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E-Waste Management: Awareness, Strategies, Facilities, Sources and Treatment in Tanzania

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Abstract
There is an urgent need to have the e-waste management and information security framework in Tanzania in order to rescue the country from the danger brought by improper management of e-waste and loose regulations for illegal importation of the devices from the developed countries. Tanzania like other non-industrialized /industrializing/developing countries is greatly affected by the e-waste problem as it can't escape from the tremendous advancement in the Information and Communication Technology (ICT) sector which contributes to the speedy growth of the e-waste in the country, worse enough the country does not have; formal recycling industries or any other formal method to manage the e-waste appropriately, legislations and regulations specifically for e-waste management to protect the environment and human health. The e-waste dealt with under the scope of this paper are those produced from the ICT devices specifically desktop computers, Servers and Laptops. This study is about identifying the current practices in e-waste management in Tanzania. From this general objective, the following specific objectives were derived; identify the awareness of the electronic device users on e-waste issues, identify the existing strategies on e-waste management, identifying the available facilities for e-waste management, identify the sources of e-waste and finally identify the treatment of e-waste in Tanzania. It was realized from the findings of the study that in the e-waste management in Tanzania there was a lack of the following; Awareness to ICT device users and other stakeholders on the e-waste problem, Appropriate e-waste management mechanism, Use of proper data removal tool for complete sterilization of the data from the computers before they enter the e-waste stream, ICT experts involvement in solving the e-waste problem and formulation of the legislation, regulations and the framework for the management of the e-waste. Most of the Green IT and Green computing issues require ICT expert participation, centralized database that contain information of all ICT devices country wise, E-waste specific legislation, regulations and the framework for e-waste management that will address the issues of; illegal importation of obsolete ICT devices, implementation of the extended producer responsibilities (EPR)/ take-back systems and the component of information security.
Keywords: E-waste, ICT (Information and Communication Technology), ICT devices (Desktop Computers, Laptops and Servers), obsolete ICT devices, E-waste from ICT devices, Information security.

1. Introduction

The rapid advance in technology particularly the rapid growth in ICT has brought in the improvement in the performance of the computers, but at the same time has decreased the life time of the devices (Oh et al., 2003). This causes an increased number of obsolete electronics devices and due to a lack of proper e-waste management system in the developing countries, it results into an environmental concern and human health threats (Kang and Schoenung, 2004). In developing countries, e-waste are managed through various inappropriate ways such as illegal disposal in landfills, open burning and crude backyard recycling (Furter, 2004). Appropriate e-waste management and information security is required in the developing countries. Though electronic devices provide the society with more comfort and easy information acquisition and exchange but on the other side they cause human health threat and the danger of environmental pollution (Sinha, 2007). Ironically e-waste has become an emerging challenge as well as a business opportunity of tremendous significance. This is due to the volumes being generated and the content of both toxic and valuable materials in them. The fraction of iron, copper, aluminium, gold and other metals in e-waste is over 60% while plastics account for about 30% with hazardous pollutants comprising about 2.7% (Widmer et al., 2005).

The existence of well established legislations for the e-waste management and plenty of best practices from the European Union and in Japan is insightful particularly for the developing countries like Tanzania (Shawn et al., 2008). Developing countries like Tanzania do have neither formal manufacturing industries nor formal recycling industries for the electronics products that have reached the end of their useful life. This means they cannot manage the e-wastes in an environmentally accepted manner. Practices that are done on e-waste threaten the health of human involved in the process of their local recycling and recovery of materials from e-waste, they also endanger the environment and the security of information that are contained in the e-waste. Among the solutions to solve the e-waste problem in developed countries is having; the formal recycling, recovery and remanufacturing industries and the extended producer responsibility (EPR) /take-back systems. These practices have been found not to benefit the developing countries where still the electronics devices are

locally recycled and most of them are land filled. The good thing realized is that the e-waste not only contains the hazardous materials like Mercury, Cadmium, Chromium and others, but it also contains some valuable substances like Gold, Silver, Palladium and Platinum that may be considered as an economic benefit for the developing countries. Effective e-waste management and information security in the developing countries requires the implementation of EPR or take-back systems, the establishment of the product reuse through remanufacturing and the introduction of efficiency recycling facilities, efficient data/information sterilization tool from the e-waste that contain sensitive and confidential information before the device enters the e-waste stream.

This study examines the issues of e-waste management in Tanzania. The insight of which will be useful to the researcher who aim to develop the e-waste management and information security framework useful to Tanzania and other developing countries to rescue these countries from the threat of human health ,the environment pollution from the e-waste hazardous components and the security of the confidential information from the computers. This study is an important issue to Tanzania and other developing countries of the like because the developing countries are the most affected since a lot of e-waste are dumped to these countries from the industrialized countries; hence, minimizing the e-waste in industrialized countries and increasing the quantity of e-waste in developing/non-industrialized countries especially Tanzania. It is meaningful for the researcher as an ICT expert to explore it because Tanzania currently lacks regulations, legislations even framework specifically for the management of the e-waste and information security. Bearing in mind that ICT dominates in the generation of e-waste.

2. Literature review

2.1 Existing challenge to the management of obsolete ICT devices and information security in Tanzania

2.1.1 Policies, regulations and institutional framework

Currently in Tanzania, there are policies and regulations which aim at protecting the environment but there is no either specific policy or regulation that addresses the issue of management of obsolete ICT devices(e-wastes) and security of information contained in the devices (Hicks et al., 2005). Furthermore, there exist regulations and laws that provide an institutional framework for a sustainable management of the environment in general. Again, the regulations and the institutional framework have been found to be inadequate due to the challenges caused by the existing regulations and different bodies that are responsible for e-waste management, in their implementations. For instance, a local government may decide to enact by laws but they are only applicable in the respective local authority. This indicates that there is a need for more coordination efforts if e-waste management is to be effectively implemented in the country, it shows that different institutions that have been given mandate by policy or regulation to deal with environmental management, can come into conflict in their carrying out of their responsibilities. Also there is an issue of information security from the storage media of the e-wastes; this component is not addressed at all in these regulations and policies. From these examples it can be learnt clearly that the existing policies, regulations and institutional framework are insufficient in addressing e-waste management issues and information security problems. So these drawbacks show that there is a need to have an effective and efficient framework that will adequately deal with the problem of e-waste and information security from the ICT devices in Tanzania (Koloseni and Shimba, 2012).

Table1. A summary of regulations and responsible organs in implementation of the acts (adopted from Magashi and Schluep, 2012)

S/N	Legal Instrument	Responsible Organ
1.	National Environmental Management Act No.20 of 2004.	Vice President's office National Environmental Management Council Local Government Authorities.
2.	The Environmental (Solid Waste Management) Regulations of 2009.	Vice President's Office National Environmental Management Council Local Government Authorities.
3.	The Environmental (Hazardous Waste Control) Regulations of 2009.	Vice President's office National Environmental Management Council Local Government Authorities.
4.	Tanzania Foods, Drugs and Cosmetics Act of 2003.	Tanzania Foods and Drugs Authority Ministry of Health and Social Welfare.
5.	Occupational Safety and Health Act of 2003	Ministry of Labor, Youth and Culture Occupational Safety and Health Authority
6.	Tanzania Bureau of Standards Acts No.3 Of 1975	Ministry of Industry and Trade Tanzania Bureau of Standards.
7.	Fair Competition Act of 2003 Merchandise Marks Act of 1963	Fair Competition Commission
8.	Atomic Energy Act of 2003	Tanzania Atomic Energy Commission
9.	Water Resources Management Act No11 of 2009	Ministry of Water Urban Water Authorities River Basins Authorities
10.	Local Government (District Authorities) No.7 of 1982 Local Government (Urban Authorities) No.8 of 1982	Local Authorities

Table 1 shows the list of regulations and their responsible organizations in implementation of the acts

Table2. A summary of organizations responsible for e-waste management, their objectives and responsibilities (adopted from Magashi and Schluep, 2012)

S/N	Organization	Objective	Role
1.	Vice President's Office: Environment Division	Coordination of all environmental managerial issues	Policy formulation Advocacy and implementation Monitoring and evaluation Planning Legislation International cooperation.
2.	Local Government Authorities (LGAs)	Waste Management and Control	To prevent or minimize e-waste in their jurisdictions.
3.	National Environmental council (NEMC)	Regulatory Authority	To oversee the Implementation of the Environmental management Act. Coordination ,evaluation and Implementation.
4.	Occupational Safety and Health Authority (OSHA)	Ensure occupational health and safety	Safe use and handling of hazardous waste.
5.	Ministry of industry and Trade	Licensing	Registration and licensing of traders and equipment dealers
6.	Tanzania Bureau of Standards	To develop products and environment quality standards	To ensure that all manufacture or imported products meet the standards

Table 2 shows a summary of organizations responsible for e-wastes, their objectives and roles of each organization.

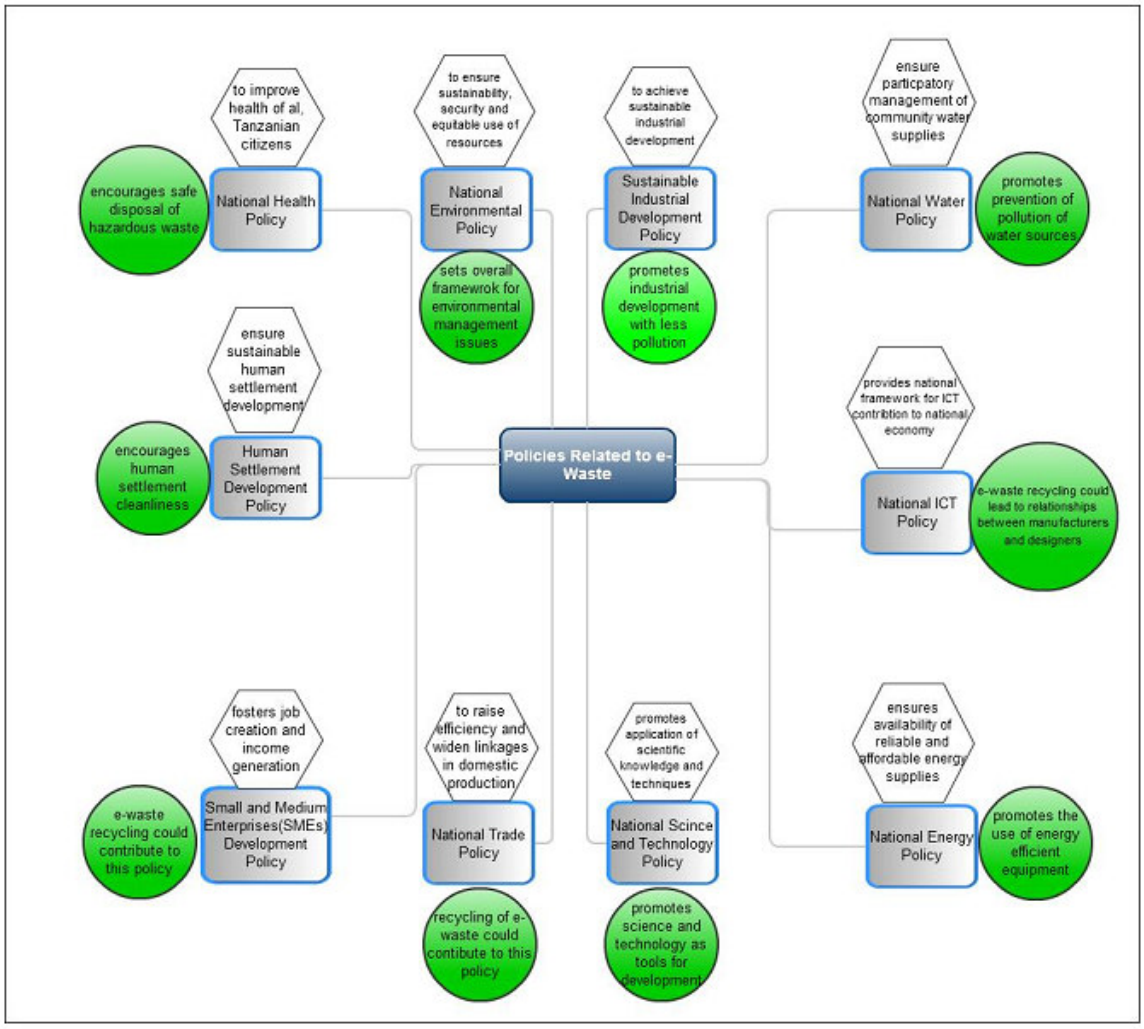

Figure1. An Overview of Policies related to e-Waste Management in Tanzania: The Policy, Objective and Relevancy (Koloseni and Shimba, 2012)

Figure1 shows a brief overview of different policies related to e-waste management. It summarizes the objectives and relevancy of each particular policy as it relates to e-waste management. In this figure1, the hexagon represents the objectives that a particular policy intends to fulfill, while the circle represents the relevancy of the policy to e-waste and the policy is represented by the smooth rounded rectangle.

Figure2. A summary of regulation related to e-waste management, their objectives and impact on e-waste management (Koloseni and Shimba, 2012)

Figure2 shows the different regulations and acts related to waste management and the way they are related to e-waste and their impact or influence in e-waste management in Tanzania. In figure2; the regulation or act id is represented by a smooth rounded rectangle, the influence of the act is represented by the circle while the objective of the act is represented by the octagon. The influence of the act is said to be low when it does not directly address e-waste or e-waste related issues, while a high influence signifies the importance of the act is regulating the e-waste and e-waste management by addressing key issues related to e-waste.

2.1.2. E-waste from ICT devices, Environment and human health

Discarded computers and mobile phones predominately contribute to the e-waste production because they have a shorter lifespan than other electronic devices (Ladou and Lovegrove, 2008). The average lifespan of electric and electronic equipment is becoming shorter, while the amount of related waste is increasing (Robinson, 2009). Furthermore, apart from the environmental threat and the illegal importation to Tanzania, researches have shown that the e-waste has negative effects to human health. The main problem of e-waste generated from computers is that computers are manufactured from over 1000 different materials, some of which are toxic and not only cause environmental pollution but are linked to human health problems (Chan *et al*., 2007). The mismanagement of the e-waste can cause the following negative impact on human health: respiratory problems, oxidative stress, DNA damage and the possibility of causing cancer (Robinson, 2009).

E-wastes contain not only harmful toxic materials but they also contain some valuable materials; study shows that they contain 2.7% of pollutants and over 60% of valuable metals (Widmer et al.,2005). E-waste

contain of steel (made for 98% of Iron, Iron being 20% of the weight of the personal computer), Aluminium (14%) and copper (7%) other metals contained in the e-wastes are Silver, Gold and Palladium; this brings economic opportunities from the e-waste disposal. It has also been found that 23% of the weight of personal computer is plastics which contain Brominated Flame Retardants (BFR's) which is very dangerous when burnt (EMPA, 2005).

E-waste is attributed to the hazardous waste because of various metals, acid and other toxic substances contained in it, this is why land filling is one of the worst options for e-waste utilization: as it causes bad environmental effect as well as losing some valuable materials from the e-waste (Hannequart, 2005). It has been found that 70% of heavy metals such as Mercury and Cadmium found in land fill sites of the United States are from the e-wastes (Pucket et al., 2005).

Heavy metal components are harmful to both human health and the environment. If e-wastes are land filled or incinerated together with household solid wastes, the heavy metals that remain in the environment for a long time will damage the soil, groundwater, lakes, rivers etc. The human body is seriously affected by bioaccumulation as the toxics gradually build up inside the body (Huang et al., 2006).

Recycling practices as one of the e-waste disposal practice also pose a concern with respect to environmental damage and work health and Safety to humans (Atlee et al., 2006).

2.1.3. Information Security Threats from Discarded ICT devices (E-wastes)

There is a need to have a means to properly sterilize the information from the hard drive of the computers before entering the e-waste stream. This is to preserve the confidentiality and privacy of information of the owner, so that they cannot fall into the hands of unauthorized people who might use the information for unintended purpose. It has been realized that formatting and deleting information from the hard drive does not completely wipe the information from these devices, still the information remains and can be retrieved and used by unintended people (Koloseni and Shimba, 2012). In order to safeguard privacy and confidentiality of information, it has been recommended by researchers that organizations apply secure data cleaner software that conforms to DOD 5220.22-M standard which requires overwriting of all addressable locations with a character, its complement, a random character and then verify (DOD, 1995).

3. Current situation of e-waste management in Tanzania

3.1Overview

The data collection was carried out through questionnaires, interview guides and observations. Other information on e-waste management and information security was obtained from literature review of previous researches. The data collected through Questionnaire and interview was analyzed using the Statistical Package for Social Science (SPSS).

The exercise of sorting was followed by coding variables that needed to be dealt with and then the statistical Package for social science (SPSS) was used to get the summation of the responses and various percentages.

Target population in the study was people working in the ICT departments of universities and government and private companies who are either in the technical, operational or managerial level of the ICT department. The sample size was 144 people.

The data collection was stopped after reaching 103 respondents, which is 71.5% of the targeted 144 respondents. This size was sufficient for data collection. Each among the 103 respondents had to be interviewed also fill the questionnaire. The data collection was conducted in ARUSHA where most of the branch offices of different organizations are situated and Dar es Salaam where most of the selected respondents have their headquarters. Each respondent was interviewed first and then handed the questionnaire so as could fill it in the presence of the researcher or at any other convenient time.

3.2 Collected data

The data was sorted according to the information required which are; Awareness of the ICT device users on E-waste and information security problem, government initiative towards e-waste management and information security and European Union e-waste regulations, Availability of E-waste and information disposal facilities and strategies, Source of importation, condition and stock of imported devices, Stock of obsolete devices, Current treatment and disposal practices of obsolete ICT devices, Treatment of sensitive information from storage media of discarded ICT devices, ICT expert's role in solving the e-waste and information security problem and finally the respondent's suggestions/opinions were taken.

3.3 Awareness to issues related to e-waste and information security

3.3.1 Awareness on the security of information from e-wastes

The study shows that 45.2% of respondents are aware of security of information from e-wastes while 54.8% are not aware of it.

3.3.2 Awareness to e-waste problem
This was to identify the number of ICT device users, who are aware to the problems caused by the obsolete ICT devices to human health and environment.
It was found that 55.8% of the respondents were not aware of the e-waste problem while 44.2% were aware of the e-waste problem.
3.3.3 Awareness to Government initiatives towards e-waste and information
This question was intended to get the respondent's awareness on initiatives taken by the Government towards addressing the problem of e-waste and information. The respondents as users and managers of the ICT devices have to be aware on the measures taken by the government in solving the problem.
The results showed that 97.1% of the respondents were not aware of the government initiatives on e-waste and information and only 2.9% were aware of the government initiatives on e-waste and information.
3.3.4 Awareness to treatment of discarded ICT devices
The question aimed at identifying the respondent's awareness to what happens to ICT devices they discard either by selling or donation. This was to identify if the respondents were aware of the final treatment of the devices and information they discard. This will help them to regulate the disposal procedure for the benefit of human health, Environment protection and Information security.
The results showed that 98% were not aware of what happens to the items they discard while 1% knows that the discarded devices are finally burned and another 1% of the respondents know that the discarded devices are land filled at the end of the day.
3.3.5 Awareness to e-waste regulations from developed countries
This question was intended to identify the awareness of the respondents on some international regulations. They should be interested to know the regulations that are in place in developed countries, this will help in identifying the regulations that will be suitable to adopt for Tanzania.
The results of the study show that 100% of the respondents are not aware of the European e-waste regulations.

3.4 E-waste and Information disposal facilities and strategies
3.4.1 Better disposal Strategy
This question was asked to realize from the respondents if in their organizations they have identified the problems caused by mishandling the e-waste and information and if they have any strategy to improve their current practices to better handle the e-wastes and information.

For the question asked about the plan or strategy to better handle the issue of e-waste from the ICT devices and information contained in the devices, 70.2% said that there was no strategy while 29.8% said they did not know as to whether there was a strategy or not.
3.4.2Collaborations between government and private sector organizations to e-waste and information
This question was intended to realize if the respondents in their organizations have observed collaborations between government and private sector organizations in efforts to mitigate in their organizations the e-waste and information security problem.

It was found that 99% of the respondents said there is no such kind of collaborations and 1% did not answer the question.
3.4.3 Availability of the Policy to better handle the e-waste and information
The respondents were asked if there were any policy in their organizations to make sure that the ICT devices are handled properly to avoid the human health, environmental impact and information security from the obsolete ICT devices resulting from poor handling of the e-wastes from these devices.

The results showed that 97.1% of the respondents said that they don't have a policy to better handle the e-waste and information, while 2.9% said they have that policy in their organizations.
3.4.4 Availability of e-waste and information security assessment tools
The aim of this question was to know from the respondents if they have e-waste and information security assessment tools in their organizations, tools that could be used to determine the ICT devices that are obsolete and qualify to enter the e-waste stream. The assessment tools that could also be used to assess the information from the e-waste that are removed completely and could never be retrieved by any means.

The results showed that 98.1% of the respondents said that there were no e-waste and information security assessment tools in their organizations; while 1.9% did not answer at all.
3.4.5 Availability of support or directive from non-governmental organization on e-waste and information
This was to seek information from respondents if in their organizations they get support or directive from non-governmental organizations in solving the e-waste and information security problem.

The results showed that 98.1% of the respondents said that they get no support from the non-governmental organizations on the problem of e-waste and information security, while 1.9% said they get support from non-governmental organizations.

3.4.6. Availability of Procurement policy that addresses the issue of e-waste and information
This question was intended to learn from the respondents if in their organization's procurement policy, the issue of e-waste and information is addressed.

The results showed that 99% of the respondents said they didn't have a procurement policy that addresses the issue of e-waste and information while 1% did not give any answer.

3.4.7. Availability of Recycling. Reuse and Remanufacturing plan of the e-wastes
On the issue of recycling, reuse and remanufacturing plan, 100% of the respondents said they did not have such a plan or practice in their organizations.

3.5 Root source of e-waste

3.5.1 Source of importation
This was to find out the source of importation of the ICT devices, that if the devices are purchased directly from manufacturer or through authorized local dealer of the manufacturer.

The results showed that 94.1% of the interviewed users do not purchase their ICT devices directly from the manufacturer that is they purchase through the manufacturer authorized local dealer .The results also showed that 5.8% do purchase directly from producer of international brand.

3.5.2 Condition and way of importation of the devices
This was to identify how the devices are imported either by purchase or donation and the condition in which the devices are imported either new or old.

The results showed that 98.1% of the respondents reported to import new devices through purchase. The other 1.9% said they obtained old devices through purchases. Furthermore, on the issue of obtaining the devices through donation or not, the results showed that 38.5% of the respondents said that they don't obtain any device by donation whether old nor new, while 61.5% said they obtain old devices through donations.

3.5.3 Stock of obsolete devices
The respondents were asked to give their stock of obsolete devices, but they could not give the number immediately as the devices were not kept in a single store, they were always scattered in different offices/departments, they collect and count when they are about to sell or offer them as donations. This indicates the lack of proper storage place.

3.6 Treatment practices of e-waste and information
This question was intended to find out from the respondents, the current disposal practices of the obsolete ICT devices in their organizations. This was to know the way they treat the obsolete devices and the sensitive information in the devices.

3.6.1 Treatment practice of Obsolete ICT devices
This question was intended to reveal how the obsolete ICT devices are treated either by keeping them in store sell them, donate them to schools etc or throw them to the dumpsite with other wastes.

The results showed that 48.1% of the respondents said that they stored the obsolete ICT devices, 22.1% sell the obsolete ICT devices, 42.3% donate them to schools etc and 3.8% throw them to the dumpsite with other wastes.

3.6.2 Treatment practice of sensitive information from discarded devices
This question was intended to reveal how the users of the ICT devices in different organizations do treat the sensitive information from the obsolete ICT devices before the devices are subjected for selling, donation and thrown to the dumpsite or kept in store.

The results showed that 17.3% of the respondents said they delete the information from the hard drive before discarding the devices, 24% said they format the hard drives containing the sensitive information before discarding the devices, 76% said they keep the hard drive with the sensitive information and discard the box and 3.8% said that they keep the devices with the sensitive information and discard the devices that does not have the sensitive information.

4. Discussion and Findings

4.1 Awareness to issues related to e-waste and information
Generally on the issue of Awareness the above results show that more than 50% of the respondents were not aware of either the e-waste problem or the security of the information from the e-waste. That means 50% of the respondents don't know the human health threat, environment pollution and the security of information threat caused by their discarded ICT devices. Also more than 97% of the respondents were not aware to Government initiatives towards e-waste and information, treatment of discarded ICT devices and international regulations on e-waste and information.

This level of awareness is not enough and has to be improved through training. User's awareness is an important component to overcome e-waste and information security problem. The study, conducted by UNIDO

e-waste initiative for Tanzania in 2011, suggests that there is a need of e-waste awareness campaigns to the public in order to safeguard the environment and public health in general (UNIDO, 2011) It has been found also that one of the most effective way to deal with the e-waste stream is to educate the people (Babu et al., 2007).

4.2 Root sources of e-waste

4.2.1 Source of importation

The study in this paper shows that the new ICT devices are imported by either purchasing from the manufacturers of the international brand or from manufacturers authorized dealers. Other old ICT devices are obtained as donations from developed countries; this is in accordance to the data collected from the universities and other government institutions. Additionally, for the private institutions they purchase the used computers from these institutions or import the used computers from developed countries.

4.2.2 Condition and way of importation of the devices

These general results show that more than 60% bought new computers from the retail shop of the international brand that was from the local agents/dealers of the manufacturer of the brand. But still there were also more than 60% who are getting old devices from donations and about 1.9% are buying old devices. This is a problem since imports through donations or purchase of old devices contributes to an increase in the number of second-hand ICT devices. Studies show that between 25% and 75% of second –hand ICT devices imported into Africa arrive in unusable condition, beyond repair or already e-waste (Greenpeace, 2005).

4.2.3 Stock of obsolete ICT devices

From the study in this paper showed that there is a lack of proper storage place of obsolete ICT devices. This lack of proper storage of obsolete ICT devices is a problem. For example, the standard operating procedures of e-wastes for companies in India emphasizes on allocation of sufficient storage space with each type of e-waste differently to ensure safety (e-waste Guide, 2009). This is because each ICT device needs a separate care as they contain different kinds of hazardous chemicals, for example batteries contain carbon, Lithium and other chemicals while Cathode Ray Tubes (CRTs) from computer monitors contain Mercury, Phosphorus, Cadmium, Barium and Lead (Brigden and Santillo,2009). These may leak if stored carelessly. There is a need to have some scientific way to monitor the discarded ICT devices in proper storage allocations.

4.3 Treatment practice of Obsolete ICT devices

Results showed that more than 40% of respondents stored the devices for unspecified period until they sell the devices. The rest either donate the devices to schools, employees etc or throw the obsolete devices to the dumpsite, and there are some who do both sell and donate depending on the condition of usability of the devices. All these practices are dangerous to human health and environment; keeping the devices for long time or for infinite time with hazardous component inside is dangerous to human health and environment just like throwing the devices in the dumpsite or sell to scrap dealer who take the metal parts and throw the circuitry to the dumpsite. All at the end are land filled, burnt or thrown in the sea or rivers; this results in land pollution, air pollution and water pollution respectively (Miller, 2005).The government coordination committee on e-waste management(CCeWM) under Tanzania Communications Regulatory Authority (TCRA) gave the guideline on procedure for storage of e-waste "Any producer, collection centre, dismantler or recyclers may store e-waste for a period not exceeding one hundred and eighty (180) days and shall maintain a record of collection, sale, transfer, storage and segregation of wastes and make these records available for inspection: (TCRA,2012).

4.4 Treatment practice of sensitive information from discarded devices

The study realized three ways in which information from the discarded devices are treated in the visited sites; delete, format, and keep the hard drive or device with the sensitive information. Keeping the hard drive and leave the other parts of the device go into e-waste stream being the highest practice (76%). All these are not the proper way to handle the information securely. Keeping the hard drives and the devices with the sensitive information, results into accumulation of e-wastes from the ICT devices. Deleting and formatting the hard drives has been found that can't remove completely computer hard drives, information stored in them have been found to be alive and can easily be recovered using data recovery software (Koloseni and Shimba, 2012).

4.5 Role played by ICT experts towards e-waste and information problem

This result shows that ICT experts were not involved in solving the e-waste problem though they are the manufacturers, users and managers of the ICT devices. The problem cannot be left to the environment experts only since ICT development without an eye on environmental protection is not sustainable (Tedre et al, 2009). A key finding in a major study on ICT and sustainability was that several ICT applications cancel each other out, leading to the conclusion that a set of specific ICT-related policies is necessary to harness the potential of ICT to support sustainable development while at the same time inhibit its potential for negative environmental impacts (Hilty et al., 2006). Green IT issues are the contribution of ICT expert in mitigating the e-waste and information

security problem. Green IT addresses environmental impacts of the whole IT life-cycle, ranging from designing an IT device, to its use and its end-of-life management (Molla et al., 2009). Tanzanian ICT experts should put effort on Green IT issues in order to preserve the sustainability of ICT development.

4.6 E-waste and information disposal facilities and strategies

It was learnt from the study that there is no recycling or remanufacturing industry of the computers in Tanzania. This is a challenge in developing countries. While in industrialized countries where there are ICT manufacturing industries they emphasize on four levels presented in order of preference to ensure environmental sustainability (Defra, 2007) which are: Level1 Waste Reduction (Such as extended product durability), Level2 Waste re-use (such as remanufacturing product for the second life), Level3 Waste recovery (Such as raw materials recycling and finally level4 Waste landfill (as the last resort).Furthermore, it was realized in the paper that in Tanzania there is a lack of the following facilities; (i)Enough better disposal strategy (ii) Collaboration between government and private sector organizations to e-waste and information (iii) Enough policy to better handle the e-waste and information (iv) e-waste and information security assessment tools (v)Support from non-governmental organization on e-waste and information (vi) Procurement policy that addresses the issue of e-waste and information.

4.7 Respondents Opinions and Suggestions on e-waste and information

The following are the general opinions of the respondents on the problem of e-waste and information security; (i)Respondents suggested the need of having Awareness programs on e-waste and information security (ii)Government institutions should have proper inventory management systems for the whole country of the imported desktop computers, laptops and servers, life-time of these devices so as to sort specifically which device, at which date is supposed to enter the e-waste stream (iii) Proper e-waste and information Security mechanism should be in place and regulations, legislations and policies should be reinforced (iv) Cloud computing can help to minimize e-waste, avoid buying many large servers or heavy duty machines (v) Directives are needed from the government to all ICT stakeholders on the standard and safe way to handle the ICT devices and information in them when they reach the end of their useful life (vi) Government should reinforce collaborations between public and private partnership in assisting the government to solve the e-waste and information problems (vii)Government should adopt a proper framework for e-waste management and information security.

4.8 SWOT analysis of the current practices in the management of obsolete ICT devices and information security in Tanzania

The results of the analysis of the data collected and discussions can be summarized using the SWOT analysis.

Table3. SWOT analysis of the summary of Strengths, Weaknesses, Opportunities and Threats in the current practices in the management of obsolete ICT devices and information security in Tanzania

STRENGTHS	**WEAKNESSES**
• Existence of the bodies/institutions dealing with the environmental issues including e-waste management. • Importation of devices from certified local dealers of international brands. • Availability of the Countries with systems of e-waste and information management which might be helpful for benchmarking.	• No specific legal framework which address e-Waste issues and information security. This includes' appropriate policy, legislation and regulations. • Users and public awareness on issues of e-waste and information Security is very low. • Lack of effective and efficient means to completely remove the information from the ICT devices before they enter the e-waste stream. • There is no framework for establishing data base and keeping statistics of ICT devices in use or imported/exported and the obsolete devices. • Illegal dumping of e-waste such as burning and burying could lead to environmental pollution as well as pose risks to human health. • Lack of Scientific way to store the discarded devices categorized according to the type of hazardous chemicals they contain. • Lack of industries for recycling, reuse and remanufacturing of the e-waste.
OPPORTUNITIES • As e-wastes contain valuable minerals and other useful materials, establishing the recycling, reuse and remanufacturing industries can make e-wastes from ICT devices turned into opportunity such as business and employment.	**THREATS** • Lacking of proper management mechanism of e-waste and information cause a threat to human health, environment pollution and security of sensitive information from the devices that enter into the e-waste stream.

Table 3 Shows the SWOT analysis of the current situation of e-waste and information in Tanzania as

realized in the study through the analysis of the data collected from sites and literature review on the subject matter. SWOT analysis in this case is used as a tool to determine the current situation of e-waste management and information security in Tanzania. It shows the summary of the Strengths, Weaknesses, Opportunities and Threats (SWOT), identified from this study through interview, questionnaire and literature review.

4.9 Findings

This paper has discussed several e-waste and information security current management practices in Tanzania. The following are the findings from the study; (i)There is a lack of awareness among the ICT experts and other users in the operational and managerial level in the site visited on; E-waste and information security problem, government initiatives and strategies over the problem, existence of government legislations, regulations and laws and international regulations and conventions that Tanzania is a part on the issue of e-waste problem (ii) E-wastes are mismanaged in the current practices. According to the findings in this study; the discarded devices are stored for unspecific period of time before they are sold in public auction, throw them to the dumpsites like other municipal waste or donate them to the needy without knowing what happens to the discarded items. These are bad practices because the last practice to the remaining parts of the discarded devices after the scrap dealers dismantle the metal parts they need is throwing them to the dumpsite and at the end exposed to burning and land filling(iii)Lack of proper management of the security of information as in the current practice the ICT devices users tend to delete or format the hard drive of the device with the sensitive information with the intention of removing completely the information from the computer because they do not want to share them with unauthorized people. This is a bad practice because it has been realized by researchers that deleting and formatting is not enough to remove the information completely from the computers as information still remain alive and can be recovered by the data recovery software and be seen or used by unauthorized people. The other practice is keeping either the hard drive or the computer with the sensitive information for undefined period because they are not sure on what to do with the information inside; the other alternative to this could be to destroy the device by grinding which has the same effect like burning and land filling (iv) Most of the devices are imported new with some few numbers of importations of old devices either by purchase or donation from industrialized countries. For the importation of the old devices either obtained by purchases or donations the regulation and law should prohibit strictly the importation of used devices. It important to promote ICT application advancement by having more imports of the devices for the sustainable development of the country, but at the same time it is crucial to inhibit its potential for negative impacts on environment and health (URT, 1997). Tanzania is one of the developing countries which suffer from financial instability, at the same advancement in the ICT sector is crucial for sustainable development and some of the efforts are getting more ICT devices at the cheaper price or donation, cancelling of taxes in importation of ICT devices etc. But this is dangerous because the developed countries can take it as an advantage to off-load their e-waste by dumping them to Tanzania under the umbrella of donations for sustainable development (v) Lack of proper inventory for imports and stock of usable and obsolete ICT devices. It has been found from the sites visited that there is no reliable data on stock of the devices even the procurement department cannot give accurate data on stock of the devices. The obsolete computers are scattered in different offices and the exercise of collecting and counting is done when they are about to be sold or offered as donations. This lack of proper storage place has also been found as the problem, there is a need to have proper storage place categorized according to the type of device, hazardous chemical it contains and they should be monitored scientifically like having sensing mechanism to detect any harmful leakage from the devices (vi) ICT experts are not involved in solving the e-waste and information security problem. The problem of e-waste is taken as environment expert responsibility only. But Computers contribute larger amount of e-waste than other e-wastes, also the computer treatment needs ICT expert assistance as some of them contains sensitive information whose handling need the support of ICT expert, it can be seen from the review of legislations, regulations, laws and the conventions; the component of information security is not touched. Green IT and Green computing issues need full participation of ICT expert (vii) Lack of e-waste specific Legislation, Regulations and Institutional Framework for management of e-waste and information.

5. Conclusion

There is a need to have the E-waste management and information security framework which will harness the findings and recommendations of this study and hence provide the implementable set of procedures to solve the problem and rescue the Tanzanians from the health and environmental threats.

6. Future research directions

This study was limited to e-waste management and information security especially from computers. Further research directions are on the ICT support towards proper e-waste management. More research is needed on intelligent recycling systems, intelligent sorting technology and improved e-waste logistics.

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