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E-Waste Management Practices in the Kumasi Metropolitan Area of Ghana: Status and Challenges

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E-WASTE MANAGEMENT PRACTICES IN THE KUMASI METROPOLITAN AREA OF GHANA: STATUS AND CHALLENGES.

By

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DECLARATION

I, Ernest Kwaku Bekoe, declare that this thesis is my own work and that all sources herein are properly acknowledged. This work has not been submitted to any other university. Any shortcomings and mistakes in this thesis are entirely mine.

Signature……..

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ABSTRACT

In contemporary times, the small West African country of Ghana has seen a popular and extended demand for ICT, electrical and electronic devices such as personal computers, mobile phones, TV sets and fridges nationwide. However, most of these electrical and electronic gadgets contain known hazardous and with the seemingly lack of adequate e-waste management laws and an effective infrastructure to handle their end-of-life by products, the country inadvertently faces a public health and environmental catastrophe in the long term.

This qualitative research paper takes a look at the rising e-waste menace in Ghana, with special reference to the Kumasi Metropolitan City, which has seen a tremendous increase in the amount of e-waste being generated over the past decade. The paper unearths the current management practices for e-waste generated in the city, which is presently dominated by the informal sector; processing 95% of all e-waste currently generated through a well stratified system including collection, refurbishing, recycling and disposal, as against the 5% the formal sector processes.

Further, the paper takes a look at the existing institutional and regulatory framework policies that has been put in place to guide the management of hazardous, solid and radioactive waste generated within the city, including the various local government, Environmental Protection, Sanitation and Assessment Acts.

In addition, some major challenges that hinder the effective management of e-waste in the metropolis are clearly established, as it came to light during the study the absence of an updated legal, policy framework to guide the activities in the growing e-waste management sector, as well as the unavailability of proper recycling facilities posed as the major obstacles. Also, low levels of public awareness and lack of technical knowledge and skills on the part of both officials and artisans were the other challenges facing the effective management of e-waste.

Finally, the paper throws more light on some of the associated safety, health and environmental impacts of e-waste management in the metropolis, as well as making frantic appeals to the Ghanaian authorities by way of recommendations to formulate and impose the appropriate guidelines and policies in order to bring better environmental control into the thriving ICT sector.

1. INTRODUCTION

1.1 Background

The treatment and management of waste is a major test faced by essentially all countries, but in recent times, the increase in urbanization, capacity, economic growth, technological advances and change in lifestyle orientation has led to the creation of a new kind of solid waste called Electrical and Electronic waste. It is projected that 20 to 50 million metric tons of electrical waste are generated worldwide every year with United States alone discarding 14million to 20million personal computers every year, while Asia discards an estimated 12million of electrical and electronic waste annually. (UNEP, 2009)

Electronic waste (or 'e-waste') is the term used to cover all types of electrical and electronic equipment that has or could enter the waste stream. Although electronic waste is a general term, it has assumed technical usage as a term covering any household or business item with circuitry or electrical components with power or battery supply. (StEP.org).These may consist of electrical and electronic equipment and accessories that are non-operational or whose life cycles are extinguished. Obsolete electrical and electronic equipment include computers, televisions, audio- visual recorders, mobile phones, printers and other electronic goods such as air conditioners, electronic toys, washing machines, sewing machines, lawn mowers, elevators, kitchen equipment, therapeutic equipment, surveillance equipment, mobile radio transmitters, refrigerators, and their accessories.

Waste from electronic and electrical equipment is one of the fastest growing types of hazardous wastes globally, consisting primarily of waste generated from personal computers, household appliances and mobile phones. It is classified as hazardous waste due to its toxic ingredients, including heavy metals and harmful chemicals such as lead, cadmium, mercury, arsenic etc., with the potential to pollute the environment and damage human health when it is processed, recycled or disposed of. The increased rate of e-waste generation in recent times is attributed to manufacturers constantly offering new and better devices thereby reducing the life cycles of

electrical and electronic products. As evident in recent reports, studies have shown that of the entire e-waste generated, computer waste forms a significant portion and also poses significant environmental and health hazards (Mundada et al., 2004). This is because the average life span of a computer has shrunk from 6 years in 1997 to less than 2 years by 2005, as a result of a rapid advancement in Information and Communications Technology (ICT) (UNEP, 2005).

Clearly, while the age of information superhighway has brought about many benefits, rising consumption of electrical and electronic equipment coupled with increasingly rapid obsolescence due to unrelenting technological advances, and diminishing product lifetimes has led to significant increases in global electronic wastes levels.

In the more advanced countries, laws have been introduced to regulate the use of hazardous substances in electrical and electronic equipment. The European Union (EU) places a restriction of the use of certain hazardous substances in electrical and electronic equipment. The ROHS Directive (EU 2002a) prohibits the use of certain heavy metals whilst the EU Waste Electrical Equipment (EU 2002b) requires that producers set up system and finance for the collection and treatment of e-wastes. Even with such regulations, it is estimated that only 25 per cent of the e-waste generated annually within the EU is collected and treated (Huisman et al, 2007), while much of the rest is disproportionately shipped to poor or developing countries. Relative to this problem of low recycling rates, and illegal trans-frontier movement from developed to developing countries (Krueger, 1999) is the substantial increase in the demand for electrical and electronic equipment from within developing countries, driven primarily by growing incomes and the quest for electronic and electrical products. Firsthand studies have shown that because discarded electronics contain precious materials such as copper, gold and silver, many informal recycling yards have sprung up in developing countries where workers are paid low wages to extract these valuable metals from these waste products.(StEP annual report, 2005) Demand in the poorer countries of Africa and Asia for electronic waste has steadily grown as informal scrap yards found they could extract valuable substances such as copper, iron, silicon, nickel and gold, during the recycling process, with China and India being the number one ‘dumping grounds’ for such discarded global electronic wastes, although recent studies have also exposed the illegal

export of electronic wastes to African countries over the past few decades.(Probst and Beierle, 1999)

The lack of appropriate mechanisms for and standards of disposal for e-waste in most developing countries, unlike the west, has led to toxin-laden high-tech products often ending their live cycles in the 'normal' waste stream, subject to either recycling or landfilling. Previous studies in other developing countries, including China and India, have shown that the unregulated disposal of e-waste can contaminate soil, groundwater and air, as well as affecting all those involved in their end-of-life processing and the nearby communities (Ban, 2005). Free-for-all disposal offers good reasons for existing concerns about the growing trade in electronic products in most developing countries including Ghana.

This paper will provide the needed insight and analysis to the growing trade in electronic products in the Kumasi Metropolitan Area of Ghana, review the current management and regulatory policies that has been instituted to guide their end-of-life management, and also take a look at some of the challenges facing the sector in its quest to achieve sustainable solid waste management (SWM) practices. The paper will also assess some of the environmental and health effects associated with the current practices, as well as outlining potential management options for intervention to ensure proper e-waste management in the Kumasi metropolis, and possibly in other cities of the country or other developing countries. Its purpose is to raise the cognizance level about the mounting e-waste threat and also inspire serious debate around the issues.

1.2 Objective of the study

This research paper will examine the current e-waste management practices in the Kumasi Metropolitan area of Ghana. It will also highlights some of the associated environmental and health hazards, as well as unearthing the challenges hampering the effective management of E-waste in the metropolis.

1.3 Research Questions

1. What are the main regulatory frameworks and institutions involved in the management of e-waste in the Kumasi metropolis and how do they presently deal with e-waste management issues?
2. What are the current e-waste management practices in the Kumasi metropolis?
3. What are the challenges facing the management of e-waste in the city?
4. What are the associated health and environmental hazards linked to e-waste?

2. LITERATURE REVIEW

2.1 What is E-waste?

In general, e-waste describes old, end-of-life electronic and electrical equipments (EEE) or waste generated from any equipment running on electricity or a battery including computers, laptops, TVs, DVD players, mobile phones, MP3 players, etc., which have been disposed by their original users. It has been categorized into three main groups, and these are; large household appliances like refrigerator and washing machine; information technology (IT) and telecom like a personal computer (PC), monitor and laptop; and consumer equipment like television sets. Each of these e-waste items has further been classified with respect to 26 common components which form their 'building blocks' and are therefore readily 'identifiable' and 'removable.' These include metals, compressors, plastics, glasses, wiring/electrical, transformer, circuit board, fluorescent lamp, brominated flamed retardant (BFR), etc.
E-waste also contains more than 1000 different substances, which make it either 'hazardous' or 'non-hazardous'. The presence of elements like lead, mercury, arsenic, cadmium and flame retardants beyond threshold quantities in e-waste classifies them as hazardous waste.
Generally, EEEs are largely classified under three major heads, as: 'white goods,' like household appliances (air conditioners, dishwashers, refrigerators and washing machines); 'brown goods,' like TVs, camcorders, cameras, and 'grey goods,' including computers, printers, fax machines, scanners, etc. The grey goods are comparatively more complex to recycle due to their toxic (hazardous) composition.

A look into previous studies on the subject indicates that the literature is replete with conflicting statements on whether e–waste is 'stunning whitewashed of reality' or otherwise. Greenpeace for example argues that e-waste is being exported often illegally to Ghana from Europe and the U.S (Brigden et al, 2008). In the e-waste yards, unprotected workers many of them children dismantle computers and T.Vs with little more than stones in search of metals that can be sold.

The remaining plastics, cables and casing are either burnt or simply dumped. Brook as long ago as 1988, had also revealed that as safety laws in Europe and the USA push toxic waste disposal cost up to $2,500 a ton, waste brokers are turning their attention to the closest, poorest, most unprotected shores – West Africa (Brook 1988).

Nonetheless the many negative commentary and contestation about e-waste, recent studies have demonstrated succinctly that e-waste contains valuable metals like copper, gold, and silver that are lost if not recovered properly, and which have to be compensated for by intensified mining activities, which ultimately lead to severe sustainability impacts. A conundrum is created as to whether e-waste recycling is an "economic boom or an environmental doom". The nexus becomes more complex particularly at Agbogbloshie, the hub of e-waste activities in Ghana, where there is nothing like "waste"; where every object, component, and material has "value". (Ababio, 2010) .On the daily basis, computers and televisions are regularly bought and sold, assembled, disassembled, and reassembled. They disintegrate into their constituent materials- plastics, glass, and metals. Plastic printer cases are smashed with rudimentary tools including hammer, spanner, chisel and even the bare hands.

2.2 E-waste in the global context

Electronic waste is the fastest growing component of municipal waste across the world, it is estimated that more than 50 MT of e-waste is generated globally every year. In other words, these would fill enough containers on a train to go round the world once,Yet, it is expected to account for only 2% of the total solid waste generated in developed countries by 2010. However, with increasing consumerism and an anticipated rise in the sales of electronic products in the countries experiencing rapid economic and industrial growth, the higher percentage of e-waste in municipal solid waste is going to be an issue of serious concern. A report of the United Nations predicted that by 2020, e-waste from old computers would jump by 400% on 2007 levels in China and by 500% in India (UNEP, 2005). Also, it is estimated that e-waste from old and discarded mobile phones would be about seven times higher than 2007 levels and, in India, 18 times higher by 2020. (Ababio, 2010) Forecasts like the aforementioned highlight the urgent

need to address the problem of e-waste in developing countries like India where the collection and management of e-waste and the recycling process is yet to be properly regulated.

According to the UN Under-Secretary General and Executive Director of the United Nations Environment Programme (UNEP), Achim Steiner, China, India, Brazil, Mexico and others would face rising environmental damage and health problems if e-waste recycling is left to the whims and caprices of the informal sector. China already produces about 2.3 million tonnes of e-waste domestically, second only to the U.S. with about 3million tonnes (UNEP, 2005), with the European Union and the U.S. being the foremost producers of e-waste in this decade, according to estimates. As per the Inventory Assessment Manual of the UNEP, 2007, it is estimated that the total e-waste generated in the EU is about 14-15 kg per capita or 5MT to 7MT per annum. In countries like India and China, annual generation per capita is less than 1kg. (Keirsten and Michael, 1999) In Europe, e-waste contributes up to 6 million tonnes of solid waste per annum but is projected to increase at a rate of 3% to 5% per year. In the past, e-waste had increased by 16 per cent to 28 per cent every five years which is three times faster than average annual municipal solid waste generation. In the U.S., e-waste accounts for 1 to 3 per cent of the total municipal waste generation. As per the United States Environmental Protection Agency (USEPA), it generated 2.6 MT of e-waste in 2005, which accounted for 1.4 per cent of total wastes.

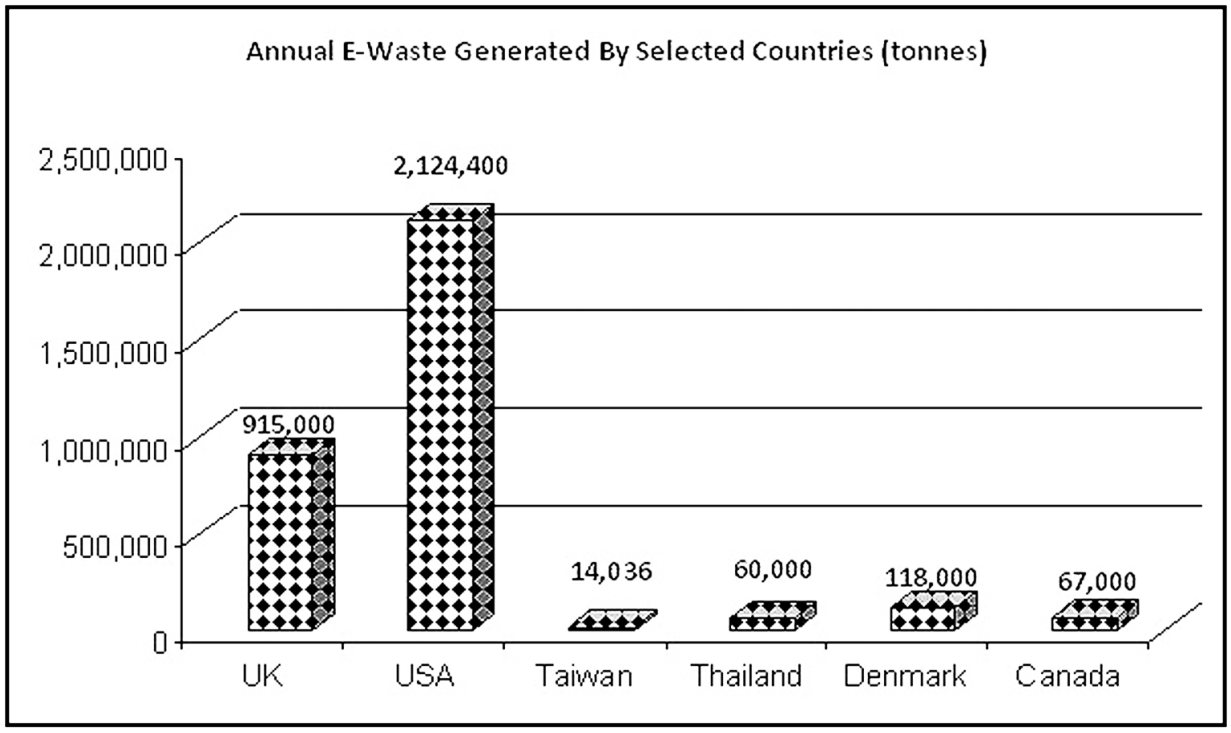

Figure 1 Annual e-waste generated by selected countries (tons)

Source: cited in Kumar et al. (2005).

E-waste generation has seen a rapid increase in the last decade, leading to a resultant growth in the recycling market. This can be attributed to the high rate of obsolescence in the electronics market. Most electronic goods, especially in the West, have very short lifespan. Such goods are routinely replaced at least every two years, and then either simply discarded or exported to developing countries where there is still a demand for second-hand merchandise.(Ching-hwa et al, 2000) In a programme called "Following the Trail of Toxic E-waste", 60 Minutes of CBS News.com traced the route of toxic electronic waste illegally shipped from America to China via Hong Kong. In this programme, Allen Hershkowitz, a senior scientist and authority on waste management at the U.S. Natural Resources Defence Council, was quoted saying that the problem with e-waste was that it was the fastest-growing component of the municipal waste stream worldwide. When asked what he meant by "fastest-growing," he said that about 1,30,000 computers were thrown out every day in the United States and over 100 million cell phones were thrown out annually. (Puckett and Roman, 2002)

Although recycling facilities abound in most advanced countries and rigorous laws have also been passed by their national governments regarding e-waste disposal, there seem to be difficulties in implementing regulations and dealing with e-waste owing to increased activism by environmentalists and the high cost of recycling. It therefore does seem easier and cheaper for these countries to ship e-wastes to the developing countries where access to and recycling of such discarded electronic goods make a good economic option despite growing concerns on the issues of fraudulent traders and environmentally unsound practices,. For both sides, it is profitable or a win-win situation. The only variance is that the rich country is dumping toxic waste on the poorer country.

2.3 The E-waste flow chart

Dealing with waste is a major issue in our endeavour to create a sustainable society (Klang, 2005). Electronics waste is increasingly becoming a colossal crisis for civil society, and like all waste management practises, the aim of e-waste management is to significantly reduce, reuse or recycle most of the materials or components found in electrical and electronic devices, with little left for landfilling. In recent years however, huge accumulations of e-waste and its primitive recycling methods; for extraction of precious metals has become a real concern in most developing countries because of the hazardous materials e-waste contains. The Recycling of e-waste through proper technologies, although profitable in developed countries due to the presence of precious metals (including gold, silver etc.) in printed circuit boards (PCB) is also an expensive venture to undertake because of its initial investments into recycling technologies. Also, the high recycling cost involved in e-waste recycling makes it an unattractive venture for most entrepreneurs in third world countries. Thus, huge volumes of e-waste are exported to the developing countries like India, China, Brazil etc., where manpower is in-expensive and enforcement of environmental laws are not so stringent (Kumar et al, 2005). Here, crude methods are applied by artisans, with no adequate knowledge in hazardous waste management, to dismantle WEE parts, in the hope of finding usable parts, mainly electronic, and scrap metal such as copper (Samuel Munene 2010).

The main motivation for non-formal operators is to extract precious metals (gold, silver) from printed circuit board (PCB) using unscientific and unhygienic methods, which are harmful to the workers and the environment. (Kumar et al, 2005)
On the flip side of the coin is the formal sector where professionals use varied methods to disassemble electrical and electronic products in an environmentally sustainable manner.

2.3.1 Flow chart; informal sector

This research will be based primarily on the informal sector, which is most prevalent in developing countries. As such, the study will seek to explore the various linkages among the different actors involved in this sector, as well as exposing its weaknesses and strengths. In the informal sector, the collection and re-cycling of e-wastes is by the local artisans (Antrekowitsch et al, 2010). The practice however exhibits a highly stratified system, comprising collection, recycling, refurbishment and reuse activities and eventually the disposal of the residuals. In the main, the electrical and electronic devices are managed informally in small workshops using basic methods such as manual disassembly and open burning (Oteng, 2012). The appliances are stripped of their most valuable and easily extracted components which are processed into directly reusable components or secondary raw materials in a variety of refining and conditioning processes. There are also indications that some selected components like printed wiring board are selected for export probably to Asia for recycling (Grant et al, 2012). The remaining parts are then landfilled or stored directly.

Also found alongside in this sector is a large number of refurbishing and repair operations for electric and electronic products that are largely imported, drawing close business linkages with importers and retailers of second hand electrical and electronic products.
The mass flow chart, as illustrated in the figure below shows the flow of electrical and electronic products between different actors involved in refurbishing and e-waste recycling chain in a typical informal sector.

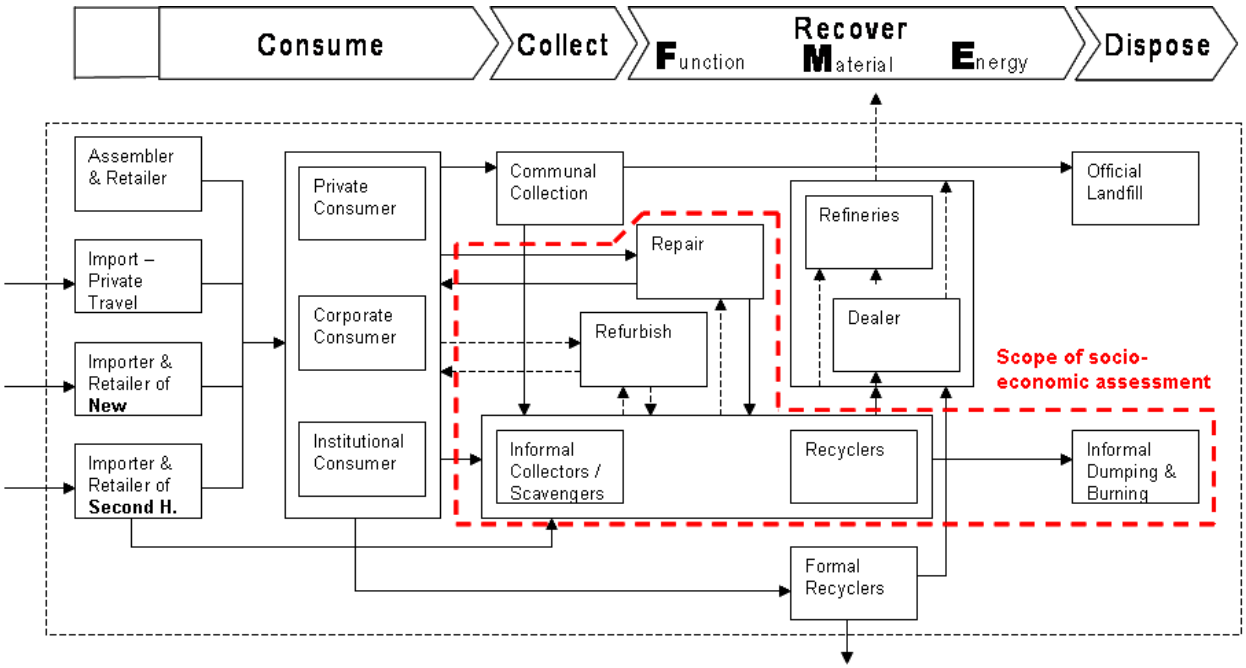

Figure 2. Mass flow chart of the refurbishing and e-waste recycling in an informal sector. It also shows a socio-economic loop within the informal sector among its structured stages: collection, refurbishing / repair, recycling (involving dismantling, also burning) and final disposal.

Source: Siddharth Prakash (2010) Socio-economic assessment and feasibility study on sustainable e-waste management in Ghana.

2.3.2 Flow chart; formal sector

Units in formal sector use all types of methods to disassemble and segregate the e-waste materials. These methods are varied from manual or semi-automated or automated techniques. These methods are environmental friendly and take care of the safety of the health of the operators. Disassembly involves the removal of hazardous components such as batteries and other high and low grade including component, part, group of parts or a sub-assembly from a product (partial disassembly) or the separation of a product into all of its component parts (complete disassembly). The recovery of valuable materials such as printed circuit boards, cables and engineering plastics is simplified by such approach.

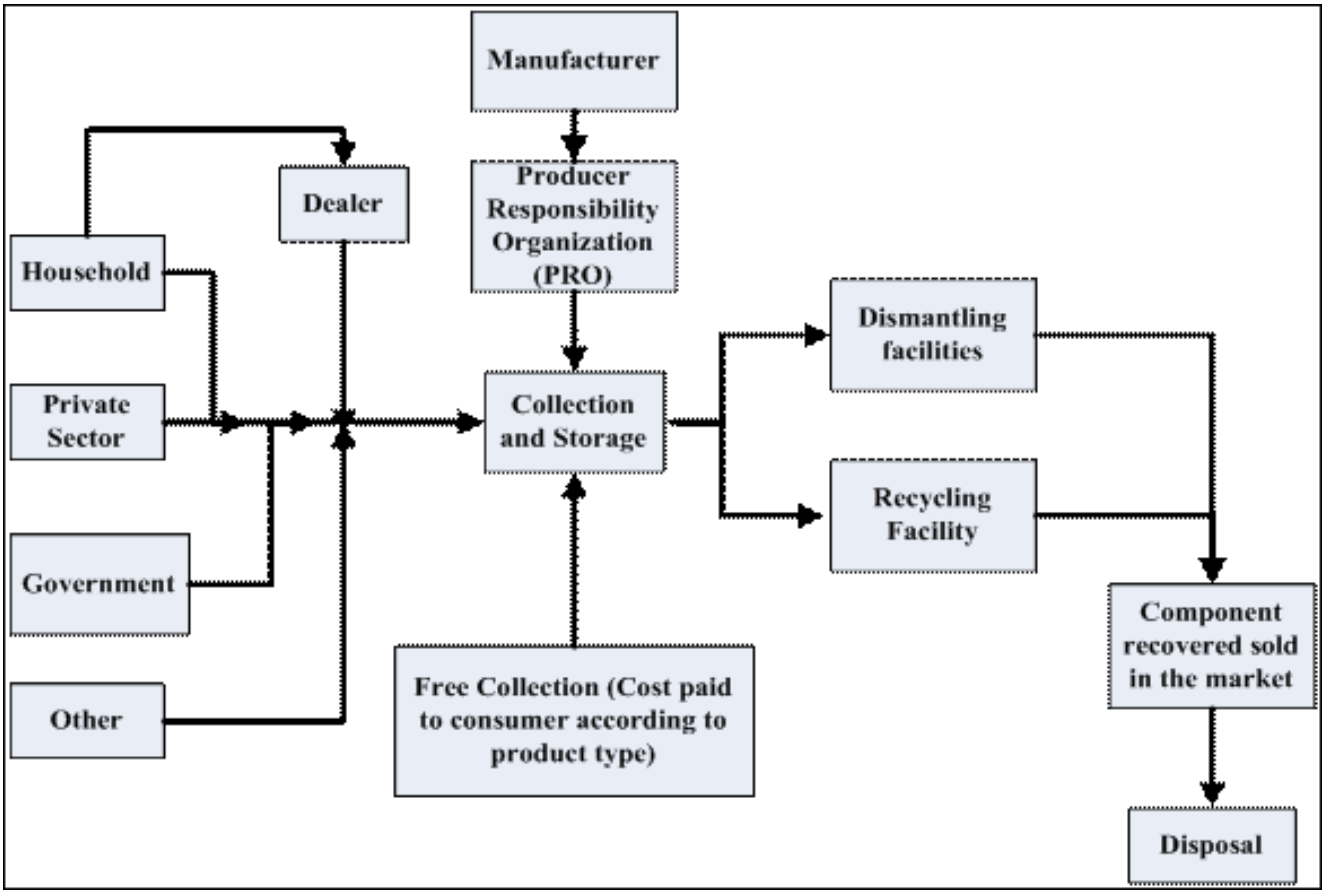

Figure 3. Typical e-waste flow chart in a formal sector

Source: Samuel Munene, (E-waste management in Kenya, 2011)

3. MATERIALS AND METHODS

3.1 Study Setting

The study was conducted in the Kumasi Metropolitan Area of Ghana. The metropolis is the most populous district in the Ashanti Region. During the 2000 Population Census it recorded a figure of 1,170,270. It has been projected to have a population of 1,625,180 in 2006 based on a growth rate of 5.4% p.a and this accounts for just under a third (32.4%) of the region's population. Kumasi has attracted such a large population partly because it is the regional capital, and also the most commercialised centre in the region. Other reasons include the centrality of Kumasi as a nodal city with major arterial routes linking it to other parts of the country and also the fact that it is an educational centre with two State Universities, a Private University, a Polytechnic, two Teacher Training Colleges, Secondary Schools and a host of Basic Schools (KMA, 2006). This however is a mixed blessing for the socio-economic stability of the city. This is because urbanization offers economies of scale and extensive benefits from economies of agglomeration. Despite numerous benefits of modernization, the metropolitan area remains largely hostage to poor and dysfunctional infrastructure. One manifestation of the city's poor infrastructure is its inability to manage and organize adequate collection and safe disposal of the solid waste generated within the city, including E-waste, which has been left in the hands of scavengers. As a result, the city has not got a collection point for E-waste disposal and treatment, with numerous satellite dumping sites dotted across the city. For the purpose of this research, two sites which were identified as being the main dumping grounds for E-waste within the city, namely; Suame light Industrial area and Afful Nkwanta dumping sites, were selected based on information gathered from key informants.

3.2 Research design

A research design represents a structure that guides the execution of a research method and the analysis of the subsequent data (Bryman, 2001:27). It can also mean the framework for collecting and analysing data. It is imperative to observe that the choice of research design depends on decisions and priority being given to the range of dimensions of the research process. These may include issues such as "understanding behaviour and meaning of that behavior in it specific context" (Bryman, 2001:27). Consequently, the case study design was selected for the purpose of this, even though there exists several research designs in social science research, which are appropriate for environment and development studies. The choice of the case study design was based on the fact that it offered the opportunity to test whether the theoretical models of managing E-waste actually worked in the real world situation, providing that perfect simulation of scientific theory and realism.

Inside the case study framework lies different types of cases which can be distinguished. These include exploratory, descriptive and explanatory case studies. The exploratory case studies are conducted to address a problem, finding what is happening or finding insights and generating new research. The descriptive case studies are often conducted to illustrate events in their specific context whereas the explanatory case studies link an event with its effects and may not show causal relationship (Yin, 2003). For this study, I combined all three types in order to find insights on the management of E-waste in the metropolis, illustrate or depict the process involved in the handling of E-waste and finally link its management style to any environmental hazard that may prevail to show a cause and effect relationship. Imperatively, a case design may employ other broader range of data collection instruments such as observation and interviews with different people involved and allows a holistic study of a phenomenon (Yin, 2003). Finally, to enhance validity and reliability to the study, the data collection process involved triangulation; which is mixing different data collection techniques such as surveys, review of old literature and interviews to enhance the validity and reliability of a study.

3.3 Validity and reliability

Validity and reliability techniques were used to guarantee the quality or value of the study results. Bryman, 2001 defined validity as issues which specify whether a set of gages devised to measure a concept really measures the exact thing it is supposed to measure, whereas reliability concerns the issue of consistency of measurement. Specifically, both internal and external validity types were used. In the case of internal validity, which places emphasise on the dependability of conclusions drawn from variables with causal relationships (independent and dependent impacts), respondents were prodded more to be sure of factors responsible for any environmental hazards as a direct consequence of the way e-waste was managed in the metropolis. Yin, 2003 indicated the importance of internal validity in explanatory case studies because of its apparent production in details of values with causal relationships.

On the other hand, external validity, which concerns primarily with the question of whether the result of a study can be generalized beyond the specific context" (Bryman, 2001:29) was ensured by selecting samples that were representative enough to depict the E-waste menace on the general or broader level. Also, considerable efforts were made to ensure that the sites chosen for this study had enough E-waste deposits and traffic to safeguard that the information gathered was useful and adequate to represent the entire metropolis.

On the issue of reliability or consistency, which according to Bryman, 2001 is directly related to validity, meaning, a measure cannot be said to be valid if it is not reliably consistent. For a study to be considered reliable, it needs to show some degree of consistency should it be replicated. Despite the challenges of achieving such consistency in a qualitative research, it was nonetheless ensured that all concepts were carefully defined to guide the next study. Furthermore, greater efforts were made to decrease possible data collection errors in order to sustain a validity level.

3.4 Data collection procedure

Since the metropolis has no centralized e-waste dumping site but rather, scattered satellite sites located in local suburbs, a plan was devised to select sites that were big enough to represent the entire metropolis in terms of e-waste disposal. As such, two (2) sites were selected for this study based on information gathered from the interview with the stakeholders during the key informant interview sessions, namely; Suame light industrial area and Afful Nkwanta e-waste disposal site, near the city's workers college.

Standardized data collection tools developed solely for this study were employed in this study. To begin with, information about existing policy and legislation on e-waste management was collected as part of an extensive literature review, which also included available and employed methods of e-waste management in other advanced and developing countries. Also, data was collected from previous studies, reports and existing records. This method provided the following additional information;

- The profile of the metropolis was obtained from the Metropolitan assembly, which included infrastructure and population distribution, social services and local economy.
- Documents on laws establishing the EPA of Ghana, district bye laws on sanitation and waste disposal in the metropolis and the draft bill on the control and management of E-waste.
- Important data on the on-going initiatives on e-waste management in the metropolis and Ghana as a whole and statistics on imports of electrical and electronic equipment into the country.

In addition, a purposive sampling technique was employed to select an official each from the major stakeholders involved in the management of e-waste in the metropolis for an in-depth key informant interview sessions. Such stake holders include; the ministries of Health, Local government and Rural development, Environment, Science and Technology, Trade, Environmental Protection Agency, Customs, Scrap dealers association, the Kumasi Metropolitan

Assembly (waste management division) and importers of second hand goods. The interviews covered central themes like Policy and legislation, trade in e-waste, perspectives on the emerging e-waste menace; current management practices, challenges, health, environmental other policy options to contain the situation.

Further, a focus group interview involving a representative each from importers, retailers and repairers of second hand electronic and electrical gadgets was organized to discuss how they manage their e-waste, using the random sampling technique. In addition, four (4) sales representatives selected from four leading wholesalers of new e-products in the metropolis was also included in this survey to understand the end-of-life management and price differentials of e-products on the market. Overall, 10 representatives from the aforementioned groups were interviewed as part of this research.

Also, there were multiple visits to the two main e-waste disposal sites in the metropolis that were selected for the purpose of this research. This enabled the researcher observe from afar how the actors in the informal recycling business manage their e-waste. Also, a number of these actors in the informal recycling of e-waste were engaged for detailed discussions in a focus group interview session bothering on their current management practices, challenges, health and associated environmental hazards.

Lastly, a visit was made to the premises of Presank Ghana limited; the only company licensed by the EPA to manage Electrical, Electronic and hazardous waste in the formal sector.

3.5 Limitations and challenges of the study

The research team encountered a number of challenges in the process of carrying out this study. Firstly, there was no direct responsible body or institution for e-waste management in the metropolis. The EPA in the metropolis, which is the regulatory body in charge of hazardous waste management had was understaffed, meaning employees had little time to effectively monitor e-waste disposal and activities of artisans in the informal recycling of e-waste. As such, data was not readily available on the state of e-waste management within the metropolis.

Secondly, it was much difficult finding an e-waste disposal site for the study since the management of e-waste was largely left in the hands of artisans who were mostly located in satellite communities that were very difficult to reach. In most cases, the research team had to trek on foot in dangerous neighbourhoods to reach these artisans who formed a chunk of the e-waste recycling process.

Further, the metropolitan assembly's waste management department lacked the capacity and personnel to manage e-waste effectively in the metropolis as the existing bye laws which were enacted several years back have not been updated to meet the growing e-waste menace within the city. As such, e-waste was still being treated as a municipal waste, making data collection very difficult.

3.6 Ethical considerations

Ethical issues were addressed at each phase in the study even though a non-exhaustive array of ethical issues arose in the course of this study. The study was conducted in a normal social setting and the consent of participants were requested before interviews were conducted, although the topic does not fall in the sensitive category, and the subject population being over nineteen years.

Also, the anonymity of participants was protected by assigning fictitious names as well as keeping their responses confidential. Furthermore, all study data, including interview tapes and transcripts, was well protected and destroyed after a reasonable period of time. Participants were told summary data will be disseminated to the professional community, but in no way will it be possible to trace responses to individuals.

4.0 Results and Discussions

4.1 E-waste: the Ghanaian trend

In the immediate past decade, beginning the year 2000, the ICT sector in Ghana has seen a tremendous growth as a result of the shift from the hitherto manual/paper or analog system to the digital system by most governmental agencies, institutions and departments. The government of Ghana in 2003 introduced a module called ICT for Accelerated Development (ICT4AD) with the vision to use ICT as the main engine for an accelerated and sustainable economic and social growth, thus changing the country into an information-rich-knowledge-based and technology driven high income economy and society (ICT4AD, 2003). Chief among this policy's strategies was the aggressive promotion of information communication and Technology in various educational institutions countrywide across the three tiers education in Ghana, namely; primary, secondary and tertiary levels.

Between 2010 and 2011, the Ministry of education, in conjunction with rlg Communications Limited, a local private computer assembling company successfully distributed 60,000 laptops to school pupils throughout the country (Ababio, 2010)). The inculcation of this new technological system into the national development has led to the common use computers in homes and schools, thereby increasing people's capacity for learning, irrespective of their physical location or fiscal restrictions.

However, the quench for technological advancement has come at a cost, as the amount of e-waste being generated over the past decade has also seen a tremendous increase. Compounding this problem is the lack of ready data on the number of electronic gadgets that become archaic, partly due to the fact that most of them are imported into the country already old, and also due to the porous nature of Ghana's borders, thus making shipments through unmonitored routes possible.

Table 1. The importation of e-equipments into Ghana in 2009 in metric tonnes (MT)

	Amount in MT	Repairable	E-waste
New e- products	64,500 (30%)	-	-
Second hand or used e-products	150,500 (70%)	30,100 (20%)	22,575 (15%)

Source; 3rd annual global e-waste management network report, 2013

The figures above, as presented by the then head of the hazardous waste management division of Ghana's Environmental protection agency during the 3rd annual Global E-waste Management Network (GEM) meeting in California indicates that the importation of new electronic products into the country represented just thirty percent (30%) of total EE imports, whereas second hand or used electronic and electrical products accounted for seventy percent (70%), out of which fifteen (15%) found its way directly into the waste stream as they were deemed unusable. This shows a worrying picture that the country is being used indirectly as a waste dump for outdated EE products from mostly rich western nations. Hitherto, this wasn't the case as the importation of second hand EE products was an unattractive venture to undertake because of the high import levy importers were made to pay. However, all that changed in the year 2004 due to the government's drive to make ICT a core part of the country's development process by tax exempting the trade in the importation of computers and its accessories. (Martin Ababio, E-waste challenge in Ghana, 2010)

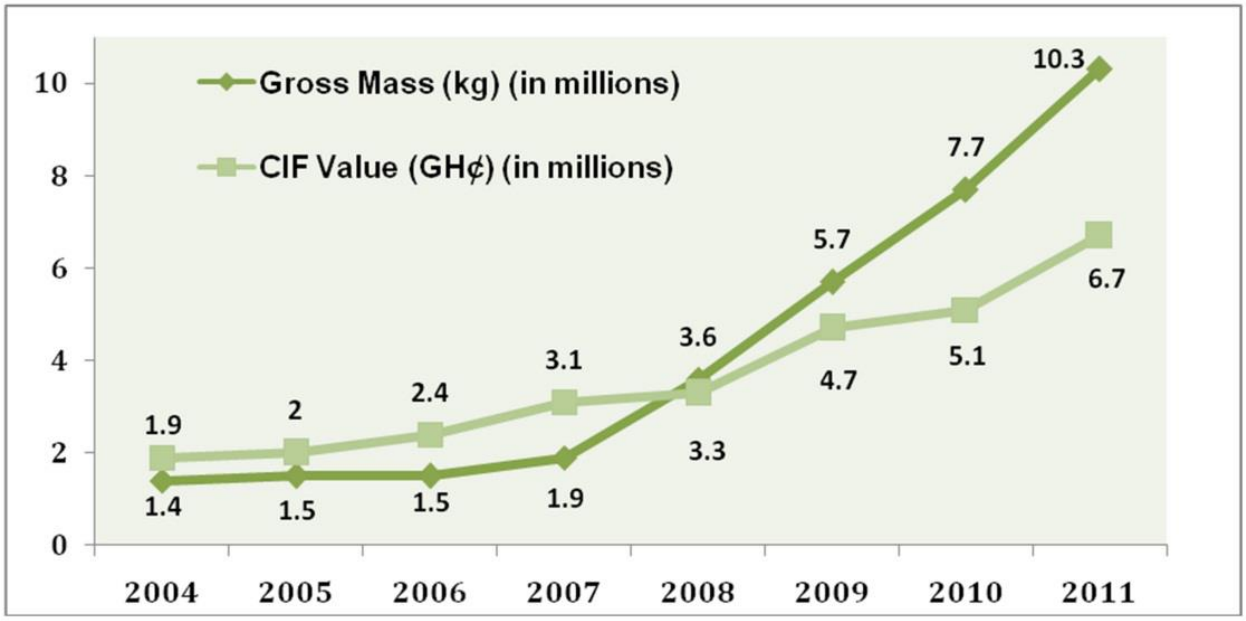

Figure 4. The trend of used computers imports into Ghana 2004-2011. Notice the exponential increase in both the cost, insurance and freight (CIF) value and gross mass of imported used computers within the period.

Source; Oteng Ababio, E-waste management in Ghana, issues and challenges, 2012

Also contributing to this increased trend in the importation of second hand EE products is low poverty rate in Ghana, which at the end of 2005 stood at 28% from a previous benchmark 51% in 1991. In reality however, an estimated 44.8% of the country's population live well below the poverty line of less than one US dollar per day (World Bank, 2007). This means that most people cannot afford brand new EE products and have to rely on imported second hand products which are far cheaper or affordable than brand new ones. For example, a study conducted during the research showed that a brand new television 40'' television costing Ghc 3200 could be purchased at more than half its price at Ghc 1300 when refurbished or bought slightly used.

Also, the emergence of mobile telephones in the last decade and half has greatly influenced the trend in e-waste generation in Ghana, as the penchant for mobile handsets have greatly reduced the demand or usage of fixed telephone lines. The situation has rendered large quantities of fixed telephone sets archaic and out of use, eventually leading to their being disposed off. Data provided by the National Communications Authority (NCA) of Ghana shows that between the

years 2000-2008, a total of 62,400 fixed telephone lines were discontinued, meaning these telephone sets also joined the e-waste stream as they had become obsolete.

Table 2. The trend of mobile and fixed telephone lines in Ghana, 2000- 2008 (in thousands)

Year	Mobile lines	Growth (%)	Fixed lines	Growth (%)
2000	90	–	206.30	–
2001	212	135.6	248.40	20.4
2002	383	80.7	270.10	8.7
2003	775	102.3	292.40	8.3
2004	1,051	35.6	370.40	5.1
2005	2,990	184.5	345.70	12.5
2006	4,969	66.2	371.90	7.6
2007	7,604	53.0	385.10	3.8
2008	11,568.85	44.40	143.90	74.4

Source: National Communication Authority of Ghana (NCA) Records 2009

In sum, even though the advent and inculcation of information technology and other EE products into the country's developmental process is a laudable one, it is also imperative that the various stake holders take adequate steps to provide the needed infrastructure to deal with its end of life management. The objective to mollify probable and real human consumption should not lead to laxity of ecological and health concerns.

4.2 The institutional and regulatory framework for e-waste management

In Ghana, sanitation and waste management is the general responsibility of the Local Government Ministry which oversees the decentralised District, municipal and metropolitan Assemblies even though the supervisory responsibility rests on the Environmental Protection Agency (EPA). These decentralized Assemblies have their own bye laws that helps them in their management of waste within their catchment areas. However, on the issue of e-waste, enquiries the researcher made at the EPA for possible regulations or legal framework guiding the management of e-waste in specific was met with disappointment as there is currently no clear e-waste management guiding framework in Ghana. In short, the country has no specific law on e-waste recycling despite the wide range of environmental legislation in Ghana (Kwakye M, 2009). Established in 1974 as an Environmental Protection council to primarily advice the government of Ghana on environmental issues, it was transformed into the Environmental Protection Agency (EPA) with regulatory powers in 1994 by the EPA Act 490. (source; EPA Ghana)

According to one Ghanaian researcher, Martin Ababio in his 2010 article (E-waste Management in Ghana), the Government of Ghana in recent times launched a collaboration with its development partners to initiate processes through workshops and seminars, aimed at enhancing awareness creation about environmentally sound e-waste management. Thus, a National Working Group was constituted by the EPA in 2005 to help formulate a strategy for e-waste recycling, which unfortunately yielded no results.

On the international scene however, Ghana is a signatory to the Basel convention which seeks to provide an outline for the international regulation for e-waste. Research shows that in the 1970s and 1980s some developed countries used to export hazardous wastes to developing countries for final disposal which before long culminated in serious environmental pollution [Shinkuma T,2008). In order to ratify this challenge, the Basel Convention came into effect in 1992. The Basel Convention requires that prior notice of any proposed export of certain hazardous items should be given to the government of an importing country and sanctioned by it. But the Basel

Convention does not regulate second hand items and some e-waste scrap, including printed-circuit boards (Martin Ababio, 2010).

Frankly, the Convention does not solve the new environmental problem caused by the recycling of e-waste. It has been argued that in order for the Convention to tackle this growing menace, it should be amended in such a way that hazardous wastes must not be exported from developed countries to developing countries for any purpose even for recycling, as presented in 1995 as the Basel Total Ban, but it has yet to be agreed upon.

The convention also prohibits trade between Annex VII countries (OECD, EU and Liechtenstein) and non-Annex VII countries. The convention contains language that exempts prohibited trade in cases where an Annex VII country has signed a bilateral trade agreement with a non-Annex VII country so long as that agreement contains equivalent provisions for "environmentally sound" treatment of waste (the convention however fails to define "environmentally sound"). Despite the ratification, the convention becomes operational and applicable only when it has been properly "domesticated" which the government of Ghana has failed to do till date. (Martin Ababio, 2010)

Currently laws and policies guiding the management of hazardous, solid and radioactive waste includes:

1. Local Government Act (1994),
2. Act 462; Environmental Protection Agency Act (1994),
3. Act 490; Pesticides Control and Management Act (1996),
4. Act 528; Environmental Assessment Regulations 1999,
5. (LI 1652); Environmental Sanitation Policy of Ghana (1999),
6. Guidelines for the Development and Management of landfills in Ghana,
7. Guidelines for Bio-medical Waste (2000). Most of these were however passed before the e-waste problem emerged. (martin A, 2009)

Recently in 2012, a draft bill on the control and management of e-waste was presented to Ghana's parliament for consideration by the EPA. Among other things, the bill seeks the following;

- To control and manage hazardous waste in general, with part two addressing the growing e-waste menace.
- Prohibition of CRTs and CRT glasses
- Making it mandatory for all importers of electronic equipment to register with the EPA and the payment of an electronic waste levy on such imported electronic items
- The levy is to cater for the costs of the collection, treatment, recovery and environmentally sound disposal and recycling of electronic waste
- The bill also provides for the establishment of an Electronic waste Recycling Fund to provide finance for the management of electronic waste and reduce the adverse impact of electronic waste on human health and the environment.
- A manufacturer, distributor or wholesaler of electronic equipment is also required under this bill to take back used or discarded electronic equipment manufactured or sold by it for recycling purposes.
- Lastly, all local, municipal and metropolitan assemblies shall under this bill be mandated to designate points at which electronic waste shall be deposited by importers, manufacturers, wholesalers, distributors, retailers, refurbishers or repairers in accordance with recycling classifications determined by the EPA, and also ensure that such importers, manufacturers, wholesalers, distributors, retailers, refurbishers, or repairers of electronic equipment comply with procedures for the disposal of electronic waste by delivering collected waste to the designated assembly points. (source; epa.gov.gh)

Additionally, there is a multi-stakeholder technical committee on e-waste management (TCEWM) that coordinates some initiatives aimed at effectively improving e-waste control and management in Ghana. The TCEWM is chaired by EPA-Ghana and comprises representatives of the Ministry of Environment, Local Government, Trade and Industry, Ghana Standards Authority, Customs, Atomic Energy commission, Ghana health service, Scrap dealers association and Ports and harbours Authority. (epa.gov.gh)

It is worth noting however that even though the country practices a decentralized system of local governance, most government agencies still take strategic instructions from their heads of institutions. It was observed that major decisions and policy instruments that needed to be taken on e-waste management within the city by the local stakeholders were still being issued from their various headquarters, all based in the country's capital.

4.3 E-waste management in the Kumasi metropolis

Data on the current e-waste being generated in the metropolis was hard to come by as both the local Environmental protection agency (EPA) and the Metropolitan Assembly's waste management division seemed to have none. Also, no reliable data was readily available on the amount of obsolete devices in metric tonnes (MT) that is discarded off annually within the city.

The research however revealed that most people normally store their out dated or archaic electrical and electronic devices for a limited period of time in order to acquire a perceived value such items tend to bring later, before being ultimately cast-off in addition to other waste into the municipal waste stream. Most of these EE devices end up in open landfill with other municipal wastes, even though most of these devices are known to contain highly toxic chemicals which have the potential to pollute the soil and groundwater through leaching. (Roman & Puckett, 2002).

The general management of e-waste in the metropolis as observed by the team is the fact that rudimentary methods such as manual disassembly and open burning prevail in a thriving informal e-waste management system. A visit to both sites used for this study; Suame light industrial area and Afful Nkwanta showed that the appliances or EE equipments were being stripped off their valuable and easily extractable parts such as plastics, metals and condensers, and then processed into direct re-usable components and secondary raw materials to feed a growing refurbishing industry.

It also came to light from our interviews with repairers and importers in the refurbishing sector, which are dotted across the metropolis that EE products are stripped off their re-usuable parts; for repairing other second hand products, before finally being cast off. As a result, most faulty EE equipments could be seen stored in workshops for many years with its parts servicing new ones. All these culminate into a system of managing e-waste known as the informal e-waste recycling, which unsurprisingly is the dominant system of managing all electrical and electronic waste within the metropolis.

4.4 Informal E-waste management system

The informal e-waste management sector forms the main engine of electrical and electronic waste management in most developing countries and the situation was no different from the Kumasi metropolis, as both the collection and re-cycling of electronic and electrical wastes are largely done by individuals in this sector.
According to a 2009 report published by the Environmental protection agency (EPA) and presented at the 3rd annual Global E-waste Management network meeting by the then head of the hazardous chemicals, control and management division of the agency, this sector forms 95% of the e-waste management in the country as a whole, including the Kumasi metropolis.

Although a general look may perceive a disorganized system with no laid down processes, a closer look at the activities of the main actors in this sector shows the direct opposite as it consists of various levels including Collection, Refurbishing, Recycling and the subsequent discarding of remains. A visit to our study sites showed an all-inclusive system which involved the treating of electronic and electrical equipments informally in small yards scattered across the site, using simple methods such as physical or manual stripping of valuable parts or components and the open burning of the remains. In some cases however, other components like copper are also retrieved from the burnt out residues. These valuable components that are extracted are then treated into secondary raw materials or directly reusable components used in servicing other gadgets in a refurbishing industry.

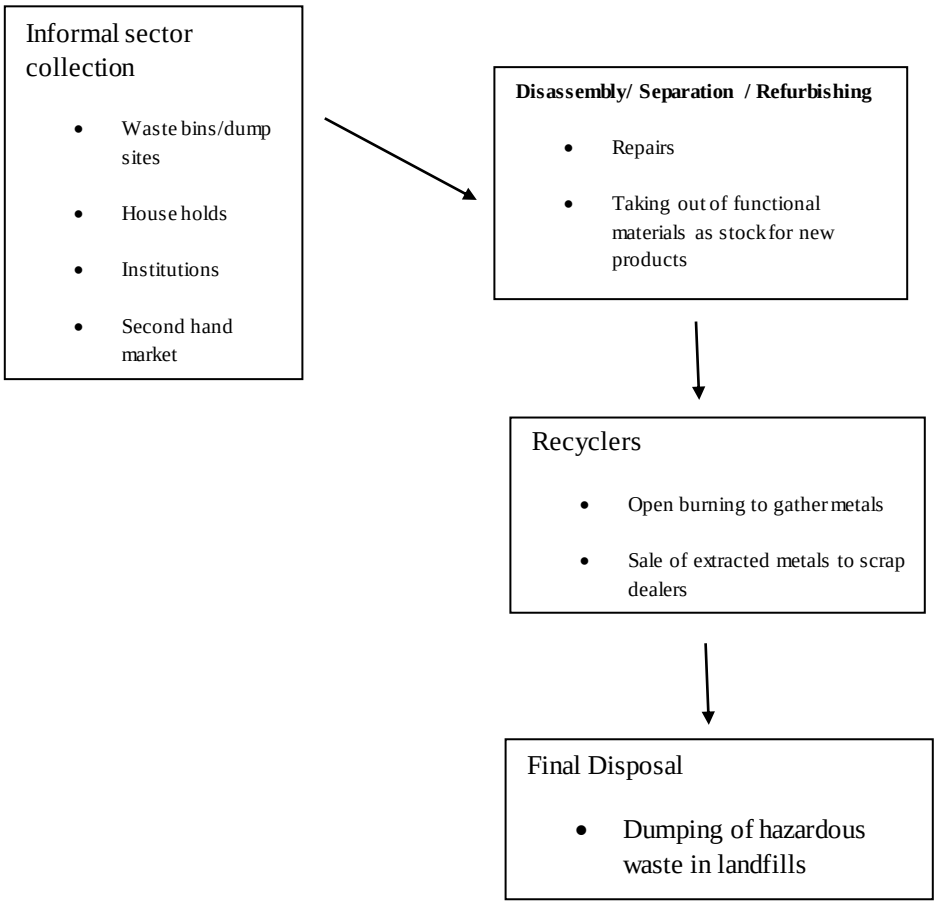

Figure 5. The informal processing of e-waste in the Kumasi Metropolis

Source: field work 2014

4.4.1 Collection/ Assembly

The assemblage of electrical and electronic equipments by young men, usually scavengers form the entry point into the informal e-waste recycling process. These actors, mostly youthful, move across the city on a daily basis on a predetermined route, mostly from door-to-door collecting second hand or outmoded electrical and electronic equipments from dumpsites, household, corporate and private bodies, as well as transfer stations. These men form a chunk of the workforce in the informal e-waste recycling trade. These scavengers hitherto were paying nothing for the outmoded EE equipments they were picking from the aforementioned places, but in recent times, the scarcity of electronic and electrical waste coupled with the emergence of competition prompted by rising levels of youth unemployment have compelled these waste collectors to pay money for such equipments. During the field research, it emerged that an e-waste collector usually pays between Ghana cedis 3.20 – 4.0 ($1-1.50) for a piece of outmoded or old television set and cables who then also sell it to intermediaries for onward sale to scrap dealers, repairers and recyclers. A small number of collectors also engage directly in disassembling and retrieval of metals and other useful components from the waste collected through open burning of cables and wires to retrieve copper. This is usually done at their dump sites, where makeshift workshops serve as store houses for their waste collected, as observed at our two study locations for this research. It is thus not far-fetched to say that e-waste collectors are indigenous, small scale entrepreneurs because they create their own jobs and earn a living rather than relying on mainstream employment avenues, although their activities is somehow dependent on both the native and global economic situation**.**

Another key observation made at the study sites, i.e Suame light industrial area and Afful Nkwanta dump site and also gathered from the onsite interviews of some waste collectors is the apparent sustainability challenge facing e-waste collectors, as the availability of electrical and electronic waste becomes difficult to come by in the metropolis. Growing competition among waste collectors has rendered the metropolis fully hewed of e-waste, thereby forcing most scavengers who hitherto operated within the city from the Suame light industrial area and the Afful nkwanta dump site to pitch camp at targeted locations, mostly outside the city's boundaries for the days building stock before returning to their workshops with their goods for onward

processing or sale, thus creating a bigger, dynamic spatial scope for collectors to explore. This implies that these collectors now have to command a substantial amount of money in order to ply their trade

Figure 6

Figures 6&7 above show a collection of e-waste sighted at the study sites

4.4.2 Repairs/ Refurbishment and Reuse

The next stage in the informal management of e-waste in the metropolis is the refurbishment and reuse of salvaged parts from collected EE products, usually outmoded, archaic or outdated. This sector has a huge market base as it affords most dwellers in the metropolis the opportunity to own electrical and electronic products. Refurbishers/ repairers renovate old or non-functioning EE products sold to them directly by scavengers or e-waste collectors by replacing malfunctioning components, after which they clean them to make the final renewed products more alluring and inexpensive to feed a thriving second hand EE produce market. As part of this study, a survey was done to ascertain the average prices of some selected brand new popular EE products from wholesalers and retailers, against the prices of refurbished products mostly found in shops along the Bantama high street, a buzzing commercial suburb in the metropolis known for the sale of second hand EE products. The table below shows the findings of the survey.

Table 3. Price differentials between brand new electronic and electrical gadgets and refurbished ones

Products/ Prices (GHC)	Cell phone	Desktop computer	Television "40"	Refrigerator 230 ltr
New	1000	800	3200	1800
Refurbished	300	250	1300	700

Source: field work

Most repairers and refurbishers throng both the Suame light industrial area and the Afful Nkwanta dump sites for amassed parts extracted from old EE products collected by scavengers,

Figure 8. A typical electrical refurbishing shop in the informal sector

Source: Martin Ababio

thus, making these two sites the central depositories for amassed EE products parts within the metropolis. Others also get their parts from middlemen who buy them from e-waste collectors.

The boom in this sector is however attributable to the widespread norm among Ghanaians that older electronic and electrical products are the best in terms of energy consumption and functionality. They are seen as durable, dependable, tried and tested as compared to brand new ones which aside being expensive, are mostly imitated copies of known brands. Also, refurbishment and reuse is seen as the ecologically desirable choice for dealing with e-waste within the city, per the views from the key informant interviewees sampled for this study.

4.4.3 Recycling

Aside the collection of obsolete or outdated electrical and electronic equipments, the informal disassembling and recycling of e-waste is the second most profitable business for young men in the informal e-waste management sector. A visit to the Afful Nkwanta waste management site and Suame light industrial area revealed a thorough process of manual E-waste recycling.

Firstly, collected e-waste from varied sources, including those sourced directly from collectors, institutions and private homes, and others, obtained through middle men who act as agents between repairers, refurbishers and recyclers are isolated into various categories such as metals, glass, components, units and plastics depending on their trade capability. Usually, those that fetch the highest cash returns are sorted out first and the rest follows in that sequence.

Next in line is the physical dismantling or disassembly of E-waste, usually by hand and with rudimentary tools without any protective gadget. This process is termed as destructive disassembly because no parts are salvaged for reuse. In effect, the recovered metals, glass and plastics are sold as scrap because of the unavailability of metal/glass smelters and a plastic re-processors to convert these scrap of coppers, aluminium, iron, glass and plastics. The dissembled pieces are then categorized into; Small & large essential metal parts, Small & large essential plastic parts, Printed circuit boards with IC Chips, electronic components and connectors, Ferrite and ceramic components, Cables and wires, and Glass components.

For example, cathode ray tube (CRT) based television and computer monitors consists of:

i) Enclosures made of plastics (can be sold to plastic reprocesses).

ii) Cables/ wires (power cords, CRT HV cable etc) of the system (can be stripped off insulator materials and copper wire thus recovered).

iii) Iron/ steel fittings and screws (can be sold to iron smelters).

iv) Lead rich glass present in the colour picture tube and computer monitors (CRTs can be mechanically separated), however, the glasses have to be separated as high lead content and low lead or of lead free composition The cullet of glasses can be sold to glass parts (panels, funnels) manufacturing units, after segregating glass culets of panel and funnel separately.

v) Deflection yoke is further dismantled into ferrite part. The small populated PCB attached to cathode ray tube and present in tuners are sent for further processing along with other populated Print Circuit Boards. (Chatterjee and Kumar)

In short, most of the recovered materials from Televisions and desktop computers at both sites have ready market. They include mild steel, stainless steel, glass, plastics, copper, aluminium and hazardous materials. Aside the hazardous materials which are often landfilled, the rest are sold to local scrap dealers at stipulated fees. For example, copper is sold at 26 US cents (0.26 USD) per half kilo, while plastic is sold at 3 US cent (0.03 USD).

Although this rudimentary method of recycling e-waste is a major source of livelihood for most young men involved in the trade, it also contributes significantly to the polluting of the air in the immediate environment due to the open burning of certain components to segregate copper from plastics in which they are sheathed, particularly from plastic coated wires and cables.

Figure 11. Workers in the informal sector separating assorted e-waste at the Afful Nkwanta dump site. Notice the impoverished conditions in which they disassemble these hazardous materials with no protective gears

Figure 9. workers at one of the study sites sorting out e-waste

Source: Field work 2014

Figure 10. A worker at one of the study sites showing the research team one of the hazardous components they look out for in their sorting of e-waste

Source: field work 2014

Figure 11. A young worker at the Afful Nkwanta e-waste dump site harvesting copper from a burnt out wire without protective gloves

Source; field work 2014

4.4.4 Disposal

Disposal of old electrical and electronic equipments in whole, without being treated or recycled is still a common phenomenon in the metropolis. As a result, most of these Electrical and electronic devices end up in the general municipal waste stream, where they are landfilled. This, however, is not exclusive to developing countries as even in the US, 3.2 million tonnes of e-waste were sent to landfills in 1997 (Antrekowitsch H, 2006). The tide seems to be changing in recent times with the advent of makeshift informal recycling in areas like the Suame light industrial area and Afful Nkwanta E-waste dumping site, where these obsolete E-devices are stripped off their valuable parts leaving remainders like ashes, batteries and metal casings which are subsequently landfilled. Undoubtedly, these materials contain toxic chemicals and are most

probable to pollute the soil and groundwater through leaching, but it is quiet a better option than having to landfill everything

Figures 12 &13 above, shows the open burning of e-waste to retrieve metals and other components at our study sites respectively

Source: field work 2014

4.5 Formal E-waste system

Units in formal sector use all types of methods to disassemble and segregate the e-waste materials. These methods are varied from manual or semi-automated or automated techniques (kumar et al not complete). The procedures are deemed environmentally responsive, as well as taking care of the wellbeing and safety of the workers. Separation and disassembly involves the removal of hazardous components such as batteries, components, part or collection of parts or a sub-assembly from a product (partial disassembly) or the separation of a product into all of its component parts (complete disassembly) through a streamlined method to recover valuable materials such as engineering plastics, cables and printed circuit boards.

The Kumasi metropolis, like the rest of Ghana has a recognized and visible informal e-waste management system even though its activities like unsuitable recycling technologies or infrastructure and inadequate assemblage or collection efforts are a major environmental and health risk. As a result, environmental groups and NGO's have made great calls on stake holders, notably the ministry of Environment and Science to institute a formal recycling system. It is however foreseen that the formal sector would be able to manage e-waste in an environmentally friendly manner, using "state-of-the-act-technique" that will ensure better environmental management and enhanced resource recovery. (Oteng Ababio, 2012)

As established during this research, the Government through the Environmental Protection Agency and the Ministry of Environment and Science has formulated an e-waste management bill, a draft of which has been sent to parliament for consideration. What is not clear in the bill however is the role the informal sector will play in this proposed legislation, whether it is going to complement a highly regulated e-waste management system or it will be totally prohibited, even though the former looks the most likely in the interim because of the capital intensive

nature of recycling technologies and modern landfills; funds local government authorities like the Kumasi metropolitan assembly do not readily have available. In addition, most of the current waste management contractors do not have installed capacity in the needed technology, infrastructure and man power to handle e-waste. Lastly, there is no take back system or service being offered by the already established mega stores and dealers of Electronic and Electrical gadgets to collect outmoded devices.

One waste management company within the city however operates a semblance of a formal e-waste management system in terms of their environmental consciousness and safety precautions for its workers even though it falls short of the needed technological infrastructure to properly treat these waste. Established in the year 1996, but formally registered under the companies code of 1963 (ACT179) in 2004, Presank Limited is a private waste management company that specializes in waste handling and recycling**.** Their operations are guided by the environmental laws of Ghana, thus making their activities environmentally friendly as the company has a strong policy aimed at protecting the environment from pollution.

Figure 14. The Front view of the company

Source; field work 2014

The company handles obsolete electronic and electrical materials of industries including telecom and IT companies which need disposal. These concentrated e-waste are then manually stripped apart in hygienic conditions to remove items such as glass components, metal fittings, screws, connectors etc., cables, heat sinks, plastic enclosures, fans, transformers, batteries etc and segregated into components. The saleable metals are sold to scrap dealers and the hazardous parts are subsequently dumped in designated landfills in the city.


picture

Figure 15 & 16, above shows Workers of Presank Limited segregating e-waste at their service station in the metropolis.

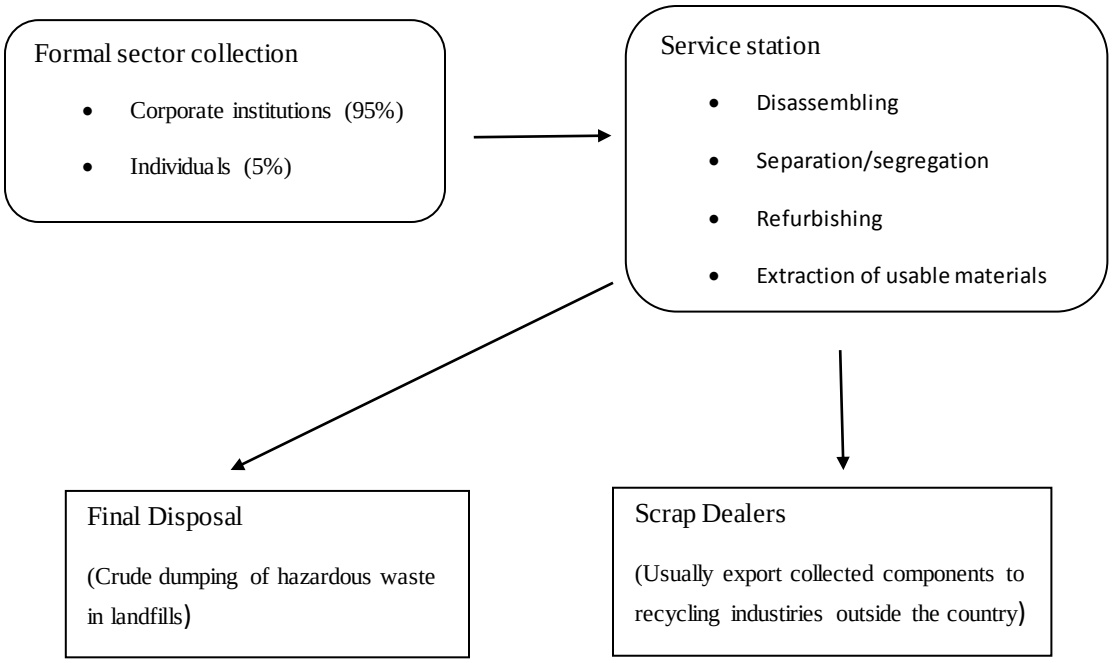

Figure 17. The various stages of e-waste management under the formal sector

Source: field work 2014

Even though the operations of Presank Limited are commendable, it's nonetheless limited in scope, as it relies mainly on industries and corporate institutions for their e-waste. Also, its operations are almost similar to the informal sector, except for their formalized collection system, as it has no recycling facility to treat the extracted components.

It is therefore imperative to say that at the current level, the formal sector cannot solely relied on in terms of managing e-waste in Ghana.

5. Challenges facing proper e-waste management in the metropolis

Many key impediments hamper the safe and effective management of e-waste in the Kumasi Metropolis, although stake holders have given the clearest indication yet of improving the current menace. Foremost on the long list of difficulties facing e-waste management in the city is the absence of a legal instrument to properly regulate the end of life management of electrical and electronic gadgets. The current laws guiding the management of hazardous, solid and radioactive waste including local Government Act (1994), Act 462 and Environmental Sanitation Policy of Ghana (1999) were passed before the e-waste problem emerged. (Martin Ababio,2010). This has created an enigma for both city authorities and the local EPA officers on how to properly regulate the end of life management of the tons of obsolete electronic and electrical gadgets that are churned out annually in the city, including the activities and processes of the informal e-waste management sector, where many of these devices end up. Additionally, the government is still yet to rectify the Basel convention, which would have greatly reduced the amount of obsolete electrical and electronic gadgets that are dumped on our shores, although it is a signatory to it. Looking forward, it is of the firm believe that an earlier e-waste regulatory framework policy if enacted, will go a long way towards a sustainable e-waste management process.

Another major challenge facing e-waste management in the metropolis is the unavailability of proper recycling infrastructure and technology in the formal sector to safely recycle e-waste. This has therefore created a situation where the ability of the informal sector to recycle e-waste is heavily relied on, even though such capacity in terms of methodology poses significant risk to both the environment and human health.

Furthermore, the low level of technical knowledge and public awareness among stake holders and the general public to the harmfulness of e-waste if not properly managed is another challenge to effective e-waste management in the metropolis. The study revealed a worrying picture of government officials lacking the requisite knowledge and skills to tackle the hazardous components mostly found in e-waste (what are the proof of this statement?). This is a significant setback considering the fact that these officials are supposed to be at the forefront in the regulation of e-waste, as well as educating the general public about the toxicity inherent in their

components if not properly managed. On the whole, those involved in e-waste management, especially the informal sector are not entirely ignorant about their potential danger as it came up during the field study but for economic reasons, they are obliged to indulge in it. Enlightening the general public on the potential effect of improper management practices with respect to e-waste will greatly enhance environmental and human-friendly practices in this respect.

6. HEALTH, SAFETY AND ENVIRONMENTAL IMPACTS OF E-WASTE

A scan through literature reveals an established pattern linked to the adversarial impacts of poor management of e-waste. Keirsten and Michael (1999) recounted studies made by BAN showing that an estimated 500 million computers produced worldwide contained 2.87 billion kilograms of plastics, 716.7 million kilograms of lead, and 286,700 kilograms of mercury. Also, Widmer et al. (2005) writing on the global perspectives of e-waste complimented the revelations made by earlier studies by reporting that electronic appliances were indeed an assembly of more than 1000 materials, many of which are highly toxic. Unfortunately, these materials which are highly toxic in nature include lead, cadmium, mercury and oxide, and can enter the environment when they are dumped in unsecured landfills (Schmidt, 2002). Also, as Keirsten and Michael, 1999 put it, they have the ability to eventually pollute drinking water, harm fish and wildlife, cause high rates of miscarriage, birth defects and cancer clusters among workers.
Indeed, mercury and lead are acknowledged to be extremely powerful neurotoxins, especially among children, and can cause significant IQ insufficiency and developmental abnormalities even at very low levels of exposure (BAN/SVTC, 2002).

A study conducted by Roman and Puckett, 2002; Hicks et al., 2005 in the Chinese town of Guiyu, noted for its e-waste industry showed the high levels of heavy metal pollution of surface and ground water, to the extent that drinking water had to be supplied from a nearby town. Furthermore, some natural scientist also uphold notion that the brominated flame-retardants (BFR) in plastics pose a major health risk (Ching-Hwa et al., 2002).

In Ghana, the situation is not different as the e-waste recycling industry is extensively linked with acute health and safety risks for workers involved in this sector (Brigden et al. 2008). It is believed that the inappropriate and rudimentary recycling techniques employed by actors in this sector to recover of raw materials is a major contributing factor to the risk in the sector. For example, the open burning of cables and wires as well as low-grade printed wiring boards (PWB) to recover copper is a major health and environmental risk for both workers and the immediate environment as evidenced in a field exercise embarked on Brigden et al. (2008) where soil and ash samples tested at a major Ghanaian e-waste scrap yard in the capital city of Accra confirmed

the deposition of astronomically high concentrations of toxic metals, such as lead and cadmium, and halogenated chemicals, such as phthalates, polybrominated diphenyl ethers (PBDEs); used as softeners in plastics, especially PVC as well as flame retardants in plastic components of electronic devices. Whereas exposure to lead fumes is known to cause multiple disorders, including neurological, cardiovascular and gastrointestinal diseases (Haefliger et al. 2009), exposure to cadmium dust also leads to malfunctioning of kidneys (Hellstrom et al. 2001) and respiratory system (WHO 1992)

It is therefore not surprising that the impact of hazardous waste on the environment has been enormous as a 2007 report by the World Bank revealed a startling statistics on child mortality by the Ghana Medication Association which showed that close to five million children die annually from environmentally related illnesses (World Bank, 2007). Additionally, the Country's Environmental Analysis estimates that poor resource management costs Ghana about 10 per cent of GDP, with 4 per cent due to water and air pollution (World Bank, 2007).

In the Kumasi metropolis, it is envisaged that higher levels of phthalates, polybrominated diphenyl ethers PBDEs in the blood of most recycling workers, especially in the informal sector will be recorded in the medium to long term. This is as a result of the lack of protective gear and other workplace standards, as a research conducted by Brigden et al. 2008; Sjödin et al. 2003; Sjödin et al. 2001 revealed that workers in electronics recycling facilities in Europe had higher levels of PBDEs as compared to their compatriots in other sectors. This is a worrying situation because Exposures to PBDEs are known to cause endocrine disruptive properties (Legler & Brouwer 2003) and neurobehavioral disturbances in animals, such as abnormal brain development (Qu et al. 2007; Kuriyama et al. 2005).

Additionally, the crude dismantling techniques employed by the sector's artisans in the city to recover metals such as iron, copper and aluminium also pose a great risk to these workers. For instance, workers in the informal sector risk inhaling hazardous cadmium dust from their dismantling of CRT-monitors using such rudimentary tools like chisels, stones, rods and hammers.

Furthermore, most workers in the informal e-waste collection business in the city are exposed to long term health risks such as spinal injuries and back pains as a result of the arduous nature of their work. A typical informal e-waste collector works for long hours, usually 12-14, lifting and transporting obsolete electrical and electronic devices and heavy machines across the city, from warehouses and e-waste shops to their scrap yards on pushcarts. Similarly, refurbishers and repairers also risk contracting lead-borne diseases from inhalation of fumes during electrical fusing processes to retrieve re-usable materials from obsolete devices. Not surprisingly, most repairers encountered during this study reported having occasional pain in the eyes and mucus, a phenomenon commonly associated with billows from soldering processes.

Another safety related matter encountered during the study is the risk of electrocution to repairers during repair and refurbishing operations. Even though our interaction with the workers at both the Suame light industrial area and Afful Nkwanta dump site revealed that they were aware to some extent of the existing health risks, but efforts made to convince them in using inhalation masks and hand gloves went unheeded because of the discomfort they claim to feel when they wear such protective apparels.

7. RECOMMENDATIONS

7.1 Investment in manpower, training and infrastructure

As established in this study, it will be imperative to suggest that the government of Ghana should create the needed manpower through training and also employ technical expertise to effectively manage the associated e-waste linked to the drive towards ICT development in all facets of our developmental process. It is envisaged that the needed investments in manpower and technology will be made to ensure effective e-waste management as the country embraces the digital age. Also, the EPA should be strengthened in its supervisory role of monitoring e-waste management within the city by making sure that actors within the sector adhere to laid down procedure and processes of managing such hazardous wastes. This will ensure culpability and accountability on the part of both managers and actors in the e-waste management business, from creation to disposal.

7.2 Development of an effective e-waste management system

Further, the government of Ghana should develop an effective e-waste management system to stop the current trend of haphazard e-waste recovering and discarding practices. This has become necessary because of the potential these practices, if unregulated, have on the environment and public health in the long run. Taking a cue from Wilder et al (2005), he propounded five considerations in drawing up an effective e-waste management system namely; system coverage, producer responsibility, system financing, legal regulation and effective compliance. It is hoped that the necessary legal and regulatory framework to effectively deal with the management of e-waste in the country will be drawn up by the authorities to deal with the disposal of these hazardous materials, with such laws also meeting or conforming to known international controls and regulations.

7.3 Taking a paradigm shift in international conventions and attitudinal change

In addition to this, it is recommended that the government of Ghana ratify the Basel convention, of which it agreed to in the 1980's. If this happens, it will greatly make producers assume responsible roles for the end of life of their products as per the "extended producer responsibility" (EPR) tenet enshrined in the convention. This we believe will greatly reduce the

wanton and open dumping of e-waste, which is occasioned by the obvious negligence of responsibility by some stakeholders such as the Ghana standards Authority, Customs division of the Ghana Revenue Authority and the Environmental Protection Agency (EPA). Also, authorities at the local and regional levels need to be more proactive in their handling of hazardous waste, which as at now is part of the larger municipal waste, rather than the current lookworm attitude being displayed now.

7.4 Taking a cue from the west; the need for institutional and regulatory reforms

Lastly, the government as a matter of recommendation, can take a cue from the European example on their management of e-waste. Directive 2002/96/EC of the European Parliament and Council, 2003 on waste generated by electrical and electronic equipment and amended by Directive 2003/108/EC, and Directive 2002/95/EC of the European Parliament and of the Council, 2003 on the limit to the use of certain hazardous substances in electrical and electronic equipment was adopted by the EU on the 27th January 2003 to ensure the recycling and reuse of electric and electronic products. Subsequently, these directions were successfully enshrined into the national legislation of member states on 13 August 2004.

Additionally, the Directive on Electrical and Electronic Equipment waste obliges EU Member States to gather at minimum 4kg of EE waste from households per year. It also mandates members to create collection systems for electronic equipment by August 2005 (August 2007 for the new Member States). When such systems are established, consumers will be in the capacity to return outmoded products to shops and collection points at no cost for safe disposal. As a matter of fact, producers of electrical and electronic equipments are supposed to bear the cost for such collection systems. Also, the Directive limiting the use of Hazardous Substances bans such hazardous substances like lead and cadmium from electronic equipment from 1 July 2006.

Further, the directive categorises e-waste into different groupings, namely;

- Electrical and Electronic tools
- Medical instruments and devices
- IT and telecommunications equipment

- Toys, leisure and sports equipment
- Consumer equipment
- Automatic dispensers
- Lighting equipment

The grouping of e-waste into such categories is to make it obligatory for producers or manufacturers to recognise improved procedures in design and assembly to ease their dismantling, recovery and recycle after disposal.

With such directives enshrined in the environmental laws of Ghana, producers, wholesalers and retailers of EE equipments can be tasked with the responsibility of collecting outmoded EE products for proper recycling and disposal. Also, it will greatly reduce the number of e-waste that end up at the dilapidated scrap yards of informal collectors, thereby reducing the amount of hazardous wastes that are landfilled, to curtail further damage to the environment and also to enhance the safety of workers.

8. Conclusion

Overall, the study has shown how the foraging of e-waste has emerged, developed and become rooted in unambiguously schmoozed places with highly distinguished paths that produce purely uneven development. Its findings give an indication that the emergence of e-waste has created a challenge for local authorities, especially in areas of providing adequate infrastructure for its end-of-life management, which is presently being spearheaded by the informal sector.

It is however an indisputable fact that workers in this sector presently epitomise the foundation of the e-waste management system in Ghana in terms of its efficiency and usefulness, but they also represent the frailest locus in the waste management system in general because of their incessant marginalization, risky working and low income levels. It is nonetheless hoped that until a finely honed formal sector is developed in the foreseeable future, stakeholders in the e-waste management business, especially government agencies and local authorities should make it an important agenda to broaden their knowledge and indulgence in the role of the informal sector in the e-waste management and processing system. This will help stakeholders develop friendly guidelines and procedures to halt the negative trends intrinsic in the sector as well as improving significantly the operational conditions of actors without compromising the sector's suppleness.

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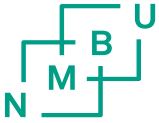

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