, 37%) felt that their companies are providing sufficient budget. The selection of green products involves making trade-offs between environmental impact. Thus, the purchasing of green product is beneficial for the companies to reduce harm to the environment and provide sense of environmental awareness. The benefits of green products are expressed in terms of money, risk or brand.

Then again, the participants (n = 18, 60%) mentioned that procurement should take place only from *suppliers that are going green* because they believe that going green will eventually lead to environmental sustainability. Fundamentally, green procurement is to ensure that the suppliers are conforming with environmental standards (Melonie et al., 2018:11). In contrast, the other participants (n = 12, 40%) stated that their procurement were not focusing on the suppliers going green. In the same wavelength, the participants (n = 19, 63%) mentioned that *too much outsourcing of IT function* was the primary factor that hampers the implementation of sustainable e-waste management. However, the other participants (n = 11, 37%) indicated that their companies were not outsourcing.

8.3.2 What Are the Factors Contributing to E-waste Generation?

The participants (n = 16, 53%) expressed that *frequent crashing of computers* as the negative factor that impedes the sustainability of e-waste management. They felt that the frequent crashing of computers is contributing to the escalating operational cost and result to failure of managing e-waste. It is for this reason that EPR should provide economic incentive for producers of electronic equipment to ensure that the environment is considered during the design and manufacturing to improve e-waste management (Torres et al., 2016:25). In contrast, the other participants (n = 14, 47%) mentioned that they were not experiencing frequent crashing of computers. According to participants (n = 17, 57%) the relative *lack of research before purchasing* is the contributing factor to the failure of e-waste management. As such, their organisations are failing to recognise the importance of research before purchasing electronic equipment. On the other hand, some of the participants (n = 13, 43%) did not perceive research as an important aspect in the purchasing process.

The participants (n = 16, 53%) mentioned that *IT system does not match business requirements* resulting in growing accumulation of e-waste. The participants felt that the IT system should match their business requirements. However, the other participants (n = 14, 47%) felt that their companies IT system match their business requirements. According to the participants (n = 19, 63%) the IT budgetary constraints inhibit the effectiveness of e-waste management. The unwillingness of management to support IT operations with financial support is magnifying the e-waste challenges. But some of the participants (n = 11, 37%) felt that their companies did not experience budgetary problems.

Then again, the participants (n = 17, 57%) expressed some serious concern about *uncoordinated and lack of defined strategy* contributing to e-waste generation. The lack of defined strategy to effectively manage e-waste is posing a daunting challenge for the organisations. However, some participants (n = 13, 43%) considered their companies to have defined strategy to manage e-waste. In the same light, the participants (n = 19, 63%) also mentioned that *too much outsourcing of IT function* is another factor that was hampering the implementation of sustainable e-waste management. The participants expressed concern that outsourcing poses a serious challenge for their organisations because they don’t have proper control. This could mean that the organisations are exposed to possibly weak management, inexperienced staff, business uncertainty, outdated technology, hidden costs, lack of organisational learning and loss of innovative capacity. Regrettably, e-waste is becoming a worry due to the increase in environmental footprint and high volumes of e-waste generation (Advanced Tropical Environment, 2012:14). However, some of the participants (n = 11, 37%) felt that their companies were not outsourcing the IT function.

8.3.3 How Does Your Organisation Manage E-waste?

The participants (n = 12, 40%) mentioned that their companies' strategy for addressing computing needs is about *increasing the IT life span*. As such, this is the underlying reason that they prefer electronic equipment to be *refurbished and upgraded* in order to prolong their life span. The circular economy encourages the producers of electronic equipment to offer buy-back or return for the refurbished obsolete electronic equipment (Wold Economic Forum, 2019:18). Similarly, studies show that 50% of the users are willing to buy used or refurbished electronic equipment under the right condition (Melonie et al., 2018:9). However, some of the participants (n = 18, 60%) felt that their companies were not refurbishing and upgrading their obsolete electronic equipment to prolong their life span.

Again, the participants (n = 15, 50%) mentioned that the *IT product life cycle* should be a prerogative during the buying process of computers and peripherals, while the other participants (n = 15, 50%) felt that IT product life cycle is not important in the buying process. Then again, the participants (n = 13, 43%) were also of the view that *repairs of IT equipment* can play a pivotal role in increasing the life span of hardware's that are outside warranty. According to them, the life span of electronic equipment is too short and most of them become obsolete. Therefore, they can be used for spare parts. To a great extent, replacing or repairing the hardware provides an opportunity to increase performance and IT product life cycle. The reuse of electronic equipment has some limitations because it can only extend the life of the electronic equipment temporarily (Torres et al., 2016:7).

Then again, the participants (n = 17, 57%) mentioned that their companies prefer to buy new pieces of IT equipment rather than increasing the life span beyond warranty. This demonstrates that there is a lack of recognition of reuse as an alternative method to e-waste management thereby posing challenges to environmental sustainability (Torres et al., 2016:7). Then again, the participants (n = 22, 73%) mentioned that their companies are not *recycling* computers to prolong their life span and reduce e-waste. They believe that their companies can recover precious metals through recycling. According to them, their organisations are using *outsourced recycling companies* because they lack the capacity to recycle e-waste. Moreover, recycling has negative consequences on both human health and the environment. In the survey conducted by Forti et al., 2020, it was found that South African organisations are dominated by the informal sector and lack the capacity to control and manage e-waste. It is projected that approximately 11% of e-waste is recycled on annual basis in South Africa (Ichikowwitz and Hattingh, 2020:44). The powerful inhibitor of e-waste recycling is the lack of coordinated effort and expertise to extract valuable resources (Heacock et al., 2016:8). However, some of the participants (n = 8, 27%) felt that their companies were recycling computers to prolong their life span. Recycling can recover about 95% of useful materials by disassembly and destruction of the equipment (De Froberville, 2019).

The participants (n = 16, 53%) mentioned that their companies should be able *to manage both the hardware and their data*. This means cloud computing options should considered to eliminate the need of having more hardware. Cloud computing has been found to play a vital role in increasing the life span of electronic equipment (Meloni et al., 2018:9). In the same way, the participants (n = 14, 47%) were of the opinion that their *software should continuously be upgraded* to provide new version of programmes that have better stability to increase performance. The rationale for software upgrade is due to organisations experiencing challenges with security threats, viruses, malware, hardware failures and software upgrades. To circumvent and reduce the security threat, the constant upgrade of software's with newer or better version enhances the system characteristics for the benefit of the companies. Despite the security challenges faced by organisations, some of the participants (n = 16, 53%) mentioned that their software was not upgraded.

Again, the participants (n = 19, 63%) mentioned that the *extended warranty* was an important factor that influences the purchasing of electronic equipment because the warranty promises to repair or replace pieces of IT equipment if necessary. The longer IT equipment lasts the less impact it has on the environment. Through the circular economy all materials and components of electronic products are kept at the highest value because e-waste is designed properly out of the system (World Economic Forum, 2019:18). However, the other participants (n = 11, 37%) felt that extended warranty was not important for their companies in the purchasing of electronic equipment.

8.3.4 How Does Your Company Dispose of Electrical and Electronic Equipment's That Are Obsolete Without Posing Health and Environmental Hazards?

The participants (n = 16, 53%) mentioned that they return *obsolete pieces of equipment* to their supplier, trade them in or sell them to achieve financial returns. This obsolete electronic equipment is posing a daunting challenge for their organisations. The Swiss model support the return of obsolete equipment free of charge at any dedicated sites in Switzerland to prevent obsolete electronic equipment reaching the landfills (Chowdhury, 2012:4). The producer of electronic equipment is held responsible for financing the return back of electronic equipment (Lundgren, 2012:36). However, some of the participants (n = 14, 47%) mentioned that their companies were not returning the obsolete electronic equipment to the supplier.

Again, the participants (n = 13, 43%) stated that they were *selling computer as scrap* to provide their companies with some form of financial gain. They also revealed that they don't recycle e-waste because they don't have the capacity. However, some of the participants (n = 17, 57%) mentioned that their companies were not selling computers to gain some financial return. In the same light, the participants (n = 11, 37%) also mentioned that they *auction/donate working and redundant* computers to address the challenges obsolete electronic equipment within their companies. But this temporary solution creates a further challenge of e-waste management for the organisations receiving the donation of the buyers. In contrast, some of the participants (n = 19, 63%) mentioned that their companies do not auction or donate computers to address obsolete electronic equipment.

According to the participants (n = 18, 60%) the disposal of electronic equipment is conducted by *segregating e-waste*. This means separating the components of electronic equipment first before disposing of electronic equipment. The underlying reason is that the discarded electronic equipment contains harmful chemicals that have potential to contribute to environmental problems. E-waste contains different hazardous substances that are highly toxic to human health and the environment (Moyo et al., 2019, Forti et al., 2020). The Waste Electrical Electronic Equipment Directive of the Parliament and Council (2002/96/EC) encourages green design in the collection of e-waste, segregation, recovery and recycling (Lundgren, 2012:36). However, some of the participants (n = 12, 40%) felt that their companies were not segregating e-waste. As a result, the handling of e-waste is posing a serious challenge because of unscientific disposal practices (Khaliq et al., 2014:2).

Then again, some of the participants (n = 16, 53%) mentioned that they use an external company to collect e-waste, while some of the participants (n = 11, 37%), mentioned that *safe disposal* of old pieces of electronic equipment is an important factor to minimise harm to the environment. They felt that effective and efficient procedures should be developed and implemented to manage e-waste. As such, this responsibility according to participants (n = 16, 53%) have been transferred to the *external company/supplier* to prevent stockpiling of e-waste and ensure safe disposal. The lack of collection of obsolete electronic equipment is a major stumbling block for many organisations (Awasathi et al., 2019). As a result, many organisations continue to stockpile their e-waste because they don't know how dispose it (Gaidajis, Angelakoglou and Aktsoglou, 2010). On the other hand, the participants (n = 14, 47%) expressed concern that their companies are utilising minimal efforts to reduce e-waste because they repair and upgrade their computers occasionally.

8.3.5 How Does Your Company Ensure Compliance With Relevant Environmental Laws in Relation to E-waste Management?

The participants (n = 13, 43%) mentioned that *IS0 14001 standard* is utilised by their companies to address environmental impact. They expressed positive opinions and perceptions that ISO 14001 standard helps the organisations to improve their environmental performance. However, some of the participants (n = 17, 57%) mentioned that their organisations do not utilise the ISO 14001 standard. Again, the participants (n = 19, 63%) mentioned that *internal and external audits* are also used to ensure compliance with relevant laws and code of practice. The participants believe that their companies should comply with environmental regulations to create environmental sustainability. However, some of the participants (n = 14, 47%) mentioned that their companies do not conduct internal and external audits. Then again, the participants (n = 15, 50%) expressed concern about *interdepartmental support* within their organisations to ensure compliance with environmental laws and code of practice for IT operations, while some of the participants (n = 15, 50%) felt that there was no need to ensure compliance with environmental laws and code of practice for IT operations.

Then again, the participants (n = 14, 47%) mentioned that their companies *conform to the relevant environmental policies and procedures*. However, some of the participants (n = 16, 53%) stated that their companies do not conform with relevant environmental policies and procedures. Hence, they felt that it is important for their companies to create an environmental system to manage e-waste. In the same vein, the participants (n = 18, 60%) mentioned that their companies were *not ensuring compliance* because the legislations dealing with e-waste are inadequate. The lack of effective enforcement of legislations and regulations that are specific to the management of e-waste is contributing to lack of compliance (World Economic Forum, 2019:13). This negative perception should be addressed by developing new regulation/legislation to manage e-waste. On the other hand, (n = 12, 40%) were of the view that their companies were complying with environmental legislations.

Again, some of the participants (n = 14, 47%) felt that their companies were ensuring compliance with the legislations that deals with e-waste. But, some of the participants (n = 16, 53%) mentioned that they don’t consider electronic equipment causing any environmental harm. This was quite surprising considering the negative impact of e-waste to the environment. Then again, the participants (n = 16, 53%) mentioned that *lack of formal penalty and regulations* were not enforceable. They stated that there is no dedicated legislation in South Africa that deals specifically with e-waste to protect the environment and improve quality of life. This demonstrates that the presence of legislation in the world means nothing if it cannot be enforced (Forti et al., 2020). As such, this is the primary reason that there is poor handling and disposal of e-waste. However, some of the participants (n = 14, 47%) felt that the regulations were enforceable.

Then again, the participant (n = 19, 63%) mentioned that *government policies were inadequate* and were reactive rather proactive, whereas some of the participants (n = 11, 37%) were of the view that the governmental policies were sufficient to handle e-waste. Then again, the participants (n = 17, 57%) mentioned that *training/education on environmental policies and procedures* should be provided to all employees. According to them, there is lack of awareness among staff members regarding the regulations because they are not publicly available. This training will benefit the organisations and minimise the environmental impact caused by e-waste. The participants perceive training or education of staff valuable to reduce the impact of e-waste in the environment. Without any training intervention, the volume of e-waste will continue to escalate (World Economic Forum, 2019:10). Unfortunately, some of the participants (n = 13, 43%) felt that the training/education on environmental policies and procedures were provided to the employees by their organisations.

9. Conclusions and Recommendations

In this study, the current situation and effectiveness of e-waste management practices in South African organisations has been assessed. This assessment was conducted from the viewpoint of IT professionals through semi-structured interviews. The study followed an interpretive positivist paradigm with a qualitative approach. Positivist components of the qualitative approach was the sensible way to undertake this research because it was concerned more with meaning than measurement. The research strategy of this study was a case study method. Given the challenges that the South African organisations are facing, several recommendations are made.

Firstly, there is a need for increased environmental awareness programme and economic development in South African organisations, conduct research, develop procurement strategy, provide sufficient budget and purchase environmentally friendly electronic equipment that are less harmful to the environment. This means that the IT life cycle should be considered upfront to get the longest life span out of electronic equipment so that the organisations can receive return on investment. Also, this suggest buying electronic equipment with good quality and that are reliable to reduce on the frequency of e-waste.

Secondly, hardware’s and software’s should be upgraded to extend the life span of electronic equipment. This means refurbishment and repairs should be conducted to increase the life span of electronic equipment. Also, hardware and data should be managed appropriately.

Thirdly, recycling of e-waste should be conducted because it is the most effective method to reduce and manage e-waste. Fourthly, obsolete electronic equipment should be returned to the supplier to ensure safe disposal. Lastly, effort should be made to ensure regulatory compliance with the policies and regulations due to poor regulatory controls. The available policies and regulations should be enforced. As such, organisations should partner with governmental stakeholders to pursue the development of sufficient legislation on e-waste to protect the environment.

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