ACQUISITION AND EFFECTS OF DISPOSAL OF ICT WASTE TO THE ENVIRONMENT IN NAIROBI COUNTY, KENYA

Edwin Kubai

A Ph.D. Student at UNICAF University
kubaiedwin@yahoo.com

ABSTRACT

Scientists welcomed the invention of Information Communication Technology (ICT) in the world as a critical propeller to scientific growth in building the economy of any Country. The purpose of this study was to investigate the acquisition and effect of the disposal of ICT waste to the Environment and explore appropriate methods for the disposal of ICT waste within learning institutions. The study adopted a descriptive survey design to examine the effect of the disposal of ICT waste to the environment on a sample population of 200 College students and 50 tutors randomly selected from ten learning institutions within Nairobi County, Kenya. The study sought to answer the following research questions; 1) how are ICT devices acquired in learning institutions? 2) How is ICT waste disposed of? 3) Does ICT waste have any effect on the environment? And 4) Do learning institutions in Nairobi County have ICT policy? Data from the findings were analyzed using descriptive statistics and presented in form frequencies, means, and percentages. The study significantly found out that the environment is polluted by 75.2% of ICT waste, which is disposed of just like any other biodegradable waste. Students in learning institutions have more than 700 connecting cables and 300 mobile phones as compared to the tutors who have 400 connecting cables and 100 mobile phones in the same respective colleges. There is a severe need to have an ICT policy in all learning institutions of which tutors and students agreed with 91% and 46%, respectively. The recommendation of the study is to use appropriate methods of ICT waste disposal like recycling to prevent its hazardous effect on our Environment.

Key Words: Information Communication Technology (ICT), E-waste, ICT-waste, Institution of learning and Environment

1.0 INTRODUCTION

ICT waste is made of obsolete metals and plastics materials that pollute the environment by emitting poisonous gases that are harmful to the living organism on the planet Earth hence destroy the Ozone layer in the atmosphere affecting the climatic conditions of the world drastically. Kenya has experienced unpredictable climatic conditions of heavy rains and prolonged droughts that have had diverse effects on its ecosystems. ICT waste consists of obsolete electronic devices like computers, laptops, printers, photocopiers, scanners, and mobile phones that have reached end life (EPA, 2001).

Most learning institutions in Kenya have embraced the use of ICT in its operations. Therefore in any office, you will find an electronic device that is used to make work easier (MOEST, 2017). Kenya, as a developing Country, receives ICT devices through donations from developed Countries or direct purchases from the dealers. It was observed that ICT devices like computers and printers produce quality work and improves efficiency in the operation of office activities for different institutions. Most learning institutions have obsolete ICT devices kept in one room or left on the office tables. Some ICT devices can be seen littered in the compound or disposed of in the composite pit like any other litter left to decompose. Electronic faulty devices of mobile phone accessories can be found in many dustbins emitting poisonous gases through rusting since most of them are non-biodegradable. This Mobile phone battery ends up bursting and even burning the entire place that

they have been disposed of hence killing micro-organisms and other living organisms in the surrounding environment (Frazzoli et al., 2010).

The environment is heavily polluted by E-waste due to poisonous gases emitted from this rusting ICT waste that is not recycled. Some of the E-waste is even washed away by speedy moving wind or coastal water into our rivers and lakes hence causing a threat to aquatic animals. Nowadays, getting fresh air to breathe in or water for consumption is a huge problem, especially in significant towns because either the air is polluted by poisonous gases from ICT waste or water contains toxic metals from ICT waste (Lincoln, 2007).

According to Balkan (2010) on E-waste management in Serbia, developed Countries have ICT policies that highlight how to dispose of ICT waste through recycling or to convert it to other usable formats. On the other hand, Kenya has not achieved her vision of Industrialization to have plants for recycling E-waste and assembling new ICT devices from the old ones. To minimize the impact of ICT waste in our environment, it is reasonable to purchase only what we can use and dispose of appropriately when they become obsolete following correct ICT disposal procedures or policies.

1.1 PURPOSE OF THE STUDY

The purpose of this study was to investigate the acquisition and effects of disposal of ICT waste to the Environment and explore the necessary mitigation framework that would guide institutions of learning on the correct disposal of ICT waste.

1.2 Research Objectives

The following were the research objectives for the study;

1. To determine the kind of ICT devices acquired and used in learning institutions in Nairobi County, Kenya.
2. To examine how ICT waste is disposed of in Nairobi County.
3. To examine the effects of ICT waste to the environment in Nairobi County.
4. To find out if learning institutions in Nairobi County have ICT waste disposal policy.

1.3 Research Questions

The following were the research questions that guided the study:

1. Which ICT devices are used in learning institutions in Nairobi County, Kenya?
2. How is ICT waste disposed of in Nairobi County, Kenya?
3. Does ICT Waste have any effect on the environment in Nairobi County, Kenya?
4. Do learning institutions in Nairobi County have ICT waste disposal policy?

2.0 LITERATURE REVIEW

Introduction

This chapter critically analyses relevant literature reviews related to how ICT devices are acquired in learning institutions, their disposal once obsolete, and their effects on the environment.

2.1 Acquisition of ICT devices

As defined earlier in the introduction section, the term ICT also refers to technologies that provide access to information through telecommunications. It is similar to Information Technology (IT) but focuses primarily on communication technologies. This includes the Internet, wireless networks, cell phones, and other communication mediums, as defined by Christensson (2010). In Kenya, learning institutions acquire ICT related

devices either from government or donations from developed countries. While some learning institutions with adequate financial resources can be able to purchase the ICT devices from sellers or import from overseas, many institutions of learning do not have enough funds to marshal the acquisition. From a study done by the Ministry of Education Science and Technology MOEST (2017), it was found out that in Nairobi County, most learning institutions have computers, printers, photocopiers, scanners, mobile phones, and massive connecting cables. It was noted that once these ICT devices become obsolete, they are damped in one of the institutions' stores for further action on the disposal procedure. Still, the institutions lack the necessary disposal policy. The focus of this study was to find out what happens to these ICT devices once they become obsolete in the learning institutions.

2.2 Disposal of ICT Waste.

ICT waste includes obsolete electronic and electrical equipment like Computers, laptops, printers, scanners, cameras, and mobile phones that are flooding the Kenyan market with the rapid change in technology, especially in the communication industry.

For this study, ICT waste is also referred to as E-waste. Asiimwe and Åke (2012) elaborated that E-waste was a term used in the 1970s and 1980s when hazardous products imported from the developed world were taken to the developing world, resulting in environmental degradation. Bleiwas and Kelly (2007) mentioned that E-waste consists of ferrous and non-ferrous metals, glass, plastics, concrete, and ceramics substances that makeup ICT devices. It is a common practice within significant towns in Kenya to find a mobile phone selling as low as Kes 500 on the streets. College students often purchase mobile phones because they are affordable but of low quality hence disposed of off quickly once they become obsolete. The society is being filled up with electronic equipment as fast as possible especially with the change in technology many people are going for the new phones that have more attractive and interactive features like Smartphone's (Sharma, Gupta and Sushil, 2010).

How they dispose of old phones, nobody knows as to whether they are recycled, re-used, thrown away, or burned. The number of mobile phones entering the Kenyan market is uncertain, and the method of disposal is not known. There is no clear policy on ICT waste management, primarily on the importation, exportation, and disposal of the obsolete ICT items, just like in the vehicle industry. The education sector in Kenya has embraced the use of ICT in the teaching and learning processes to make learners acquire 21st Century skills of critical thinking and collaboration. Most learning institutions in Kenya have computers, laptops, Televisions sets, radios, printers, scanners, photocopiers, and internet access networks (MOEST, 2017). Most institutions have policies on how to acquire ICT devices. Still, they lack the system on maintenance and disposal of the obsolete ICT devices, which poses a significant threat to our environment.

Sastry and Murthy (2012) mentioned that in developed countries like the USA and China, there are clear policies on recycling obsolete ICT devices to minimize its effect on the environment. In the USA, for instance, 100 million cellphones are thrown to trash every year, 112 000 computers discarded every single day, 20 million TVs are trashed every year while only 13% of E-waste is recycled and used correctly. In this regard, EPA (2001) estimates that in 2009, the United States disposed of 2.37 million tons of e-waste, 25% of which was recycled domestically.

According to UNEP (2005), any institution should have an E-waste collection scheme that spells out best practices on re-use and recycling procedures of E-waste to minimize the separation of hazardous substances from the ICT devices during disposal. The critical parameters of an effective E-waste management system, as stated by Widmer et al. (2005), are Legal regulation, system financing, and Producer responsibility that should be considered by institutions in designing there E-waste management system.

Switzerland is the only country in the world with an effective E-waste management system that encompasses the collection, transportation, and recycling of E-waste based on extended producer responsibility (EPR) model (Wath et al., 2010). The USA signed the Basel Convention (1992) that governs the transboundary movements of E-waste between countries but has not yet ratified it. On the other hand, Kenya has proposed a Waste Management Bill of 2017 that would ban importation, illegal trafficking of electronic and electrical waste from developed countries to Kenya that is being considered by Kenyan legislature (Anyango and Mwololo, 2013).

This Waste Management Bill of 2017 is meant to provide the Country with Clear guidelines and procedures on how to acquire, use, and dispose of obsolete ICT devices from all institutions. The concern of the Kenyan government and its citizens is to keep the environment clean and conducive for human habitat.

2.3 The Effect of ICT Waste on the Environment.

The term environment refers to the natural surroundings of an organism. The components of the environment are soil, water, and air, which are significant for human life. The effect of ICT waste is more harmful to the environment and human life as compared to traditional garbage since it contains toxic substances. When e-waste is heated, toxic chemicals are released into the air damaging the atmosphere. The damage to the atmosphere is one of the most significant environmental impacts of e-waste because it leads to the formation of acidic rain and unpredictable weather patterns. When electronic waste is thrown away in landfills, their toxic materials seep into groundwater, affecting both land and sea animals as explained by Sharma, Gupta and Sushil, (2010).

It is estimated that E-waste contributes to around 70% of toxic heavy metals exposed to landfills. This creates public health problems for the pollution of ecosystems for generations to come. The following illustrates how components of the environment are affected by ICT waste.

2.3.1 Air

Air is simply defined as a mixture of gases. Air is contaminated by e-waste, especially during the transportation, shredding, and dismantling of electronic materials. Unstandardized procedures of e-waste disposal like burning results to significant emission of toxic substances to the atmosphere that significantly affect the ozone layer resulting in un-predictable climatic conditions.

2.3.2 Soil

Soil is a natural cover of the Earth's surface. Soil is a fundamental natural component that supports human life through the production of food. Kenya is a developing country with an approximate area of 549,137km^2 (KNBS, 2012), characterized by poor solid management, uncontrolled dumping sites in significant towns, and lack of management policies on e-waste recycling procedures. According to UNEP (2005), Nairobi generates about 0.29 and 0.66kg/day of e-waste that is disposed to open damping sites like Korokocho and Dandora slums.

The report of UNEP (2005) indicates further that E-waste that is generated is11, 400 tones from refrigerators, 2,500 from Computers, 500 tones from Printers, 2800 tones from TVs and 150 tones from mobile phones. Soil is a component of the environment that is contaminated directly or indirectly by irrigation from contaminated water.

The disposal of E-waste directly in landfills exposes heavy metals like lead, arsenic, and cadmium that leaches directly into the soil contaminating underground water making the soil to be acidic and not favorable for crop production. When the soil is contaminated, the entire ecosystem is also affected by e-waste disposal affect the temperature, pH, soil type, climate, and soil composition structure; hence plants also have the same chemicals like lead that affects its growth. Animals and human beings that consume this modified crop have problems in

neurological development delays in development among children and increase the risk of multiple chronic diseases and cancers in adulthood.

Babu, Parande, and Basha, (2007) explained that Mercury, generated from both e-waste itself and the processes involved in recycling this waste, not only hurts kidneys, lungs, and skin but like other heavy metals, has compounding or synergistic interactions with other metals that are so complex that they are only beginning to be understood in the research community.

2.3.3 Water

Improper recycling of E-waste and landfills contaminates water. E-waste materials contain precious metals like gold that are usually extracted from the materials using water or exposing the e-waste to underground water, making it acidic. China has a recycling plant in Guiyu that has lefts all local streams polluted and black (Saoji, 2012). The water is exceptionally acidic such that it can disintegrate a penny in five minutes, which is a significant threat to human life. In a study done on 169 children whose parents are working the recycling firm in Guiyu, 82% of children had the highest levels of lead concentrations in their blood samples Li.et al., (2008). Bioaccumulation of these heavy metals from e-waste significantly affects the ecosystem of the entire world.

3.0 RESEARCH METHODOLOGY

This study adopted a descriptive survey (Rowley, 2012) to analyze specific factors on the acquisition and effect of the disposal of ICT waste within the specified region of Nairobi County, Kenya. A sample of 200 students and 50 tutors were selected randomly using systematic random sampling from higher institutions of learning within the Nairobi County to participate in the study. The data were collected using structured questionnaires and interview schedules because they were more comfortable to analyze and economical. The research instrument was piloted in different institutions other than the ones that participated in the main study, and a reliability Coefficient of 0.76 was established.

4.0 DATA ANALYSIS AND PRESENTATION

The study focused on the best ways of how ICT devices are acquired and how to dispose of ICT waste with a clear understanding of its effects on our environment. Data was collected from tutors and students to establish as to whether learning institutions have ICT waste management policy and the implementation process. The research questions were guiding principles of the study and the nature of data to be collected and analyzed.

4.1 Bio-Data of Participants.

The total number of tutors who participated in the study was 50 tutors, of which 70% were female, and 30% were Male tutors, as indicated in the table1.0.

Table 1.0: *Percentage Analysis of Tutors by Gender*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	35	70.0	70.0	70.0
	Male	15	30.0	30.0	100.0
	Total	**50**	**100.0**	**100.0**	

Table 1.1 indicates the percentage analysis by gender of College students who participated in the study, of which 61.5% were female, and 38.5% were Male from the ten learning institutions sampled within Nairobi County, Kenya.

Table 1.1: *Gender Analysis of Students by Percentage*.

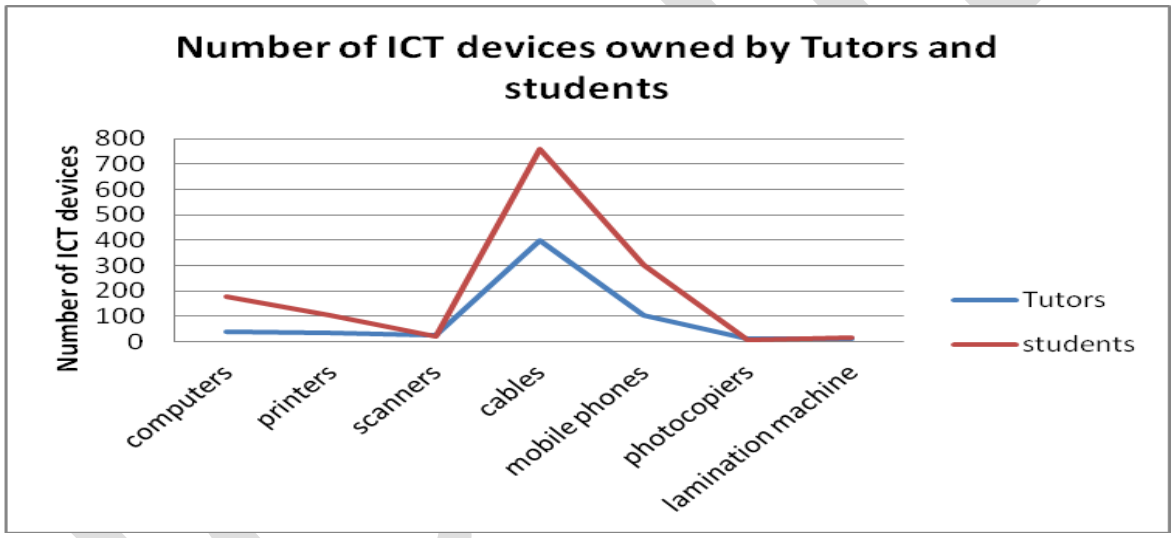
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	123	61.5	61.5	61.5
	Male	77	38.5	38.5	100.0
	Total	**200**	**100.0**	**100.0**	

The two groups selected for the study were non-homogenous. The information collected from tutors was different from the students' knowledge, but it was beneficial for validation purposes.

4.2. Acquisition of ICT Devices

Figure 1.1 below shows the number of ICT devices owned by tutors and students in their learning environment. It was observed that most learning institutions have connecting cables and mobile phones as compared to the other ICT devices. The gap of this study was to establish the best way on how Connecting used wires and non-functional mobile phones can be disposed of without having any effect on the Environment.

Figure 1.1: *Number of ICT Devices owned by Tutors and Students*



The sampled students have more than 700 connecting cables and approximately 300 mobile phones, as indicated in figure 1.1. On the other hand, tutors have 400 connecting cables and nearly 100 mobile phones. It was noticed that both tutors and students often use cables because they are used for peripheral connection for all ICT devices; hence most of them become obsolete quickly as compared to mobile phones.

4.2 Methods of ICT waste disposal

Disposal of obsolete ICT devices to the environment leads to landfills of E-waste. Naturally, people dispose of waste by throwing on a composite pit or dust bin. The study shows that 36.6 % of respondents prefer recycling as the best method of disposing ICT waste. 5.5% of respondents prefer burning as a method of disposing ICT waste. From the study, some people would prefer to re-selling (20.5%) of the total respondents. This study is in agreement with a study done by Kalana (2010) that mentioned that most consumers do not want to dispose of obsolete ICT devices because they hope they will use them later or prefer re-selling. According to NEP (2005), 25% of the solid waste forms E-waste that is sent to the Dandora dumpsite. With the increase in mobile phone penetration in the country, the percentage of E-waste is expected to increase in the near feature.

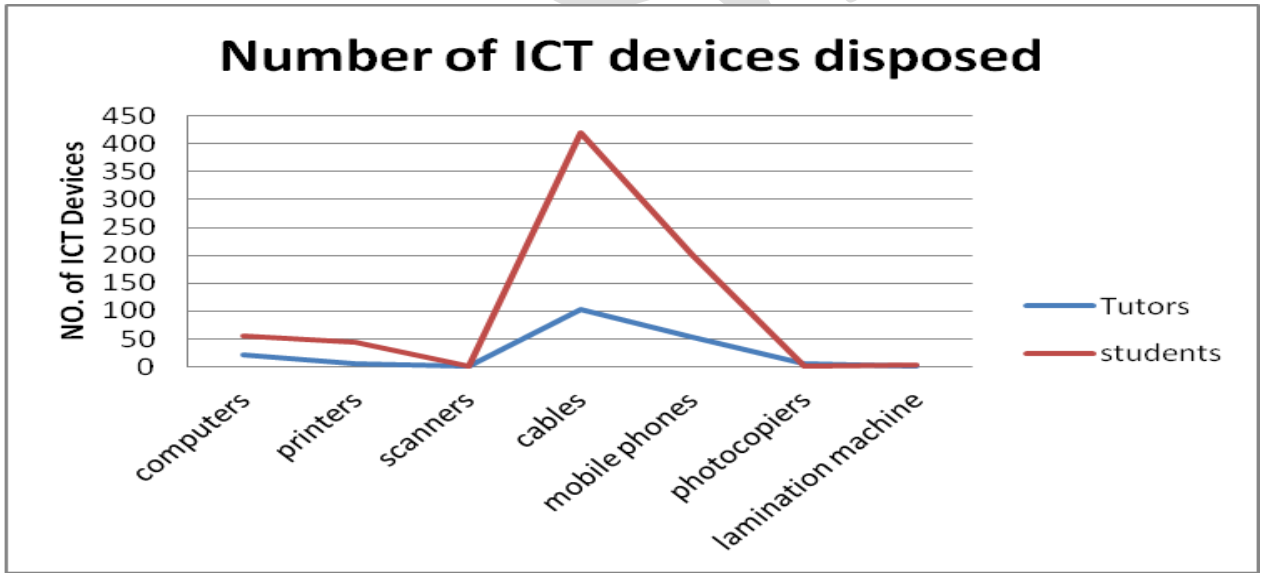
Table 1.2: *Ways of Disposing of obsolete ICT devices for Students*.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	burning	11	5.5	5.5	5.5
	burying	41	20.5	20.5	26.0
	re-selling	41	20.5	20.5	46.5
	recycling	73	36.5	36.5	83.0
	throwing to the composite pit	34	17.0	17.0	100.0
	Total	**200**	**100.0**	**100.0**	

4.3 The Number of ICT Devices Disposed

Figure 1.2 indicates that more than 400 connecting cables are disposed of by students in the ten sampled learning institutions in Nairobi County, followed closely by non-functional mobile phones. Kenya imports more than 70% of connecting cables, because it is the local industry, does not meet the demand. All mobile phones in Kenya are imported from developed countries like China, the USA, and the United Kingdom. At the same time, some ICT devices are found on the Kenyan market without proper legal documentation due to porous borders.

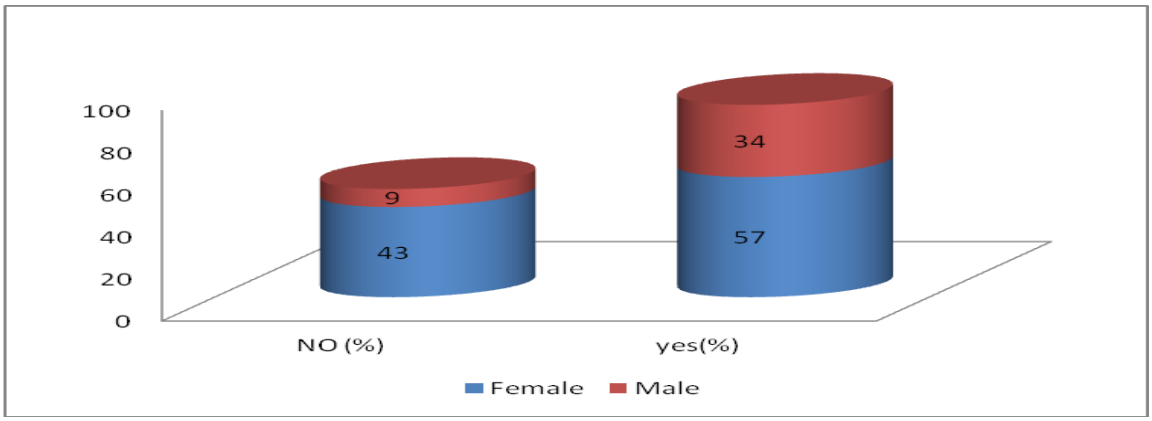
Figure 1.2: *Number of ICT devices disposed of.*



4.4 Policy on ICT-Waste Disposal

There is a need for learning institutions to have an ICT-waste disposal policy that is well outlined in the vision and mission of the institution. Most learning institutions have ICT devices but lack formal procedures on how to dispose of obsolete ICT-waste. 57.0% of the Female tutors agreed that their institutions had an ICT-waste policy management system, and 34% of Male tutors were in agreement. According to a study conducted by Omari (2018), 52% of institutions had no policy on disposal of E-waste, which indicates that most learning institutions don't have ICT policies. The concept of E-waste policy is also supported by 46% of the respondents who are students.

Figure 1.3: *Awareness of ICT-Waste Policy Disposal among Tutors*.

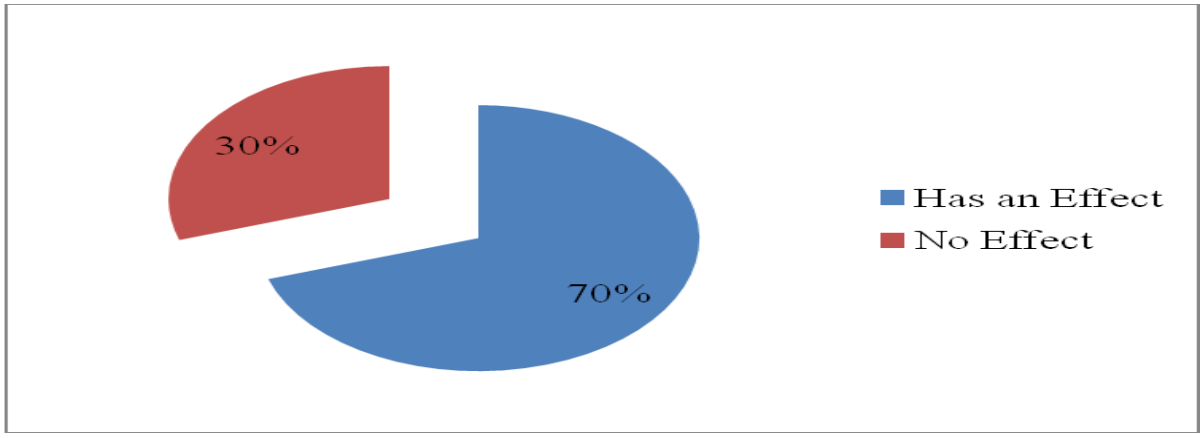


When the same question was posed to the students to find out if their respective institutions had a policy on ICT-waste disposal, it was realized that 53% had no idea about ICT-waste disposal policy. The learning institutions might be having ICT-waste disposal policy on paper, but it has not been communicated to the students and other stakeholders**.** In a study done by Omari (2018), the Implementation of E-waste policy was found to be at 10%, which is in agreement with this study. Kenya needs to have proper legislation on the acquisition and disposal of ICT devices, which should be assimilated to all learning institutions and implemented immediately. This would significantly reduce its effect on the environment as currently observed due to pollution and emission of toxic gases in the air, especially in urban centers like Nairobi, which is densely populated.

4.5 Effect of Disposing E-Waste

Figure 1.4 shows that 70% of respondents, which represents 139 out of 200 believe that disposing of e-waste affect the environment. It is only 41 countries in the world that have statistics on E-waste collection and management policies UNEP (2005). 30% of respondents have dissenting views about the effect of disposing e-waste on the environment.

Figure 1.4: *Effect of disposing E-waste among Students*.



From Figure 1.4, it is evident that people have significantly seen the effect of exposing E-wastes on the environment. In major towns like Nairobi, it is apparent to see landfills with E-waste. E-waste has polluted so many estates within Nairobi County. It is standard practice to observe children playing from these dumping sites hence ruin their health aspect. The table1.3 shows that 47% of the respondents among the students are in agreement that ICT waste pollutes the environment. Surprisingly only 8.5% of respondents say that ICT-waste

contaminates water, soil, and Air, and 27.5% believe that ICT-waste does not affect the environment. The pollution of the environment is an indicator that the majority of students are not aware of the direct effect of ICT-Waste disposal on the environment. A study conducted by Lassana (2009) indicates that millions of computers and mobile phones are disposed of in landfills or burned in smelters.

Table 1.3: *Effect of ICT Waste Disposal*

	Frequency	Percent	Valid Percent	Cumulative Percent
Contamination of water, soil, and Air	17	8.5	8.5	8.5
Landfills and lack of decay	24	12.0	12.0	20.5
None	55	27.5	27.5	48.0
pollution of the environment	94	47.0	47.0	95.0
poor hygienic	10	5.0	5.0	100.0
Total	**200**	**100.0**	**100.0**	

4.5 The Number of Mobile Phones owned by Students.

Table 1.4 shows the number of mobile phones owned by students in different learning institutions within Nairobi County. Most students have more than one mobile phone, and only five respondents had no mobile phone. The critical aspect is how the old mobile phones are disposed of among students. Six students out of 200 have four mobile phones, which are in working condition. About 3.5 billion mobile phones are used globally, and 47% of US teens believe that their social life would end if disconnected from using the phones (Omari, 2018).

Table 1.4: *Number of Mobile Phones owned by Gender among Students*

		Number of mobile phones					Total
		0	1	2	3	4	
Gender	Female	0	51	47	22	3	123
	Male	5	25	39	5	3	77
Total		**5**	**76**	**86**	**27**	**6**	**200**

Table 1.5 shows the number of mobile phones used by students for the last three years. It is observed that 86(43%) of the respondents have used more than two phones for the previous 3 years, and the percentage is high among female students than male students. 61 out of 123 Female students have two phones as compared to their counterparts at 25 out of 77.

Table 1.5: *Number of Mobile Phones used by Students for the last three years*

		Number of Phones used.			
		0	1	2	**Total**
Gender	Female	0	62	61	123
	Male	5	47	25	77
Total		**5**	**109**	**86**	**200**

4.6 Information about E-Waste

Among the sampled population of students, 57% believe that they have information about E-waste. It is only 2% that are undecided as to whether they have information about E-waste or not, as indicated in table 1.6. It was noted that both the tutors and college students have hard information concerning e-waste but do not know how it is done and procedures for implementation.

Table 1.6: *Information about E-waste among Students*

	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	114	57.0	57.0	57.0
strongly Agree	82	41.0	41.0	98.0
Undecided	4	2.0	2.0	100.0
Total	**200**	**100.0**	**100.0**	

4.7 Pollution of Environment by E-Waste

Table 1.7 shows how college students believe ICT waste disposal pollutes the environment. 53% of the respondents believe that our environment is polluted by ICT waste, and only 4% disagree with that opinion. Electronic pollution is caused by discarded electrical devices in the environment posing great danger to human life and animals due to the emission of poisonous gases.

Table 1.7: *E-waste Pollutes Environment*.

	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	106	53.0	53.0	53.0
disagree	8	4.0	4.0	57.0
Strongly Agree	64	32.0	32.0	89.0
undecided	22	11.0	11.0	100.0
Total	**200**	**100.0**	**100.0**	

5.0 RESULTS DISCUSSION AND SUMMARY

From the study, it is clear that every student or tutor in the sampled learning institutions has an ICT device, for instance, computers, laptops, and mobile phones. Once these ICT devices become obsolete, they are disposed of by burying, burning, re-selling, recycling, and throwing into the composite pit. Significantly 53% of ICT waste was noted to pollute the environment because it is not biodegradable. There is a need for learning institutions to have E-waste policy education on the effect of ICT-waste disposal to create awareness among tutors and students. The majority of the respondents at 139 out of the possible 200 believe that the dumping of E-waste to the environment affects our ecosystem by polluting the environment. Still, they don't know how E-waste pollutes the environment.

The number of communication devices like mobile phones owned by respondents is also increasing at an alarming rate, such that 43% of college students have two phones and also have used more than two phones in the last three years. The critical problem is that the students cannot account for how they disposed of the old phones, but it was noted that 57% have information about E-waste.

The study has shown that learning institutions have 72.1% of ICT devices that assist in making work more comfortable. Still, they need to have a framework policy on how to dispose of them appropriately once they become obsolete because of their effect on our environment. Most learning institutions have an E-waste policy management system, but the policy does not describe the procedure of disposal of obsolete ICT devices within our organization. There is a need to educate the members of the institution on the E-waste disposal management system. People would be able to understand how appropriately to dispose of the electronic devices that have once become obsolete, especially like the mobile phones, of which this study has shown that many college students have more than one phone.

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