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INFLUENCE OF ELECTRONIC WASTE MANAGEMENT SYSTEMS IN KENYA. A CRITICAL LITERATURE REVIEW.

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ABSTRACT

Purpose: There is a variety of electronic waste found in the country ranging from computers, cellular phones, televisions sets, refrigerators, and entertainment electronics amongst others. The general objective of the study was access the influence of electronic waste management systems in Kenya. A critical literature review

Methodology: The paper used a desk study review methodology where relevant empirical literature was reviewed to identify main themes and to extract knowledge gaps.

Findings: The study concludes that the methods employed in e-waste management were still inadequate. Most importers disposed of the undistributed computers and mobile phone at a discounted price to retailers and consumers. Very few importers used extended ·producer responsibility. In addition, majority of the end users used auctioning as a method of e-waste management.

Recommendations: The study suggested that there is a need for the manufacturer to design a system which provides incentives to consumers to bring back products to the appropriate collection points. The incentives can be used in the beginning of the collection scheme as a way of advertising the scheme and when the scheme is well established the manufacturer can review and determine if there is need for incentives.

Keywords: *influence, electronic waste, management systems, Kenya*

INTRODUCTION

Background of the Study

Electronic waste (E-waste) can be defined as various forms of electrical and electronic equipment (EEE) that are old, end of life electronic appliances that have ceased to be of any value to their owners (UNEP 2010). E-waste is composed of various materials, including bulk materials, hazardous, and valuable substances. In general, almost 80% of the weight of electrical and electronic equipment is made of glass, iron, aluminum, and plastic (Deathe et al., 2008). Some of the substances that are used in the electrical and electronic equipment are nonhazardous in nature; however, they become hazardous after they end up in a toxic compound when used in manufacturing of electrical and electronic equipment (UNEP, 2007; Robinson, 2009). E-waste accounts for 8% of municipal solid waste worldwide (Babu et al., 2007). Over the last decades, the electronics industry has revolutionized the world. Electrical and electronic products have

become ubiquitous of today's life around the planet. Without these products, modern life would almost be impossible in (post-) industrialized and industrializing countries. Electrical products serve in diverse disciplines such as medicine, mobility, education, health, food-supply, communication, security, environmental protection, and culture. Like all products in the market, at the end of their useful stage electrical products are potential wastes.

In developed countries, electrical and electronics waste equals 1% of total solid waste on an average and is expected to grow to 2% by 2010 (Li et al., 2006). In USA, it accounts for 1 to 3% of the total municipal waste generation. In European Union, electronic waste increases by 16-28% every five years, which is three times faster than average annual municipal solid waste generation. A recent source estimates that the total amount of electronic waste generation in EU ranges from 5 to 7 mi IIion tonnes per annum or about 14 to 15 kg per capita and is expected to grow at a rate of 3 to 5% per year (UN EP, 2007). In developing countries, it ranges from 0.01 to 1% of the total municipal solid waste generation. E-waste has raised concern considering that many components of such equipment are considered as toxic and are not biodegradable. The toxicity is due in part to lead, mercury, cadmium and a numberof other inorganic but toxic substances (UNEP, 2007). Responding to these concerns, many European countries banned e-waste in landfills in the 1990s. The European Union further advanced e-waste policy in Europe by implementing the - Waste Electrical and Electronic Equipment directive (WEEE) in 2002 which holds manufacturers responsible for e-waste disposal at end-of-life. Similar legislation has been enacted in Asia, with e-waste legislation in the United States limited to the state level due to stalled efforts in the United States Congress regarding multiple e-waste legislation bills. Due to the difficulty and cost of recycling used electronics as well as lack-lustre enforcement of legislation regarding e-waste exports, large amounts of used electronics have been sent to developing countries where lower environmental standards and working conditions make processing e-waste more profitable (Li et af., 2006). Growth in the Information Technology sector in developing countries has been intensified by the importation of "hand me-down" used equipments from rich developed countries, whose consumers are all too happy to find buyers for it. As a result many brokers and businesses have sprung up to channel used equipment from North to south, rich to poor. Much of the trade is illegal under international rules governing trade in toxic waste such as the Basel Convention (Basel Action Network, 2005). These trades are often justified under the name of 'bridging the digital divide'. This expression is also used as excuses to obscure and ignore the fact that these bridges double as toxic waste pipeline to some of the poorest communities and countries in the world. While closing the 'digital divide' we are opening a 'digital dump' and electronic manufacturers to evade their responsibilities over the ultimate fate of the products they put out in the market (Basel Action Network, 2004).

The environmental pollution resulting from. inappropriate management of e-waste in the developing countries is potentially immense considering that about 40% of lead found in the soil originates from the electronic waste (Milojkovic, 2005). In addition, 70% of heavy metals found in the soil are from electronic origin (Milojkovic, 2005). Disposal of computers and its accessories in developing countries adds to the waste management problem, because these countries are not as likely to have adequate resources and waste management infrastructure to protect human health

and the environment. The disposal of computers thus needs to be managed in an environmentally sound way, to minimize releases into the environment and threats to human health (BASELIMPPI, 2004). The current transboundary movement of e-waste to developing countries and the subsequent inappropriate management/ disposal will exacerbate the present high level of environmental pollution in these countries. But information on e-waste management in Africa needed to drive this process is scanty (Williams, 2005). Kenya has experienced a remarkable growth in the ICT sector in the last decade. A growing number of Kenyans today have access to computer facilities at home, school, business centers and internet cafes. A greater number also have access to mobile phones and this is now playing a huge role in the development of the Kenyan economy (Basiye, 20 I I).

The European Environment Agency and United Nations Environment Program estimate that 40-50 million tons of electrical equipment waste is produced each year globally. It's increasing three times faster than all other types of domestic waste.The problem is that only around 10% of all this e-waste is collected and taken care of in adequate recycling facilities (La Dou& Lovegrove 2007, Cobbing 2008), "Across Africa, the technology market is predicted to grow by over 8% a year for the next three years. The problem is that only around 10% of all this e-waste is collected and taken care of in adequate recycling facilities (La Dou & Lovegrove 2007, Cobbing 2008). Africa as a continent is not spared and though it does not handle as much e-waste as in developed countries, it is in bad shape since no formal systems exist for recycling of e-waste. In most of sub-Saharan African countries, E- Waste has in the recent past been a big problem. The lack of a sustainable e-waste management infrastructure means that e-waste is collected and recycled in crude methods, causing the release of toxic chemicals to the environment and putting those refurbishing and dismantling e-waste at risk. This is aggravated by the fact these countries usually have little e-waste legislation and no regulations to protect the health of e-waste workers. Kenya, like most Africa countries lacks effective polices and strategies to dealing with e-waste. This spells a perilous lack of effective guidelines to deal with trade and disposal of e-waste in many African countries hence exposing the continent to vulnerabilities associated with e waste. Across Africa, the technology market is predicted to grow by over 8% a year in the next years. This is great news for the region, but comes at a cost (UNEP 2009).E-waste in Africa is growing 20% each year due to rising sales of electronic goods and legal and illegal imports of second hand and surplus equipment"(HP Environmental Compliance 2009). In Africa, the exportation of electronics wastes by developed countries to poor developing countries like Kenya, presents the main culprit of all. Electronic equipment and devices are becoming widely used in offices and by students due to the necessity to communicate and do research in emerging countries. The rapid economic growth has led to a rise in the generation of electrical and electronic waste (ewaste), coming both from local consumers and recycling of second-hand equipment imported for re-use.Therefore, Solid waste creation and disposal is a distinctly human phenomenon that is placing increasing pressure on both the environment and modern infrastructure in developing countries, one of the biggest challenges facing human beings is the unhealthy disposal of solid waste resulting from activities of development (Joseph, 2006). Increased electronic equipment use has led to increased electronic waste. Poor management of the resultant waste will lead to increased pollution, potential problems

in public health, ecological as well as socioeconomic impacts. Among other regulations, International conventions such as Basel convention, Bamako etc., have been key to e-waste management however the menace continues. The continued generation of electronic waste and the unclear responsibility for the disposed electronic products in Kenya is posing a great challenge to the Kenyan government due to increased usage and importation of second hand electronic equipment such as computers in the recent past.

Problem Statement

The disposal of wastes in or on land without careful planning and management can present a danger to health and the environment and is a serious problem in many societies (Ehrampoush&Moghadam, 2005). Increased use of technology especially ICT in institutions of learning and offices, low initial cost, unplanned obsolescence of electrical and electronic equipment has led to an e-waste generation problem for Kenya. New and improved electronics and advanced models e.g. cellular phone and personal computers) are coming out in the market everyday making the older models technically and technologically obsolete and less satisfying to consumers thereby contributing to potential electronic waste stream. A recent baseline study done in 2008 showed that Kenya generates 3,000 tons of electronic waste per year (NEMA 2009). The study predicts that the quantity is expected to increase as usage increases and asKenya positions itself as the Silicon Savannah in Africa. The current e-waste generated in Kenya is at 11,400 tons from refrigerators, 2,800 tons from TV`s, 2,500 tons from personal computers, 500 tones from printers and 150 tons from mobile phones (press release UNEP,2010). Kenya is a favorite destination for second hand computers which are affordable and mostly cost on average $100. These are used in institutions of learning and cyber cafes. The downside of such computers is that they have a shorter shelve life and break down faster than new computers. This is expected to worsen as Kenya positions itself to become an ICT hub. Institutions of learning among them schools and colleges use a high number of electronic equipment. This means that they are key contributors to electronic waste; however they don't have elaborate mechanisms of managing the resultant electronic waste at the end of their useful life. The e- 4 waste problem is likely to be compounded by the expected stream of electronic waste that will be occasioned by the free government laptops project expected to benefit thousands of primary school pupils spread all over Kenya.This Electronic waste will pose a great challenge to the Kenyan government and threatens the health of the people and the environment as 2%. Of ewaste is toxic..The current study will bring into light the influence of electronic waste management systems in Kenya. A critical literature review.

Objectives of the Study

The general objective of the study was to access influence of electronic waste management systems in Kenya. A critical literature review.

Justification and Significance of the Study

Technology has become a part of every aspect of modern life in everything we do including education.Managing the resultant e-waste at the end of useful life is challenging not only due to

its increasing volume but also because of its hazardous nature as 9% of electronic waste is hazardous. E-waste is increasing exponentially due to the penetration of electrical and electronic devices in any aspect of modern day life. E-waste is the fastest growing waste stream (Nuoron and Osibanjo 2008) with the growth rate of 3to 5% per year which is 3 times faster than the general waste (Pucket et al 2002) , which is equivalent to 20-50 million tons a year worldwide (UNEP 2005), This has been brought about your constant desire for newer and more efficient technology, combined with the aggressive marketing by the producers, making the consumers replace their electronic devices more and more frequently. For instance, cell phones have now an average life span of less than two years in the industrial world, and computers two to four years (BAN & SVTC 2002, UNEP 2005). thus creating great management challenges to the government`s free laptop project expected to generate a further stream of electronic waste across Kenya .

The rate at which these mountains of obsolete electronic products are growing will reach crisis proportions unless measures are taken to manage the menace in Nairobi which is already saddled with the problem of poor solid waste management. This coupled with the fact that institutions are receiving "hand me-down" used equipment's from rich developed countries in form of 'donations' and lack of policy interventions and systematic management strategies has aggravated the problem of e-waste management in Nairobi. The situation In Kenya, is reaching crisis proportions, because in the official dumpsite (Dandora dumpsite) there is evidence of electronic waste ranging from obsolete computers to mobile phones and batteries - all containing highly toxic substances (Mbalo, 2008). This is an indication that e-waste is not considered as hazardous or special type of waste and therefore efforts for special handling of this type of waste is not yet effective. E-waste has been associated with a myriad of risks for the human and environmental well being (CTBC, 2004). The prospect of this threat is made worse when one considers that Kenya is at the verge of an IT revolution.

This study will play a significant role in creating awareness of the uniqueness of e-waste problem in Kenya in that E-Waste is relatively new and its quantities are rapidly growing as technology becomes more common. It is hoped that the results from this study form a base for decision makers in formulating strategies towards improving electronic waste management in institutions of learning. The research will explore the government’s readiness to manage the expected extra stream of electronic waste

LITERATURE REVIEW

Literature

Health and Environmental Impacts ofE-waste

E-waste is unique and different from any other form of solid waste in Kenya, and has currently increased in the environment due to the uptake in information and telecommunication technology. This kind of waste is regarded as e-waste based on the characterization of the inherent constituent components including heavy metals such as lead, mercury, silver, cadmium and other Hexavalent chromium elements. Other harmful materials include plastics made of polyvinyl chromium (PVC) and Brominated Flame Retardants (BFR). The above elements, which are common in fC'F

products such as computers and mobile phones have both chronic and acute effects on the human system when exposed at variant levels in the human environment. A computer monitor contains 6.3% lead, which if not well contained and recovered, infiltrates the water, soil and/ or air system as a result of burning of wastes.

The main environmental issue concerning of electronic waste managementis the uncontrolled release of hazardous substances into the environment as well as sub-optimal use of recyclable materials Improper disposal can be extremely hazardous to the environment and health some of health hazards include a number of ailments as a result of contact with toxins such as dioxin, cadmium, mercury, furans, and lead among others, emitted in landfills or incineration processes. E-waste Recycling process can also result to Emission and effluents therefore care should be taken during the process

Toxic elements account for about 2% of the total weight of E-waste; Secondly, the majorities of materials have an economic value and therefore a considerable recycling or reuse potential (i.e. copper, aluminum, gold, nickel).While the toxic elements are of low risk during the use phase of equipment; these substances can become harmful in the end-of-life phase. Different toxic chemicals are used in the manufacturing of electrical and electronic equipment such as plastics, , gallium, nickel, mercury, aluminum, vanadium, beryllium, lead, chromium, cadmium, and arsenic (Robinson, 2009; Van de Merwe, 2009).If these products are not disposed of properly and are landfilled, toxic components can leach into soil, and ground water (Rushton, 2003). A computer monitor contains 6.3% lead, which if not well contained and recovered, infiltrates the water, soil, and/or air system as a result of burning of wastes. The amount of pollutants in a computer is much higher in than in other EEE such as washing machines and refrigerators (Barba-Gutierez et al., 2007). Poor conventional methods of disposing e-waste, which are mainly open dumping and open burning results in to oxidation of plastics made of plastics of BFR, this releases dioxins, furans and toxic Respiratory Suspended Particles that cause risks to human health upon exposure and alters environmental systems.Most risks arise during the uncontrolled e-waste recycling activities that occur in developing countries, and are results of the rudimentary methods used. These include manual disassembly and sorting; heating and acid leaching of printed circuit boards (PC-boards); shredding, melting and extrusion of plastics; open burning of plastic coated wires and other components; and sweeping and collection of toners from toner cartridges.

Waste Management Strategies There are various strategies that can be employed to manage e-waste. These strategies can be combined through integrated e-waste management to provide maximum effectiveness (Goosey, 2009). These strategies include reuse, service, or refurbish, remanufacturing, recycling, and final disposal (Goosey, 2009; Envirosris, 2000). Reuse means trade of the electrical and electronic equipment or its components in the way that they were originally designed (Jofre and Morioka, 2005). Service or refurbish means repair or maintenance, which leads to the extension of functional lifespan of the electrical and electronic equipment (Jofre and Morioka, 2005). Reuse and refurbishing provide many environmental and social advantages such as saving materials and energy by decreasing the use of raw materials in order to manufacture electrical and electronic equipment, which can lead to less required packaging; less waste

production; and more importantly, diversion of e-waste from the solid waste stream (EPA, 211; Jofre and Morioka, 2005). Reuse also enables low-income individuals to have access to electrical and electronic equipment at cheaper costs (EPA, 2011; Goosey, 2009). Remanufacturing is an ewaste management strategy and consists of removing some parts of e-waste in order to utilize them in the manufacturing of new electrical and electronic equipment (Goosey, 2009). Recycling (with or without disassembly) includes substituting virgin materials by recycled components and includes recovery of raw materials, and reprocessing (Bilitewski et al., 1997; Jofre and Morioka, 2005). Recovery of raw materials is considered an important concept in application of e-waste management strategies due to the fact that it leads to conservation of valuable resources (Goosey, 2009). One of the key elements in implementing successful 32 recycling management is to keep e-waste clean and uncontaminated, which will facilitate and enhance disassembly, and recovery processes (Goosey, 2009). Resource recovery and recycling is one of the best strategies in waste management. It has been necessitated by the overwhelming increase of both domestic and municipal solid waste. Most ewaste has recoverable and valuable metals. Other benefits of recycling involve saving on the costs of waste disposal, and the substitution of secondary materials for virgin ones. According to Gachamba (1993), the major form of recycling in Kenya is done through scavenging. This is for metals, plastics, paper, and bottles. Recycling business has a high potential however, a strong legislation is necessary to guide on e-waste recycling as well as favorable market conditions.

E-waste in Kenya Kenya's

ICT industry is growing fast. The rate of ICT acquisition specifically computers and mobiles is increasing. Most ICT products come from EU countries such as Britain, Asian countries such as China and Malaysia and USA. Generally ICT imports are new and old products are discouraged. However, there is a considerable portion of refurbished and old products brought in country through various channels such as NGO donations to institutions like schools. The primary reason for importing refurbished and old products is that people prefer cheap goods. It is not until September 2006 when that Kenya held the Eighth Conference Of Parties (COP 8) in Nairobi that e-waste management problem was perceived urgent. The low consumption of EEE and the general trend by households to dispose them with the general solid waste made it seem less urgent. A lot of e-waste has been dumped in Kenya in the disguise of donations (Musili 2008). The un usable computers are shipped back to donor countries by Non-governmental organizations, up to a quarter of the computer donations to recipient countries such as Kenya are unusable.10 to 20 per cent of the computers of the computers donated to Kenya by the United Kingdom and the 35 United States are unusable (make it fair, 2008). Kenya`s susceptibility to more E-waste is due to the availability of huge market for second hand computers as well as the affordability compared to the price of new computers (Waema, 2008).there is an influx of cheaper computers both new and old among other EEEs from Asia. Now more and more people can afford these cheaper products bust the contentious issue is the end of life disposal of these EEEas they have a short life span.

Kenya lacks clear data on the availability of various EEE in the country or the available one is contradictory.According to Omosa and McCormick, (2004), it was estimated that in the year 2004

only 17% of Kenyans owned a personal computer while Intermedia (2004) stated that in 2005, 32% of Kenyan owned a computer. Waema, (2008) indicated in his study that approximately 1 million out of 33billion Kenyans own a computer. Evidently there are discrepancies in the figures and it necessitates a clear study to establish and validate the right number and data on the available EEE in Kenya. This would facilitate informed planning for the control and management of the resultant e-waste. Generally, little has been done in management of e-waste in Kenya;however, there have been some initiatives of E-waste management in Kenya after the eighth COP to the Basel convention. The forum for the Future and Practical Action Aid in collaboration with Vodafone conducted an E-waste pilot project primarily focusing on cell the phones waste with the aim of determining the volume of the waste and possible collection methods. Nokia then set up a take- back scheme for the EoL mobile phones. Several NGOs have developed project proposals on E-waste management with special focus on ICT equipment. Currently, computer for schools Kenya (CFSK) program has a functioning computer repair and refurbishing centre and intends to expand the program into a fully-fledged e-waste management centre.

Empirical Review

Kaloki,(2014) conducted a study on the role of institutions of learning and Kenyan Authorities in combating electronic waste menace. It further looked at the Government's lack of enforcement of existing laws dealing with e-waste management, the legislative bodies that are concerned in management of e-waste and furthermore account for the chemicals and hazardous substances in e-waste and the impacts they can have on the environment and human health. The Data for this study was collected using questionnaires, interviews, and discussions with key policy officers in government agencies, institutions of learning and collectors in Ruiru sub county. Secondary data was collected from review of literature. Data acquired was analyzed using SPSS and excel programs and illustrated where possible to draw conclusions. A Framework of integrated waste management was used to ensure e-waste is managed in a strategic way that leads to an e-waste management approach that could exist in a sustainable society. Data analysis revealed that institutions of learning are among the largest producers of e-waste such as Computers, typewriters, printers, Power cables, photocopier, TV sets, radios, projectors ,desk phone, audio mixers , binding machines, microphones, UPS, video switcher, video cameras, still cameras, CCTVs; however none of the sampled institutions had an e-waste management policy or a defined method of e-waste management. 40% of them disposed of their waste with general waste without prior separation while 40% simply stored it and 18% gave it to scrap dealers. The level of awareness on e-waste was low especially it's environmental and health effects at 25 % and 23% respectively. 68% of institutions were willing to give out their e-waste for free. 32% percent who were willing to sell or give it out but with conditions of free pick up at 60%, guarantee of proper disposal at3%, 28% if the law required them to and 10% would give it out if they were sure it was of no value to them. This revealed a high investment potential in E-waste recycling sector. The highly anticipated Governments free laptop program is likely to compound the e-waste steam management in primary schools spread all over Kenya if proper mechanisms of handling the resultant stream of waste are not put in place. Kenya lacks an e-waste specific policies but the government recognizes the challenges posed by e-waste and has already come up with draft regulations on E-waste due for

adoption. The study recommends that e-waste specific policies and regulations be developed to govern e-waste from the production, importation, collection, transport, recycling and disposal. A proper National and institutional collection system needs to be developed and consumer sensitization and awareness increased.

Lucy, (2012) conducted a study on The aim of this study was to quantify e-waste generated by the institutions, to identify the methods currently employed in the management and disposal of e-waste by the selected institutions, to evaluate current e-waste management policies and strategies implemented and recommend strategies that may be used to improve the management of the e-wastes by the institutions. The respondents were drawn from the major potential e-waste generators in the city including: medium to large scale computer and mobile phone importers and assemblers, end users of computers and its accessories, formal e-waste recyclers and key ICT and e-waste management institutions such as the CCK and NEMA provided key information. The researcher administered questionnaires to key informants, used observation record sheets, and secondary data from relevant institutions as the main sources of information. Analysis of data focused on generating-waste flow stream, quantifying the amount of e-waste generated and evaluating national and institution policies on e-waste management. T-test was used to quantify the amount of e-waste generated by the stakeholders. The results showed the tonnage of mobile phones and computers that remained undistributed by importers was statistically significant at 95% confidence level (t= 6.52, df = 2; p= 0.00456) and (t =-0.63294, df = 2; p=0.0322), respectively. In the category of end users the tonnage of e-waste generated was insignificant at (t=8.4, df = 2; p>3.l8) for universities and (t=7.97, df = 2; p>3.18) for ministries. This could be attributed to the long period of possession of equipment by end users. Analysis of the results further showed that tonnage of e-waste generated by recyclers was statistically significant at 95% confidence level (t=-13.82, df = 2; p=0.00089). Further analysis of the e-waste flow stream from the importer to recycler has showed that significant amount of e-waste is being generated importers in comparison to other stakeholders. This means that a high percentage of equipment brought into the country by importers is potential e-waste due to the high amount of electronic equipment that remains undistributed and this poses a great threat to the environment. The methods employed for disposing e-waste included dropping off old IT technology at garbage collection point, storing in offices room, selling scrap, donation and re-use, selling to staff, friends, family or public, take back schemes and extended producer responsibility. The implication of these methods used is that e-waste generation is likely to increase downstream as a result of channeling e- waste to end users and recyclers. Approximately 75% of the stakeholders in the study lacked a policy on e-waste management and only 36.1 % planned to have a policy in place. While the Government has recognized the challenges posed by-waste, the level of preparedness in terms of policies and legislation is low. The study recommends that specific policies and regulations on e-waste be developed. These should govern e-waste from collection to final disposal, and licensing of key actors. A national collection system needs to be developed, and consumer awareness enhanced. Capacity building programmes should be launched in the sector, possibly funded by fees levied on importers of second-hand equipment.

Sta,(2013) conducted a study that investigated the main sources of e-waste in Korogocho and Dandora informal settlements. It also established ways in which the e-waste is used. It investigated the impacts of the waste on the livelihoods of the community members. The study also determined ways in which administrative officers responded to the e-waste menace. The study applied descriptive survey research design. It used purposive and simple random sampling strategies and targeted two informal settlements; Dandora and Korogocho. Interview schedules were used to collect data. This was then presented in tables and charts. The study found that shops and other commercial agencies are the main sources of e-waste found within households in Korogocho and Dandora informal settlements. Most of these are shops that located within the city council waste collection routes. Private sources (individual and groups) are also significant sources of e-waste. A significant proportion of the community store and involve themselves in re-sale of e-waste. Some use the e-waste for re-fabrication of secondary and subsequent re-use. The level of awareness among households and community members about the impacts of e-waste on their health is low. The members are not aware of the e-waste potential for toxicity and disease. A correlation statistic established that the respondents discard their e-waste irrespective of knowledge of government laws and policies and therefore points to lack of enforcement of the regulations. Fencing of dumping places and, arresting and prosecution of law-breakers are popular options for enforcement of e-waste regulations, policies and laws. It is recommended that shops and other commercial enterprises should put in place measures for effective collection and management of e-waste. Proper separation mechanisms should be implemented to prevent such waste from reaching households. Private individuals and groups that generate e-waste should similarly use effective management strategies. Public awareness and education about hazards involved in storage and sale of e-waste should be enhanced. The same should target households and other main stakeholders who use e-waste for refabrication and, subsequent re-use and sale. The level of awareness among households and community members about the impacts of e-waste on their health should be also enhanced. This should particularly cover the potential for disease spread and toxicity. Public administration officers in informal settlement areas should embrace all the available procedures to enforce environmental management regulations, policies and laws relating to e-waste management.

Diana, (2015) conducted a study that looked at solid waste management in Embu Town, Embu County. In Kenya, urban centres are facing problems such as lack of proper policies and poor implementation of policies dealing with solid waste management, lack of finances, lack of proper institutions to deal with solid waste and lack of public awareness and cooperation from the communities when it comes to dealing with solid waste management. Some urban centres have been able to come up with their own by laws for solid waste management. Involving the private sector in solid waste management has been adopted in major towns and cities in Kenya to help cope with solid waste management. There is no available literature that shows the existence of such policies in Embu Town. The general objective of this study was to investigate the effects of solid waste management in Embu Town. The specific objectives of the study were: to identify policy development by Embu Town on solid waste disposal, to examine management of solid waste disposal used by Embu Town and to investigate the challenges of managing solid waste in

Embu Town. The research done has focused on big cities and towns like Nairobi, Mombasa Nakuru and Eldoret. However, there is scant literature on medium and small towns like Embu. Lack of literature on medium and small like Nyeri, Naivasha and Embu prompted the researcher to embark on this research. This research sought to fill in such gaps in the solid waste management issues in Kenya. Results from the study of solid waste management in Embu Town may inform research and policy making in similar towns in other counties. The theory of new public administration (NPM) was used. This study used a descriptive survey research design. Purposive sampling was used to select 10 policy makers for interviews conducted by the researcher. 323 residents and business people were selected randomly and given questionnaires to fill on their own. The data collected was coded and categorized into patterns or themes. Research findings were presented using graphs and tables. Descriptive statistics such as frequencies and percentages were used to summarize the data in the questionnaires. Tables, graphs and pie charts were used to present the results. The research fmdings showed that Embu Town has yet to develop policies to deal with solid waste management. The disposal methods used in Embu Town include waste collection and dumping of waste in the open dumpsite. The research also found out that Embu Town faces many challenges in regard to solid waste management

Francis, (2014) conducted a study to determine the waste generation from both onboard ships and offshore operational activities. It also sought to establish the waste management capacities of Kenya Ports Authority (KPA) and assess its conformity to regulations, requirements and standards. This research was conducted at the Port of Mombasa which is located at S 4° 3.1' and E39° 36.8'on the east coast of Africa between the months of November 2006 to May 2007. Data was collected through interviews, questionnaires, actual characterization and measurement of the waste streams. Photography was used for illustration purposes, while observation and participation were used to observe the actual waste management practices. One way ANOV A was used to analyze the variation of means of the waste categories, while Z score was used to test the difference of waste categories at collection centers. Chisquare was used to test for conformity to the required standards. The study revealed that KPA generates different categories of waste (F (lO, 77) = 13.85, $P < 0.05$) with significant difference among the total means of waste categories ($Z = -0.439$, $P, < 0.05$) and a difference in total means of the waste generated at different collection centers ($Z = -0.795$, $P < 0.05$). The highest category of waste generated is paper at 17.09%, followed by wood waste 14.65% and plastics at 14.54% while the lowest was miscellaneous and tin at 2.55% and 3.91% respectively, The highest generation is at collection centre number five at 20.6%. The study further revealed that there was no segregation at source, storage was in improvised containers such as open top steel drums, troughs and at many collection centers waste was dumped on the open ground. The reusable and recyclable waste materials if salvaged can have an economic value of ksh. 95,000 per month, which is about one third of the current monthly cost of waste management at the port that stands at ksh.300, 000. Waste collection was contracted out to private contractors who have only two 4 tonne open top vehicles for transportation of waste which are of small capacities, inadequate and not refuse purpose. The refuse was dumped indiscriminately at a disposal site managed by the municipal council of Mombasa situated 20 km from the port and at times along the road side on the way to the dumping site. The study revealed that, the current

management practices do not conform to the required standards (X2 = 23.98 P < 0.05). The findings of this study will enable KPA develop a waste management plan that will ensure waste minimization, segregation at source, re-use, recycle and appropriate transportation and disposal options in conformity with the legal requirements and standards.

2.5 Research gaps

Methodological gap is the gap that is presented as a result in limitations in the methods and techniques used in the research (explains the situation as it is, avoids bias, positivism, etc Francis ,(2014) conducted a study to determine the waste generation from both onboard ships and offshore operational activities .One way ANOV A was used to analyze the variation of means of the waste categories, while Z score was used to test the difference of waste categories at collection centers. Chisquare was used to test for conformity to the required standards. The study revealed that KPA generates different categories of waste (F (lO, 77) = 13.85, P < 0.05) with significant difference among the total means of waste categories (Z= - 0.439, P,< 0.05) and a difference in total means of the waste generated at different collection centers (Z= -0.795, P < 0.05). The studies presented a methodological gap as it used regression analysis while current study adopted a desktop literature review method.

Conceptual gap arises because of some difference between the user's mental model of the application and how the application actually works. Diana, (2015) conducted a study that looked at solid waste management in Embu Town, Embu County. Descriptive statistics such as frequencies and percentages were used to summarize the data in the questionnaires. Tables, graphs and pie charts were used to present the results. The research fmdings showed that Embu Town has yet to develop policies to deal with solid waste management. The study focused on solid waste management in Embu Town, while the current study examined influence of electronic waste management systems in Kenya. A critical literature review.

METHODOLOGY

The study adopted a desktop literature review method (desk study). This involved an in-depth review of studies related to influence of electronic waste management systems in Kenya. Three sorting stages were implemented on the subject under study in order to determine the viability of the subject for research. This is the first stage that comprised the initial identification of all articles that were based on influence of electronic waste management systems in Kenya from various data bases. The search was done generally by searching the articles in the article title, abstract, keywords. A second search involved fully available publications on the subject on influence of electronic waste management systems in Kenya. The third step involved the selection of fully accessible publications. Reduction of the literature to only fully accessible publications yielded specificity and allowed the researcher to focus on the articles that related to influence of electronic waste management systems in Kenya which was split into top key words. After an in-depth search into the top key words (influence, electronic, waste, management, systems), the researcher arrived at 5 articles that were suitable for analysis. The 5 articles were findings from Kaloki, (2014) who conducted a study on role of institutions of learning and Kenyan Authorities in combating

electronic waste menace. Data acquired was analyzed using SPSS and excel programs and illustrated where possible to draw conclusions. A Framework of integrated waste management was used to ensure e-waste is managed in a strategic way that leads to an e-waste management approach that could exist in a sustainable society.The result revealed that The level of awareness on e-waste was low especially its environmental and health effects at 25 % and 23% respectively. 68% of institutions were willing to give out their e-waste for free. 32% percent who were willing to sell or give it out but with conditions of free pick up at 60%, guarantee of proper disposal at3%, 28% if the law required them to and 10% would give it out if they were sure it was of no value to them.

Lucy, (2012) who conducted a study on The aim of this study was to quantify e-waste generated by the institutions, to identify the methods currently employed in the management and disposal of e- waste by the selected institutions, to evaluate current e-waste management policies and strategies implemented and recommend strategies that may be used to improve the management of the e-wastes by the institutions. T-test was used to quantify the amount of e-waste generated by the stakeholders. The results showed the tonnage of mobile phones and computers that remained undistributed by importers was statistically significant at 95% confidence level (t= 6.52, df = 2; p= 0.00456) and (t =-0.63294, df = 2; p=0.0322), respectively. In the category of end users the tonnage of e-waste generated was insignificant at (t=8.4, df = 2; p>3.l8) for universities and (t=7.97, df = 2; p>3.18) for ministries.

Sta,(2013) who conducted a study that investigated the main sources of e-waste in Korogocho and Dandora informal settlements. It also established ways in which the e-waste is used. It investigated the impacts of the waste on the livelihoods of the community members. The study also determined ways in which administrative officers responded to the e-waste menace. The study applied descriptive survey research design. A correlation statistic established that the respondents discard their e-waste irrespective of knowledge of government laws and policies and therefore points to lack of enforcement of the regulations.

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SUMMARY, CONCLUSION AND POLICY IMPLICATION FOR FURTHER STUDY

Summary

Awareness and training of the people involved in the management of e-waste are an important factor. Most of the e-waste activities have not yet been regulated thus making it impossible to know the e-waste handlers and there level of awareness on the hazardous nature of e-waste. While conducting the interviews it was very clear that the waste handlers were not aware of the contents in the EEE that they were handling. Most recyclers dismantled e-waste without appropriate protection. The lack of awareness applies to the end users too. Most of the end users interviewed had no information on how to dispose of their EoL EEE, thus necessitating creation of awareness on e-waste management and safe disposal channels.

Conclusion

The study concludes that the methods employed in e-waste management were still inadequate. Most importers disposed of the undistributed computers and mobile phone at a discounted price to retailers and consumers. Very few importers used extended ·producer responsibility. In addition, majority of the end users used auctioning as a method of e-waste management. This is a slow and cumbersome process. This suggests that excessive stock is held by the end user and structures that are not developed enough to handle e-waste disposal and therefore cause a 'drag' on waste volumes. Therefore, obsolete computers are still in 'government and varsity stores waiting auctioning. Most common method employed by recyclers to manage the e-waste was dismantling and cable stripping which is done manually and thus exposes workers to health risks.

Recommendations

The study suggested that there is a need for the manufacturer to design a system which provides incentives to consumers to bring back products to the appropriate collection points. The incentives can be used in the beginning of the collection scheme as a way of advertising the scheme and when the scheme is well established the manufacturer can review and determine if there is need for incentives. There is a need to formulate and calculate working relations with the various stakeholders for the collection scheme to be effective and efficient. As the scheme driven by private industries, the manufacturer needs to define the roles of the various actors and determine how the e-waste collection scheme will interact with the existing initiatives. The collection scheme should be convenient.

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