WORKING CONDITIONS OF ELECTRONIC WASTE WORKERS AT AGBOGBLOSHIE, ACCRA

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BY

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DECLARATION

I, Matthew Kwame Akormedi, declare that except for the other people's investigations which have been duly acknowledged, this work is the result of my own original research, and that this dissertation, either in whole or in part has not been presented elsewhere for another degree.

Signed: ..... Date: .....

Matthew K. Akormedi

STUDENT

Signed: ..... Date: .....

Dr. Julius Fobil

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ABSTRACT

Background: Ghana's increased use of technology has resulted in massive generation of electronic wastes in the country. These wastes contain toxic chemicals which are injurious to human health, yet there is only little information on how these wastes are managed at the informal level in the country. This study, therefore, investigated the informal level e-waste processing activities at Agbogbloshie and described its associated working conditions.

Methods: The study used a descriptive qualitative approach and purposively selected and interviewed 20 e-waste workers at Agbogbloshie, Accra. The interviews were audio-recorded, transcribed, translated into English, manually coded and analysed using grounded theory principles.

Results: It was found that the workers obtained the e-waste from the various residential areas in Accra and dismantled and burned them in open-air to recover useful components for sale. The workers together with inhabitants of the area were, thus, exposed to inhalation of poisonous smoke from the burning process. In addition, they were engulfed in refuse and human excreta. Majority of the workers demonstrated poor knowledge of the hazards they were exposed to and as a consequence did not use protective clothing, a situation which exposed them to frequent burns and cuts. The economic benefits derived from these activities were irregular so the participants formed associations based on their hometowns or place of origin to support one another in times of difficulty. The majority of the

participants were looking for opportunities to return to the Northern Region of Ghana where they migrated from to learn trades.

Conclusions: The study concludes that the informal e-waste processing activities present health threats to e-waste workers and others living around the sites of operation and that the e-waste workers have limited knowledge about these health threats. It is therefore imperative for the Government of Ghana to take urgent measures to formalize the e-waste processing activities at Agbogbloshie and adopt technologies that safeguard the health of the workers and the general public. It is the view of the author that frequent education of the e-waste workers on health and safety issues is also needed.

DEDICATION

I dedicate this work to my dear wife, Mrs. Suzzy Abla Mawusinu Akormedi and our sons David Akormedi and Emmanuel Akormedi. I owe this lovely family of mine a debt of gratitude for the love, motivation, support and encouragement they gave me while I carried out this research.

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LIST OF ABBREVIATIONS

CRT	Cathode Ray Tube
EPA	Environmental Protection Agency
EEE	Electrical and Electronic Equipment
LCD	Compute Liquid-crystal Display
GH₵	Ghana Cedis
ICT	Information and Communication Technology
IT	Information Technology
MEST	Ministry of Environment, Science and Technology
MRF	Material Recovery Facility
NYC	National Youth Council
OECD	Organisation for Economic Cooperation and Development
PBDEs	Polybrominated diphenyl ethers
PCBs	Polychlorinated biphenyls
SBC	Secretariat of the Basel Convention
UK	United Kingdom
US	United States
USA	United States of America
UNEP	United Nations Environment Programme
WEEE	Waste Electrical and Electronic Equipment

DIFINITION OF TERMS

Basel Convention

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; adopted in 1989 and entered into force in 1992.

Component

Element with electrical or electronic functionality connected together with other components, usually by soldering to a printed wiring board, to create an electronic circuit with a particular function (for example, an amplifier, radio receiver or oscillator).

Digital divide

It is the gap between developed countries and developing countries in terms of access to Information and Communication Technology.

EEE (Electrical and electronic equipment)

It is any equipment which is dependent on electric currents or electromagnetic fields in order to work properly.

Electrical gadget

A gadget that is dependent on electric currents in order to function properly.

End-of-life EEE

Individual equipment that is no longer suitable for use, and which is intended for dismantling and recovery of spare parts or is destined for material recovery and recycling or final disposal.

E-waste dealer

An e-waste worker who buys e-waste from the scavengers for re-sell or processing.

E-waste dismantler

An e-waste worker who breaks down e-waste into its constituent parts.

E-waste scavenger

E-waste workers who look for electronic waste from the communities for re-sell or recycling.

CHAPTER ONE

INTRODUCTION

Background of the Study

Technology plays a vital role in many aspects of human social interactions. It is an absolute need, which humans cannot get away from. The development of technology has helped many people, especially business owners. Over the years, most businesses have become reliant on technology without which majority of business operations would be grounded (Hall, 2012). Industries use refrigerators, computers, telephones, and other products of technology to solve problems and improve their services. Information and Communication Technologies (ICTs) as a whole is known to underpin many development activities and efforts are being made to ensure that every village or institution is connected with it. Unfortunately, the use of technology is more pronounced in developed countries than the developing countries. In an attempt to bridge the digital divide, Africa has been undergoing rapid ICT transformation in recent years by importing mostly second-hand or used computers, mobile phones, and TV sets from developed countries.

The increased use of technology has brought in its wake a growing electronic waste (e-waste) stream not only in industrialized but also in developing countries. It is estimated that 20-25 million tons of e-waste is produced annually, mainly in industrialized countries (Robinson, 2009). As the world population grows, the demand for electronic gadgets increases and the amount of e-waste generated worldwide is likely to be exacerbated.

Quite a number of developing countries, including Ghana, are implementing various policy interventions and programmes towards ensuring that their citizens become abreast with information and communication technology, which seems to drive economic growth and other social interactions. In Ghana for example, the policy of "One Laptop Per-Child" is currently being implemented with the goal to help enhance the teaching and learning of information and communication technology (ICT) at the various levels of education. This means that in the near future, the quantity of e-waste that will be generated in Ghana when these computers become obsolete will increase significantly. While pursuing the agenda to revolutionize ICT in Ghana, it is equally imperative for the Government to put in place measures that would formalize and reduce the health risks that are associated with e-waste recycling in the country.

E-waste includes cathode ray tube (CRT) televisions and monitors, computers, LCD monitors, cell phones, printers and other discarded electronic equipment. E-waste is classified as hazardous waste and its proper disposal and recycling is quite expensive. Unfortunately, due to the frequent transboundary movements of used and obsolete Electrical and Electronic Equipment (EEE) from Europe to Africa, a substantial amount of e-waste tends to accumulate on the Continent. African countries lack the capacity for handling and recycling the hazardous materials contained in the e-waste, resulting in massive pollution of the environment. A typical and arguably the largest e-waste dump in Africa is the Agbogbloshie scrap metal site, which is located in the capital city of Ghana.

Since e-waste has both valuable and hazardous components, its disposal site in Agbogbloshie has become a business centre for many people. People scavenge the waste; dismantle the scrap in open-air burning to recover precious components such as gold, copper, silver, aluminium, iron and brass for sale. The livelihood of many people now depends on the income generated by these activities (Gabel, 2011). The scavengers are, therefore, prone to inhalation of poisonous smoke emanating from the burning process and may thus suffer the risk of environmental toxin overdose. Their activities also end up polluting the air and soil. Soil sampling carried out at the surrounding properties revealed that toxic chemicals from the dump are affecting the local market, church headquarters, and school. The contaminants identified included lead, cadmium, chromium, and others. Some of the contaminants were over 50 times higher than risk-free levels recommended by the World Health Organization (Gabel, 2011; Bishop, 2011). The situation is alarming as the high levels of the pollution have serious health implications for the inhabitants living around.

As a result, the Government of Ghana is contemplating an appropriate measure to solving the e-waste problem. This study is, therefore, imperative in generating data on the working conditions of e-waste processors so as to guide Government's decisions on e-waste management in Ghana.

1.2 Statement of the Problem

E-waste is dumped in developing countries each year under the guise of second-hand goods, without any form of restriction or detection. Sometimes, second-hand electronic dealers find that many of the goods they purchase from importers are faulty and should

be passed on to scrap collectors. According to Amoyaw-Osei, Agyekum, Pwamang, Mueller, Fasko and Schluep (2011), the total Electrical and Electronic Equipment (EEE) imports into Ghana in 2009 added up to 215,000 tons and about 70% of it was second hand products. They further went on to state that about 15% of the second hand electronic imports was unsellable with a significant portion destined to be absorbed directly by the informal electronic waste recyclers. In addition, most of the items that were imported were close to the end of their lifespan. Such items would therefore become obsolete in no time and be discarded. This suggests that the large importation of such almost end-of-life electronic gadgets tend to increase the volume of e-waste in most of the developing countries. Ghana's e-waste dump at Agbogbloshie is reportedly the biggest in West Africa and has, therefore, attracted the attention of many environmental groups, researchers and journalists (MacDougall, 2012).

Like most developing countries, Ghana does not have the requisite recycling facilities to manage the increasing volume of e-waste that is generated or finds its way into the country. The seeming lack of controls and regulations on disposal of electronic goods has worsened the situation and makes the dumpsite in Agbogbloshie an open and ready source of employment as well as point of entry for economic migrants, mostly people who seem not to have any education or employable skills. These people, together with scrap handlers, work in appalling conditions, which constantly expose not only them but also nearby communities to serious health and environmental hazards. The burning process, in particular, emits toxic substances such as heavy metals (lead and cadmium) and extremely toxic dioxins and furans (TCDD tetrachloro dibenzo-dioxin, PCDDs-polychlorinated dibenzodioxins, PBDDs-polybrominated dibenzo-dioxin and PCDFs,

polychlorinated dibenzo furans) into the atmosphere, soils and water bodies with dire health consequences (Amoyaw-Osei, Agyekum, Pwamang, Mueller, Fasko and Schluep, 2011; Institute for Environment and Sanitation Studies, 2011). Today, the toxic chemicals from the Agbogbloshie scrap site are affecting the nearby local market, church headquarters, and school (Gabel, 2011).

Studies conducted in Ghana only documented the amount of EEE imports into the country, e-waste management practices, legal and regulatory framework in place as well as the extent of soil, water, air and breast milk contaminations by toxicants in e-waste (Amoyaw-Osei, Agyekum, Pwamang, Mueller, Fasko & Schluep, 2011; Bishop, 2011; Asante et al, 2011). Although some of these studies mentioned the appalling conditions under which the e-waste collectors and recyclers work, they did not provide any in-depth analysis of the conditions. This situation resulted in inadequate information on the working conditions that are associated with the informal e-waste recycling sector at Agbogbloshie. In addition, there is lack of data on the structure and organization of the scrap activities, social networking as well as social security, including health insurance for the scavengers and market for the recovered products. It is also unclear whether the scavengers are aware of the health and environmental implications of their activities, and the kind of alternative works they would prefer if they were given the opportunity to switch jobs. The study, therefore, seeks to generate these information so as to contribute to guiding any future intervention on e-waste management in Ghana.

1.3 Objectives

1.3.1 General Objective

The general objective of this study is to investigate and characterize e-waste processing activities, the associated working conditions and their typology in order to generate baseline information, which will guide a future intervention on e-waste management in Ghana.

1.3.2 Specific objectives

The study specifically seeks to:

1.3.2.1 describe the working conditions that are associated with the activities of the e-waste scavengers at Agbogbloshie.

1.3.2.2 describe the processes involved in e-waste recycling at Agbogbloshie.

1.3.2.3 develop a typology for the working conditions associated with e-waste processing activities at Agbogbloshie.

1.3.2.4 assess the e-waste scavengers' knowledge about the potential human health hazards associated with the processing activities.

1.3.2.5 ascertain from the e-waste scavengers, the livelihood alternatives , which would be most acceptable to them if authorities were contemplating a social and environmental intervention.

1.4 Conceptual Framework

Considering the limited amount of empirical and theoretical evidence on working conditions of informal e-waste recycling in Agbogbloshie, the researcher followed the

inductive Grounded Theory (GT) approach developed by Glaser and Strauss (1967, 1978). As Strauss and Corbin (1998) point out, the value of the GT approach "lies in its ability not only to generate theory but to ground that theory in data". Thus, grounded theory appears to be particularly suitable approach for theory-building when the topic is little researched and no theoretical basis has been developed yet. The issue of e-waste is now emerging and there is the need to solicit the workers' views on the conditions under which they work so as to develop a theory that would guide policy formulation on e-waste management. Figure 1 shows conceptualized framework of working conditions associated with e-waste recycling in Agbogbloshie, Accra.

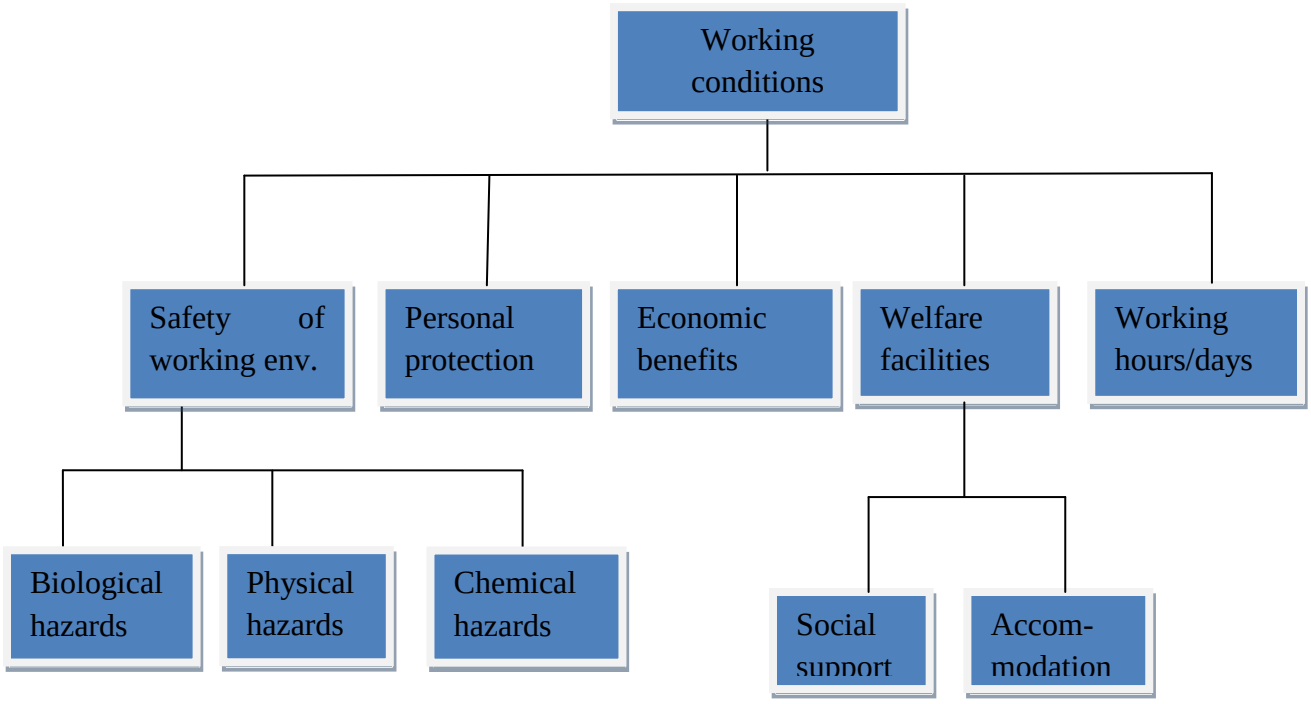

Figure 1 shows a simplified theoretical framework of the working conditions that are associated with e-waste recycling at Agbogbloshie. It explains graphically the key variables studied in this research. It is shown that during the course of e-waste recycling, the workers are exposed to physical, biological and chemical hazards in the environment. It further looks at what the workers do to protect themselves from these hazards. The study also explored economic benefits, working hours and days and welfare facilities that exist for the workers. It is the view of the researcher that the data generated would provide insight for the formulation of the right policies that would make e-waste recycling at Agbogbloshie more humane and rewarding.

1.5 Justification

Agbogbloshie, a suburb of Accra, has in recent years become a dumping ground for computers and electronic waste from Europe and the US (McCornell, 2010). Even though residents of Agbogbloshie and the e-waste scavengers and recyclers are exposed to chemical dangers from e-waste, it appears there are no proactive efforts to stem the tide before the situation gets out of hand. More worrying is the lack of a reliable data on the activities and working conditions of the e-waste workers. This poses a challenge to policy makers wishing to design an e-waste management strategy and to industries wishing to make rational investment in the sector. The study, therefore, hopes to address the existing gap in literature on the working conditions of the e-waste workers and their activities in the Agbogbloshie dump site. The study is justified as it is expected to make information available, which could inform policy direction of the Ministry of Environment, Science and Technology (MEST) and the Environmental Protection Agency (EPA) on making e-waste recycling in Ghana more humane and rewarding.

1.6 Delimitation of the Study

The study was delimited to informal electronic waste workers at Agbogbloshie scrap metal yard. The research participants included workers who were involved in scavenging of the waste, buying of the scrap and the recovered products, as well as dismantling and burning of the e-waste. The study, however, did not cover importers and distributors, assemblers and consumers of electronic gadgets. It used only interview guide for the data collection and specifically focused on the working conditions of the e-waste workers, their knowledge of the health impact of their activities and the alternative livelihood they would prefer if they were given the opportunity to make choices. The period for the data collection was from 21st May to 3rd June, 2012.

1.7 Limitations of the Study

Findings of this study should be considered in the light of some limitations. One of such setbacks was language barrier. Most of the respondents speak only Dagbani, a local language that the researcher does not understand. This situation compelled the researcher to largely rely on research assistants who are proficient in the language to do the data collection, transcription and the translation.

Another setback worth mentioning was that only one method was used for the data collection. The researcher wished to use more than one method so as to triangulate and validate the findings but could not do so due to the limited time of six weeks for the dissertation and field residency.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter presents a review of the available literature related to the conceptual issues in connection with the problem under investigation. These include the concept of e-waste and its characterization, generation of e-waste, hazardous constituents and informal recycling of e-waste. It further discusses literature on the effects of improper disposal of e-waste and the legislation on conditions of work in Ghana.

2.2 Definition of E-waste

Electronic waste is one of the categories of waste in general. Davies (2004) defines waste as "any substance or object, which the holder disposes of or is required to dispose of in pursuant to the provisions of national law in force." E-waste on the other hand is defined by various authorities differently. Widmer *et al*., (2005) for instance define electronic waste as a "generic term embracing various forms of electric and electronic equipment that have ceased to be of any value to their owners." UNEP (2007) also defines e-waste as the "electrical or electronic equipment which is waste including all components, sub-assemblies and consumables, which are part of the product at the time of discarding."

For Puckett and Smith (2002), "e-waste encompasses a broad and growing range of electronic devices ranging from large household devices such as refrigerators, air conditioners, cell phones, personal stereos, and consumer electronics to computers which have been discarded by their users." Whereas OECD (2001) views e-waste as "any appliance using an electric power supply that has reached its end-of-life," Sinha (2004)

thinks it is "an electrically powered appliance that no longer satisfies the current owner for its original purpose."

From the foregoing definitions, it could be summarised that e-waste is any electrical or electronic device that is of no use to the current owner and for that matter should be discarded.

2.3 Characterization of E-waste

According to Widmer (2005), the definitions in the Directive 2002/96/EC of the European Parliament and of the Council (January 2003) on Waste Electrical and Electronic Equipment (WEEE) (EU, 2003) indicate that WEEE consists of ten categories. They are large household appliances, small household appliances, IT and telecommunications equipment, consumer equipment, lighting equipment, electrical and electronic tools (with the exception of large-scale stationary industrial tools), toys, leisure and sports equipment, medical devices (with the exception of all implanted and infected products), monitoring and control instruments, and automatic dispensers. This categorisation seems to be in the process of becoming a widely accepted standard (Widmer, 2005). Of the above ten categories, large household appliances, small household appliances, IT and telecommunications equipment, and consumer equipment categories account for approximately 95 percent of the WEEE generated (Widmer, 2005).

2.4 Generation of E-waste

E-waste is generated when electrical and electronic equipment (EEE) reaches end-of-life and becomes obsolete. The generation of e-waste is worldwide and is estimated that 20-25 million tons of e-waste is produced annually, mainly in industrialized countries

(Robinson, 2009). It is also noted that developing countries with high imports of used EEE, like Ghana and Nigeria, generate relatively high volumes of e-waste. This is because some of the imported equipment are non-functioning and non-repairable while others have shorter lifespan compared to new EEE (SBC, 2011). In order to check the importation of used and end-of-life EEE into Ghana, Amoyaw-Osei, Agyekum, Pwamang, Mueller, Fasko & Schluep (2011), conducted a study on e-waste country assessment in Ghana between November 2009 and January 2011. The study subjects included importers and distributers, assemblers, consumers, collectors, repairers, dismantlers, and recyclers of EEE. Data were collected from a variety of sources. The key ones included import data from the Customs, Excise and Preventive Service (CEPS), literature review, meetings and work-shops of key stakeholders, surveys involving questionnaires and field visits to the places of operation of importers, repairers and other downstream processors. The findings indicated that the EEE imports into Ghana in 2009 added up to 215,000 tons and a per capita import of 9kg. About 30% comprised of new products and 70% second hand EEE. Around 15% of the second hand imports was estimated to be unsellable (i.e. would not respond to power, broken or outdated), a significant portion of which was destined directly to informal recycling. Another 20% of the imports can be serviced (re-paired/refurbished) to get them functioning.

From the foregoing statements, it could be deduced that e-waste is generated in developing countries in two main ways namely; direct importation of e-waste from developed countries and e-waste generated internally as a result of the use of imported second-hand equipment and originally bought new products. In addition, countries that

import large quantities of used EEE are more likely to accumulate and generate more e-waste in their countries.

2.5 Hazardous Constituents of E-waste

Electronic devices are a complex mixture of several hundred materials. A mobile phone, for example, contains 500 to 1000 components. Many of these components contain toxic heavy metals such as lead, mercury, cadmium, beryllium and hazardous chemicals, such as brominated flame-retardants (BFRs). Polluting Polyvinyl Chloride (PVC) plastic is also frequently used (Greenpeace, 2005). BFRs refer to a wide range of brominated chemicals added to materials to both inhibit their ignition and slow their rate of combustion. Common examples include polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD) and tetrabromobisphenol A (TBBPA), as well as brominated polymeric and oligomeric materials (Greenpeace, 2005). Several of these compounds are known to have toxic properties and are highly resistant to degradation in the environment and for that matter are able to bioaccumulate (build up in animals and humans) (Greenpeace, 2010).

Polyvinyl chloride (PVC) is a relatively cheap and widely used chlorinated plastic. It is naturally rigid and through the addition of various chemical additives, including plasticisers to make it flexible and soft. PVC is often used by the electronics industry, mainly as an insulator and coating for electrical cables. Its manufacture involves the use of hazardous raw materials, including the basic building block of the plastic, vinyl chloride monomer (VCM), which is explosive, highly toxic and carcinogenic. When it enters the waste stream, PVC presents problems as a result of both its chlorine content

and its additives. For example, when PVC is burned for disposal (e.g. incineration, uncontrolled burning) or, in the case of electrical cables, to recover valuable copper wire, its high chlorine content can contribute to the formation of highly toxic and persistent chlorinated dioxins. In landfills, some of the chemical additives contained in PVC may leach out, adding to the overall contaminant burden of landfill leachate (Greenpeace, 2010).

2.6 Importance of Recycling E-waste

Although e-waste contains toxic heavy metals and hazardous chemicals, materials of strategic value such as indium and palladium and precious metals such as gold, copper and silver are also contained in e-waste. These can be recovered and recycled, thereby serving as a valuable source of secondary raw materials (SBC, 2011). The recycled materials can be used to make new products. This practice helps to conserve natural resources, save energy, reduce pollution and greenhouse gas emissions by extracting fewer raw materials from the earth. Recycling of e-waste further creates jobs for professional recyclers and refurbishers as well as new markets for the valuable components that are dismantled (Kansas Department of Health and Environment, 2012).

2.7 Informal Recycling of E-waste

E-waste is known to be recycled by either formal or informal sectors. A comparison of currently practised recycling technologies in the informal sector with best available recycling technologies in the formal sector showed that there is considerable potential for improvement in the field of ICT recycling. For instance, the current recycling practices in

the informal sector mainly focus on the recovery of steel, aluminium and copper and are quite inefficient for other metals (SBC, 2011).

In China for example, e-waste is largely recycled by the informal sector where quite a number of waste recycle workers are hired at extremely low wages, and they apply crude and polluting recycling techniques for separation of reusable components and quick recovery of precious metal parts (Chi, et al, 2011). Chi et al. (2011), therefore, investigated the factors that contributed to the existing state of informal recycling sector in China; described the status quo of e-waste management in China from economic and regulatory perspectives; analysed why the informal recycling thrives while highlighting some major challenges by the industry in China and proposed an innovative and integrated e-waste management approach.

Chi *et al.* (2011) established that the e-waste recycled in China came essentially from three sources: consumption, importation and production. Floating private collectors and a mass of second-hand shops and waste reclamation depots constituted the main channels of e-waste collection. Characteristic of the informal sector was the extensive manual dismantling and other crude recycling methods, as compared to the highly automated processes in well-developed formal sectors of recycling. Some crude techniques worth mentioning are the: physical dismantling through the use of tools such as hammers, chisels, screw drivers and bare hands to separate different materials (Puckett *et al.,* 2002; Wen *et al*., 2006; Chi *et al.,* 2011); removal of components from printed circuit boards by heating over coal-fired grills (Puckett *et al.,* 2002; Chi *et al.,* 2011); stripping of metals in open-pit acid baths to recover gold and other metals (Wong *et al.,* 2007; Chi *et al.,* 2011);

chipping and melting of plastics without proper ventilation (Wong *et al.*, 2007); burning of cables to retrieve copper, and burning unwanted materials in open air (Wong et al., 2007); and disposing unsalvageable materials in fields and riverbanks (Huo *et al*., 2007; Chi *et al.*, 2011).

These treatment techniques are less expensive due to the use of non-skilled manual labour and disregard of any hazards to environment or health (Chi *et al.*, (2011). The high demand for second-hand electronic appliances and the norm of selling e-waste to individual collectors also encouraged the growth of such a strong informal recycling sector (Chi *et al.*, (2011). The economic and social factors that drive the informal pattern of recycling in China include the growing rural demand for Electrical and Electronic Equipment (EEE), together with the shortened urban lifespan of these products. Also, Chinese recyclers prioritized component re-use because economically, the remaining functional value of these products was usually higher than the inherent recoverable material value. The low treatment costs maintained by applying simple and polluting methods; the highly specified dismantling processes which maximize the recovery of functional value by efficient separation of reusable components and parts; the steady downstream demands which absorb the majority of different products from informal workshops were some of the major reasons behind the thriving state of China's informal recycling sector (Chi *et al.*, 2007).

Chi *et al*., (2011) recommended that simply prohibiting or competing with the informal collectors and informal recyclers is not an effective solution. New formal e-waste recycling systems should take existing informal sectors into account; and more policies

are needed to improve recycling rates, working conditions and efficiency of the informal players. Developing a better understanding of informal recycling and implementing more supportive policy for the informal sector could result in hundreds of thousands of job opportunities for low-skilled workers (Chi *et al*., 2011).

A key issue for China's e-waste management is how to set up incentives for informal recyclers so as to reduce improper recycling activities and to divert more e-waste flow into the formal recycling sector. Due to the inherent flexibility and adoptability of the informal recycling, radical government interventions, aiming at forbidding informal recycling by enforced removal of operation, often find it difficult to achieve their planned objectives (Chi *et al.*, 2011).

Wasswa and Schluep (2008) undertook a situational analysis with respect to the generation and management of electronic waste in Uganda. The aim was to provide data to define a solution for handling the e-waste associated with the UNIDO/Microsoft refurbishment project. The project by UNIDO/Microsoft was to develop a comprehensive refurbishment model, which could address each stage of the refurbished computer programme - from the time it arrived in the recipient countries, all the way to its proper disposal. Wasswa and Schluep (2008) study used questionnaires to obtain information about the presence and nature of possible informal recyclers and the purpose for which e-waste was used. The investigation revealed that no formal e-waste recyclers existed in Uganda. A few informal activities were identified. There were collections of computer wastes and re-sell of key components by a few individuals; some monitors were

transformed into TV screens and resold in Kampala suburbs; plastic covers were sold to plastic recycling plants.

According to Wasswa and Schluep (2008), electronic-waste provides jobs for people that had difficulty accessing formal employment, and for the fact that e-waste was handled informally; there was little regulation in place to safeguard the health of those who were handling the equipment. Both consumers and collectors were unaware of the potential hazards of e-waste, crude recycling and other disposable practices to human health and the environment. Workers handling plastic waste for instance, had no protective gear. In a plastic recycling plant, employees were paid US $ 3.5 per day depending on availability of activities. In the case of Uganda, waste collection centres were in some cases located in residential and mainly slum areas. This provided breeding grounds for malaria spreading mosquitoes. In terms of social benefits, the e-waste products made goods available to low-income earners, thereby raising their standards of living.

Wasswa and Schluep (2008) recommended the development of a business case for a material recovery facility (MRF) associated with the UNIDO/Microsoft refurbishment initiative. The associated cost analysis should particularly focus on revenues through the sale of material fractions, investment costs for infrastructure and equipment, labour costs, transport costs and disposal costs. The business case should also quantify the job creation potential.

2.8 Effects of improper E-waste Disposal

According to the Institute for Environment and Sanitation Studies (2011), e-waste is known to contain a cocktail of poisonous chemicals such as arsenic, cadmium,

chromium, copper and lead. These chemicals are known to have grave adverse implications on health and the environment. Arsenic for example may disrupt cell communication and interfere with the triggers that cause cells to grow, possibly contributing to cardiovascular disease, cancer and diabetes if someone is exposed in chronic, low doses. Cadmium affects the body's ability to metabolize calcium, leading to bone pain and severely weakened fragile bones. Chromium on the other hand can cause skin irritation and rashes and is potentially carcinogenic. Whereas copper can irritate the throat and lungs and affect the liver, kidneys and other body systems, lead can cause a whole slew of health problems including the impairment of cognitive and verbal activity, and eventually cause paralysis, coma and death.

Due to the hazardous content of the e-waste, its proper disposal is of utmost concern for the global environmental community. As a result, Luo (2010) investigated metal pollution to the surrounding environment from a primitive e-waste processing facility in China. Soils at sites where e-waste is burned in the open air, those of surrounding paddy fields and vegetable gardens, as well as common vegetable samples were collected and analyzed for heavy metals. The results showed that the soils of previous incineration sites had the highest concentrations of Cd, Cu, Pb, and Zn with mean values of 17.1, 11,140, 4500, and 3690mgkg−1, respectively. The soils of nearby paddy fields and vegetable gardens also had relatively high concentrations of Cd and Cu. In the edible tissues of vegetables, the concentrations of Cd and Pb in most samples exceeded the maximum level permitted for food in China. Sequential leaching tests revealed that the Cu, Pb, and Zn were predominantly associated with the residual fraction, followed by the carbonate/specifically absorbed phases with the exception of Cd, which was mainly in the

extractable form in paddy fields and vegetable soils. The data showed that uncontrolled e-waste processing operations caused serious pollution to local soils and vegetables. The cleaning up of former incineration sites should be a priority in any future remediation programme.

According to Noble (2008), lead causes damage to the central and peripheral nervous systems, blood systems, kidney and reproductive system in humans. Mercury, on the other hand, can cause serious damage to organs including the brain and kidneys. More serious is the fact that the developing foetus is highly susceptible through maternal exposure to mercury (Babu *et al.*, 2007). Chromium VI is another metal that could easily pass through cell membranes and is absorbed by the body, producing various toxic effects (Babu *et al.*, 2007; Noble, 2008).

Some other harmful substances in e-waste include arsenic, polychlorinated biphenyls (PCBs), chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), nickel, and asbestos (Ogilvie, 2004). The presence of these chemicals in e-waste in slightest quantity, could contribute to toxic landfill leachate and vapours, such as the vapourisation of metallic and dimethylene mercury. In addition, there may be fires in landfills, releasing extremely toxic dioxins and furans into the atmosphere (Noble, 2008).

The Environmental Protection Agency noted that about one-in-four Americans resides within four miles of a hazardous waste site. Consequently, findings from both state-based surveillance programmes and studies of individual hazardous waste sites have shown increased risk of congenital malformations and reductions in birth weight among infants born to parents living near hazardous waste sites (Johnson, 1999). A study conducted in

Ghana by Asante et al (2011) revealed unexpectedly high mean levels and ranges of PBDEs (4.5; 0.86–18 ng/g lw) and PCBs (62; 15–160 ng/g lw) in the breast milk of mothers. There were significant increases in the concentrations of PCBs and PBDEs over the years. The estimated hazard quotient (HQ) showed that all the mothers had HQ values exceeding the threshold of 1 for PCBs, indicating potential health risk for their children. This finding was linked to unsafe handling of e-waste in the country.

Other studies that used data from reproductive outcomes surveillance systems in New York, California, and five European countries reported increased risk of congenital malformations among infants whose parents lived near hazardous waste sites. Defects of the heart, neural tube, and oral cleft palate were the malformations most frequently reported (Johnson, 1999; Croen, Shaw, Sanbonmatsu, Selvin, & Buffler, 1997). In addition, congenital malformations of the heart were reported in infants born to parents exposed to trichloroethylene and other volatile organic compounds in drinking water that was contaminated by a hazardous waste site in Tucson (Johnson, 1999; Golberg, Lebowitz, Graver, Hicks, 1990). Decreased fertility was also reported by some female smelter workers and persons exposed to large amounts of lead in soil and ambient air from a primary smelter which later became a hazardous waste site (Johnson, 1999; Lee, 1997).

Patients who are potentially exposed to hazardous substances in ambient air or in drinking water supplies must contact the local health department for help. The use of bottled water was recommended for patients who depend on well water until the potability of the water could be established. A restricted consumption of fish that are

known to bear toxic substances such as methyl mercury, in their tissue, was recommended (Johnson, 1999).

Indeed environmental remediation of hazardous waste sites is the best long-term solution to the prevention of adverse reproductive effects from exposure to hazardous substances released from such sites. By that process, contaminated soil, chemical hazards, groundwater or surface water could be treated or removed from the area of the waste site to help curb any human exposure and thereby prevent adverse health effects among persons living near the site (Johnson, 1999).

2.9 Legislations on Conditions of Work

Since workers play a vital role in a country's development, every nation has laws that protect the rights of both workers and employers. In view of this, the Parliament of the Republic of Ghana (2003) enacted an Act to amend and consolidate the laws relating to labour, employers, trade unions and industrial relations; to establish a National Labour Commission and to provide for matters related to these. This Act is referred to as the Labour Act, 2003 and applies to all workers in Ghana except the security services. Among the things that the Act stipulates are the general conditions of employment including annual leave with pay and a maximum of eight working hours per day with a weekly rest of forty-eight consecutive hours; prohibition of employment of young persons in hazardous works; protection of remuneration; freedom of association; and general health and safety conditions at the workplace. With regard to health and safety issues, employers are to ensure that workers do not contaminate the workplaces and are also protected from toxic gases, noxious substances, vapours, dust, fumes, mists and

other substances or materials likely to cause risk to safety or health. The need for safety training, use of personal protective equipment, suitable toilet and hand washing facilities as well as clean drinking water at the workplace were highlighted.

All nations all over the world have national labour laws, including the Ghana's Labour Act, 2003 and other similar Acts. Irrespective of these, there are still reports of unacceptable long hours of work and poor working-time arrangements, which infringe on the labour laws, especially in the developing countries. This motivated Tucker and Folkard (2012) to examine the link between different aspects of working time and outcomes in terms of workers' health, well-being and workplace safety. The objective of the study was to provide information concerning how different kinds of working time organisation can impact on workers' health and well being, in order to estimate both the short and long-term consequences for workers and employers, as well as for society as a whole. The paper reviewed the amount of working hours on a daily and weekly basis, i.e. daily and weekly hours of work and found out that while long daily hours tend to be associated with acute effects of fatigue, long weekly hours tend to be associated both with acute effects of fatigue as well as chronic fatigue, generating long-term negative health effects.

The paper also examined newer forms of working time arrangements such as flexi-time arrangements, and concludes that providing employees with "flexibility" and control over their working time is associated with positive outcomes on workers' health and wellbeing, as well as positive organisational outcomes (e.g., increased productivity, reduced absenteeism and staff turnover).

CHAPTER THREE

METHODS

3.1 Overview

This chapter presents the general approach and specific techniques adopted to address the objectives for the research. It begins with the research design, which explains the rationale for using the qualitative approach. It further discusses the study location and population, methods used in the selection of the research participants and for the data collection. The chapter also presents information on measures taken to ensure collection of quality data and how data were analysed and interpreted. It also highlights ethical issues and concludes with the delimitations and limitations of the methodology employed in the conduct of the study.

3.2 Type of Study Design

The problem of e-waste management is an emerging issue in Ghana and for that matter limited information exists on the subject. In order to amass information and develop a database on it, a descriptive qualitative cross-sectional design was used to gather the relevant data through in-depth interviews with e-waste pickers and recyclers. This allowed for an informal but systematic way of canvassing information on the recycling activities at Agbogbloshie with the view of understanding the problems from the perspective of the workers.

3.3 Study Location/Area

The study was conducted at the e-waste recycling site at Agbogbloshie, a suburb of Accra, the capital of Ghana. It is reportedly one of the largest e-waste dumps in the world, processing millions of tons of e-waste each year. The settlement of Agbogbloshie or Old Fadama consists of about 6,000 families or 30,000 people. The settlement is situated on the left bank of the Odaw River and in the upper reaches of the Korle Lagoon in Accra. The Agbogbloshie site started as a foodstuff market for onions and yam. Over the years, it has grown into a slum with people dealing in all kinds of scraps. This resulted in the site being used as a dumping ground for old electrical and electronic products as well as household wastes. The scrap yard has grown steadily into a popular recycling area where recovery of precious materials from old and discarded EEE forms a source of income earning for a majority of the unskilled migrant population. Hundreds of tons of e-waste end up there every month as a final resting place, where they are broken apart to salvage copper and other metallic components that can be sold (Amoyaw-Osei, Agyekum, Pwamang, Mueller, Fasko & Schluep, 2011).

According to Amoyaw et al (2011), after the scrap dealers' discovery that the place is a good location for business, they started to erect temporary stalls and sheds to house their wares and activities. The National Youth Council (NYC), the custodians of the land was approached by the scrap dealers for a portion of the land as a permanent base for the scrap industry. The dealers later registered with the NYC as the Scrap Dealers' Association of Ghana, and the land was leased to them in 1994. To date, Agbogbloshie has become the hub of informal 'recycling' industry in Ghana.

Figure 2: Map of Accra showing the Agbogbloshie scrap yard (Source: Amoyaw et al., 2011)

3.4 Variables

The variables measured were:

a. scavengers' knowledge of the health implications of their activities

b. working conditions associated with e-waste recycling

c. alternative works for e-waste workers

3.5 Study Population

The study population were people who engaged in e-waste processing at Agbogbloshie scrap metal yard. It also included workers who bought e-waste from the communities to the site for processing as well as business people who bought the recovered e-waste

products. This helped to examine the issues of interest from the perspective of various people who had something to do with the e-waste business.

3.6 Sample Size

The sample size was based on the concept of saturation. As the research participants were recruited and interviewed, a point was reached where new data collected no longer brought additional insights to the stated objectives. At this point the interview was discontinued (Mack, Woodsong, Mackqueen, Guest and Namey, 2005).

3.7 Sampling Method

A purposive sampling method was used to recruit research participants for the study. The categories of workers recruited for the study included those involved in the scavenging, buying, dismantling and burning of the e-waste. The recruitment criterion was workers who had at least one-year continuous experience in e-waste processing. The purposive sampling method is a non-probability sampling method and allowed the researcher to select subjects who were very informative on the topic (McMillan, 2000). The method was ideal in getting in-depth information about the working conditions of the e-waste processors at Agbogbloshie.

3.8 Data Collection Techniques

In-depth interviews were used to collect data for the study. The in-depth interview allowed the researcher to collect rich data on the e-waste scavenging activities, recycling methods, working conditions, knowledge of potential health hazards associated with informal e-waste processing activities as well as alternative livelihood of the e-waste workers. The in-depth interview was conducted in Dagbani and in a secluded

environment so as to avoid interruptions by other people. It was face-to-face and involved two interviewers and a participant at a time. As one interviewer was conducting the interview, the other was taking notes. The written notes covered the interview and those aspects of the interaction such as facial expressions and gestures that the audiotape was not able to pick up (UKMi, 2006). Each interview lasted for about 1 hour and the outcome of the interview was documented in the form of tape recordings and interviewer's notes. The tape recordings were later transcribed and translated verbatim into English at the end of each day's work. This helped to remember the most salient points raised by the participants and also to prepare adequately for the next day's work.

3.9 Data Collection Tools

Semi-structured in-depth interview guide was the tool used for the data collection. Lists of relevant questions needed to meet the study objectives formed the basis of the interview guide. This guided the direction of the interview and ensured that all the relevant information was obtained. The interview guide was useful in eliciting responses that were classified into themes for easy analysis.

3.10 Quality Control

The following measures were put in place to ensure that the data collected were of superior quality and guaranteed the validity of the data:

a. Two research assistants with the requisite background were recruited and trained for the study.

b. The research instrument which was prepared in English was translated into Dagbani and later into English again by two different individuals. This was to ensure semantic equivalence of the instrument across the two languages before use.

c. Researcher and field supervisor made regular unannounced visits to the study area to ensure that relevant data were collected and recorded.

d. Each day, data were checked to ensure that all information has been properly collected and recorded.

e. Errors and omissions detected were discussed with the research assistants to enable them make follow-up revisits in order to make the necessary corrections.

f. The voice recorder was checked for its proper functioning before the beginning of each day's work.

g. The interview guide was pre-tested to ensure that the data collection tool was validated.

3.11 Data Processing and Analysis

The data processing and analysis was an on-going process, taking place throughout the data collection as the researchers thought about and reflected upon emerging patterns. At this stage, the researchers tried to confirm what they already knew or suspected and what was surprising or puzzling. As part of the analysis, the two research assistants who were fluent in Dagbani, Twi and English expanded the interview notes, and separately transcribed and translated verbatim all the interviews into English in a word processing

application. In a situation where there was no consensus, the research assistants reviewed the transcriptions and the original recordings until consensus was reached. The transcripts and expanded notes were stored as files and coded manually using principles of grounded theory approach (Glaser, 1992). Specifically, the coding process involved identifying major themes and sub themes in each of the transcripts. The identified themes were compared across the transcripts to determine differences and similarities in the e-waste scavenging activities, working conditions of the e-waste workers, their preferred alternative livelihood and knowledge of potential health hazards associated with the e-waste processing.

The names of the themes were used to label the sections of the data and information about each theme was then brought together in a coherent manner to obtain a comprehensive view of the working conditions. The themes were illustrated with verbatim quotes and interpreted in the light of extant literature in a meaningful way to reach conclusions.

3.12 Ethical Considerations/Issues

Ethical clearance was sought from the Ghana Health Service Ethical Review Board. Permission was also sought from the gatekeepers including the chairman of the site and oral/verbal consents obtained from the individual respondents. Before the individual respondents gave their consent, the consent form, which contained the benefits, risks and the procedures for the research was read and explained to them. They were given the opportunity to ask questions for clarifications and the researchers assured them of privacy

and confidentiality of information. Each study participant was given GH¢5.00 after the interview for snack.

3.13 Pilot study

The interview guide was pretested on five (5) e-waste scavengers. Problems identified in relation to logical and smooth-flowing order of the questions as well as wording issues of the questions were addressed. This helped to enhance the integrity of the data. The amount of time needed to conduct an interview was also brought to light during the pre-testing stage.

CHAPTER FOUR

RESULTS

4.1 Overview

This chapter presents the findings of the study in relation to the stated objectives. It first of all presents the characteristics of the e-waste workers interviewed, their recruitment and training, and the processes involved in e-waste recycling. It further presents a description of the working conditions and their classifications, knowledge of potential health hazards associated with the work and the alternative livelihoods that the e-waste processors would prefer if they were offered the opportunity.

4.2 Characteristics of the Participants

Twenty e-waste processors with varying years of experience were purposively selected and interviewed. The characteristics of the participants are described in Table 1.

Table 1: Participants' characteristics

Interview ID. No.	Age	Sex	Category of work done	Ethnicity	Educational Level	Years of experience
1	34	M	Buying	Dagomba	Nil	3
2	*22	M	Buying	Dagomba	Primary	3
3	30	M	Dismantling	Dagomba	JHS	1.5
4	20	M	Buying	Dagomba	JHS	1
5	24	M	Dismantling	Dagomba	Primary	3
6	31	M	Scavenging	Dagomba	JHS	8
7	28	M	Dismantling	Dagomba	Primary	5
8	26	M	Dismantling	Dagomba	Primary	9
9	18	M	Burning	Dagomba	Primary	2
10	21	M	Burning	Dagomba	Primary	3
11	*28	M	Burning	Dagomba	Primary	2
12	13	M	Burning	Dagomba	Nil	5
13	30	M	Burning	Dagomba	Primary	6
14	17	M	Burning	Dagomba	Nil	2
15	25	M	Scavenging	Dagomba	JHS	3
16	*30	M	Scavenging	Dagomba	Nil	6
17	*34	M	Scavenging	Dagomba	Nil	10
18	*25	M	Scavenging	Dagomba	Nil	2
19	21	M	Scavenging	Dagomba	JHS	4
20	23	M	Scavenging	Dagomba	Primary	2.5

*Estimated age

The study revealed that all the e-waste workers interviewed came from the Northern Region of Ghana and belonged to the Dagomba ethnic group. All of them were males and their reported ages ranged from 13 to 34 years, with the majority in their twenties. Five of the workers did not know their exact ages, hence, reported only an estimate of the ages. Out of the 20 participants, only five had Junior High School education and the rest were either school drop-outs at the primary level or did not receive any form of formal education at all. Some of the responses provided by the participants included the following:

"I am from the Northern Region, I am a Dogamba, I am 34 years old and I have not been to school before." (E-waste dealer).

"I am from Northern Region and a Dagomba. I can't remember date of birth, don't know my age but I think I am up to 30 years. May be 20 years and beyond, I have been to school before. I stopped at JHS 3 before the BECE exams. I got seriously sick." (E-waste dealer).

"I am from the Northern Region of Ghana and a Dagomba by tribe. I stopped schooling at class 3. I don't know my date of birth but I think I am about 30 years." (A person involved in e-waste burning).

4.3 Recruitment and Training of E-waste Processors

The e-waste processors did not undergo any formal recruitment. Most of them got to know of the work through social networks, mostly through friends and relatives who earlier on came to Accra to engage in the e-waste business. Upon reaching the site, the new workers understudy their friends and relatives for a brief period. One of the e-waste workers skilled in e-waste burning explained how he got into the work.

"*I followed my senior brother to learn of how to do the job. I am yet to be perfect,"* (A person involved in e-waste burning).

The new workers refer to these friends and relatives they understudy as "masters." They observe what their masters do and gradually practise them until they become perfect and begin to work independently. This is illustrated in the following excerpt:

"I came to this my brother here who made me to work with him until I left and started working with a different person. Now I work alone", (E-waste buyer).

In some few instances, the interviewees got into the job without working under anybody or being assisted by anybody. They constantly visited the site and observed how people go about the work and eventually started practising it. This was the situation in the case of this respondent.

"*I got to know of the job after I came to Accra, I observed and got to learn how to do the job so I don't have a master except a computer master who teaches me certain parts of the computer that may be relevant",*(E-waste dismantler).

4.4 Working Conditions of E-waste Workers

The study revealed that the e-waste workers at Agbogbloshie worked under appalling conditions which exposed them not only to abysmal economic income, long working hours, poor welfare facilities but also biological, chemical and physical hazards in the environment.

Figure 3: Condition of e-waste burning site (Photogragh by author)

In terms of economic income, the study revealed that the scavengers and e-waste buyers/dismantlers earned more money per day compared to those who did the burning. While on a good day a scavenger and dismantler could make GH₵50.00 and GH₵100.00 respectively, those who did the burning made only GH₵ 30.00. The worrying aspect was that the daily incomes varied widely by day and were irregular to the extent that the e-waste workers sometimes even went home without any money as indicated in the following responses:

"I make about GH₵30.00 a day. Other times too I get nothing," (A person involved in e-waste burning).

"I earned about GH₵100 a day, sometimes less. Other times I get nothing," (E-waste dealer).

Figure 4: Working environment for e-waste dismantlers (Photograph by author)

The e-waste workers tend to work for longer daily hours and number of days in a week compared to workers in the government sector. They generally work for 10 to 12 hours per day and six days in a week. These were reported by the following workers:

"We usually start around 5am in the morning and close around 5pm. When we arrive from the bush we don't do any other job. We just rest." (E-waste scavenger).

"I work from 6am – 5pm that is about 11 hours." (A person involved in e-waste burning).

"It is only Sundays that I don't work because I rest on that day." (E-waste dismantler).

The electronic waste business at Agbogbloshie was done at the informal level and there was no well-established scheme to cater for the welfare of the workers. However, some of the workers came together to form unregulated informal associations based on their ethnic groups/places of origin and not on the basis of any particular type of work or

processing activity. Some of the recognized associations in operation in the area were Nanton Youth Association, Gushegu Association, Savelugu Association, Bipala lan'gu Association and Tolon/Kumbungu District Association. Membership to these associations was completely voluntary and the benefits derived from the associations were generally limited to financial and moral support during social events such as marriage, naming ceremonies and bereavement. Members of these associations made financial contributions but only in times of occurrence of such social events as conveyed by the following responses:

"I belong to Nanton Youth Association. The association supports members when they are getting married or having a naming ceremony, also when a member is bereaved, they support." (E-waste scavenger).

"We don't have a particular group or association for only those who burn the electronic waste." (A person involved in e-waste burning).

In terms of shelter for the informal e-waste workers, two different arrangements existed. In the first place, a majority of the e-waste workers passed the night with friends and relatives in wooden structures or kiosks at the neighbouring Komkomba market, which was situated very close to where they worked. Whereas the kiosks in which they spent their nights in most cases belonged to colleagues; waste pickers, a few with families lived with their families in rented single rooms in nearby suburbs of Accra as reported in the following responses:

"I pass the night with friends in kiosk at the Komkomba market".

"I have bought a kiosk at the market and that is where I sleep with my friends after every day's work". "I have rented a room at Sukrura that is where I live with my wife".

The physical environment that the e-waste workers operate was full of refuse, faeces and smoke from the burning process. These conditions exposed them to biological, physical and chemical hazards. Among the hazards reported by the research participants were symptoms of faecal oral diseases, burns, cuts, injuries from piercing objects and inhalation of smoke.

"... sometimes if I dismantle the computers, I get cuts." (E-waste dismantler)

"Last week I went to toilet frequently but I don't think it was because of the work I do." (A person involved in e-waste burning)

Despite the workers exposure to these hazards, majority of them did not use protective clothing. This was revealed in one of the responses.

"I don't rely on safety equipment when I am burning electronic waste except some heavy shoes which protect me from the fire." (A person involved in e-waste burning).

4.5 Processes involved in E-waste Recycling

4.5.1 Sources of Raw Materials

The goal of the e-waste workers at Agbogbloshie was to make a living out of the sale of e-waste products. In order to achieve this, the e-waste workers engaged themselves in various activities. Some of the workers were scavengers who went to the various suburbs of Accra with trucks to collect electronic wastes and other metallic scraps from peoples'

houses. The e-wastes that they collected include damaged and faulty computers, television sets and refrigerators which their owners were willing to dispose of or sell at a price. The prices at which the scavengers bought these gadgets were very low since their owners considered them as wastes. The scavengers conveyed the e-wastes with a truck and push it through the suburbs until they got to Agbogbloshie scrap metal yard. Sometimes the scavengers tested some of the gadgets at electronic repair shops to determine those that were functioning so that they could sell them at higher prices. The scavengers usually moved in pairs, one person pulling the truck and the other person pushing it. These were what two of the e-waste collectors said when they were interviewed.

"I push truck to some suburbs in Accra to collect e-waste." (E-waste scavenger).

"We go to all areas in Accra: Korle-Bu, Ashaiman, Osu, etc. to collect the waste." (E-waste scavenger).

The second group of e-waste workers was the dealers and dismantlers. These people bought the e-wastes from the scavengers for processing. Some of the buyers of the e-wastes had specific places where they sat and wait for the scavengers. In situations where the scavengers did not have enough money to go to the communities to hunt for the obsolete electronic gadgets, the dealers gave them money to do so. Some of the e-waste buyers bought motorbikes purposely to meet the scavengers at various locations of the community to negotiate the price with the scavengers before they got to the recycling site. One of the purposes was to make the buyers to get more e-waste in order to enhance their chances of making more profits. These were some of the things the buyers said when they were asked how they got the e-waste for recycling.

"I buy the e-waste from the boys who go to the various suburbs in Accra with truck." (E-waste dealer).

"I sit here and wait to buy from those who get the electronic waste from various parts of Accra. Sometimes, when they are going to hunt for the computers and they don't have enough money I give them some money." (E-waste dealer).

"I go to meet those who go and buy computers from several parts of Accra. I negotiate and buy from them. If the system unit is working well I can buy it GH₵ 70 and if it's not working I would normally buy it GH₵ 20." (E-waste dismantler).

4.5.2 Methods of Processing E-waste

After buying the e-waste, the dealers either dismantled it themselves or contracted others to dismantle it for them for a fee, depending on the quantity of the e-waste. The dismantling was done to remove vital components such as the mouse, power pack, wires, motherboard, keyboard, hard disk and transistor. Those components that were not functioning but contained valuable materials like copper and aluminium were sent for burning. The dismantling of the gadgets was done with the help of tools such as hammers, screw drivers and cutters. The screw driver, which they popularly referred to as ''star'' for example was used to unscrew the computer to remove the useful components. Force was also sometimes applied to physically separate the metallic parts from the copper wires and plastic covers. When a dismantler was asked how he went about the work, this was what he said,

"I will dismantle it with tools such as hammer and screw drivers to remove the parts that I need. The copper is covered with rubber but aluminium is not covered by rubber. The copper is burnt to extract it from the waste", (E-waste dismantler).

The last major activity that was undertaken by the e-waste workers was burning. They burned the e-waste to extract copper and aluminium from the rubber that covered them.

Figure 5: Picture of Copper cables ready for burning (Photograph by author)

The workers involved in the e-waste burning situated themselves a little far from where the dismantling, weighing and selling of the e-waste were taking place. This was because of the smoke generated during the burning process. Their main work was to wait for the dismantlers to send their boys to bring them the e-waste to burn for the removal of copper and aluminium.

"Usually we sit here and wait for the extractors/buyers of electronic waste to bring their copper for burning." (A person involved in e-waste burning).

"We don't have to go there for the copper to burn. They, the dismantlers I mean, will bring it to this site themselves." (A person involved in e-waste burning).

4.5.3 Disposal of unwanted Fractions

During the dismantling and burning stages of the e-waste recycling processes, waste was generated. The study revealed that the waste generated was always left at the site by the e-waste workers – sometimes close to the Korle Lagoon or thrown into it. This was revealed in the following responses:

"I dispose of the other parts of the computer I don't want over there [open dump] where the rubbish are normally left." (E-waste dismantler).

"We usually discard the unwanted components at where we work." (E-waste dealer).

"We discard the unwanted component at our work site near the lagoon." (E-waste dismantler).

4.5.4 Marketing of Recovered Products

The e-waste workers sold the recovered products to customers at the site or in the Agbogbloshie market. Some of these customers were the Ibos from Nigeria. The prices of the products depended on their weight. Therefore, the copper, aluminium and steel were weighed before they were sold. Some of these customers were responsible for the determination of the prices at which the recovered products of a particular weight were supposed to be bought. Usually when there was a change in price, the dismantlers informed the scavengers about it and when the price was unfavourable, the scavengers resisted it for some time. The customers later sold the recovered products at Tema when they were able to buy a lot.

"We have buyers at this place who will weigh your material and they will buy your equivalent price." (E-waste dismantler).

"The metals we buy from those who dismantle computers are gathered and sold to companies in Tema." (Recovered product buyer).

4.6 Typology of the Working Conditions

The working conditions of the e-waste workers studied were systematically classified under the following thematic areas: safety of working environment, personal protection against hazards, economic benefits, welfare of workers/social support, working hours and days, and accommodation.

4.6.1 Safety of working environment

The study revealed the appalling nature of the working conditions of the e-waste workers at Agbogbloshie. A reasonable number of the workers sat and worked close to a big filthy drain. According to the workers, the drain ended up in the Korle-lagoon. The unwanted fractions of the e-waste were often dumped into this drain since there were no special arrangements for their disposal. Other refuse generated were also left at the site and sometimes washed by run-off into the drain. This made the drain almost always stagnant and stinky. The stench from the drain really made breathing uncomfortable for first-time visitors whereas the e-waste workers said they were used to it.

"The bad environment here is not a challenge because I am used to it." (E-waste dealer).

Another condition of work which was of interest was lack of places of convenience. This made the workers to practise open defecation at the site. The e-waste workers seemed to have divided opinions about the insanitary conditions under which they worked. While

few of them felt the situation was bad and needed attention, majority felt the place should remain dirty otherwise Accra Metropolitan Assembly (AMA) would sell the land to market women and they (e-waste workers) would lose their livelihoods.

"The dirt and the bad water here is disturbing, we are not really doing enough to make this place clean." (E-waste dismantler).

"We want our working place to remain dirty because if it becomes clean other workers in this market will locate their containers here. That means our working place would be taken over. So we like our environment as dirty as it is. I am just trying to be frank." (A person involved in e-waste burning).

"Now AMA is selling the land, if we keep the place neat AMA will come and sell the place and we will have no place to work." (A person involved in e-waste burning).

Apart from the offensive odour that emanated from the drain and refuse, the atmosphere was heavily polluted with poisonous smoke resulting from the open-air burning of the e-waste. The heat that accompanied the burning could not also be glossed over or even underestimated.

Figure 6: Picture of smoke from burning of e-waste at Agbogbloshie (Photogragh by author)

4.6.2 Personal Protection against Hazards

It was revealed during the interview that majority of the workers did not use anything to protect themselves from hazards associated with e-waste processing. Among the protective equipment that a few of them used included heavy shoes, hand-gloves, nose masks, and dusters. According to them, the heavy shoes protected them from burns and cuts, hand-gloves from only cuts and nose masks from inhaling poisonous smoke. Other workers who were not involved in the burning of the e-waste claimed to use dusters to cover their nose when walking through the area.

"I don't rely on safety equipment when I am burning electronic waste except some heavy shoes which protect me from the fire." (A person involved in e-waste burning).

"I use heavy shoes to protect me from cuts in my legs, I don't use gloves, but what I do is I don't get close to where they do the burning and in case am passing by I use duster to cover my face, nose and eyes." (E-waste dismantler).

Figure 7: Workers at burning site without protective clothing (Photogragh by author)

4.6.3 Economic Benefits

The e-waste workers were sometimes able to make money out of their activities. However, the amount of money a worker got depended on the specific activity that he carried out. The study revealed that the scavengers and the e-waste dealers/dismantlers made more money compared to those who did the burning. While on a good day a scavenger and dismantler were able to make GH₵50.00 and GH₵100.00 respectively, those who did the burning made only GH₵ 30.00. The sources of the moneys were irregular so the e-waste workers sometimes went home without any money. Most of the e-waste workers were not satisfied with the situation and wished to return home to do something else after saving enough money. These were what some of the interviewees said when they were asked how much money they made in a day.

"I make about GH₵30.00 a day. Other times too I get nothing," (A person involved in e-waste burning).

"I can make GH₵50 a day and am satisfied with it because I am able to spend some and save the rest," (E-waste scavenger).

"I earned about GH₵100 a day, sometimes less. Other times I get nothing," (E-waste dealer).

The workers who did the burning of the e-waste were the worst affected economically since they did not have any specific fee that they charged for their services but rather negotiated with their customers to either pay them in-kind (give them some of the extracted materials) or cash. In some instances, their customers did not pay them anything at all. A situation that sometimes compelled them to enter into illegal agreements with the boys that brought them their master's copper for burning. The agreement enabled those who did the burning of the e-waste to retain part of the recovered copper and aluminium for sale without the knowledge of the masters. The proceeds of the deals were later shared with the boys. In addition to this, those who receive their rewards in-kind also sold them out to dealers in the market. This was revealed during the interview with the group of workers who did the burning of the e-waste.

"We don't charge our customers for the work we do for them, they sometimes give us some of the extracted materials which we later sell", (A person involved in e-waste burning).

"Sometimes we go into terms with the boys who bring their masters' copper; we let them give us part of the copper or aluminium. After selling we give them their share. Their masters usually wouldn't get to know." (A preson involved in e-waste burning).

4.6.4 Welfare of Workers/Social Support

The electronic waste business at Agbogbloshie was not a formal or well organized profession. Therefore, there was no well-established scheme to cater for the welfare of the workers. However, some of the workers deemed it necessary to form informal associations based on their ethnic groups/places of origin and not on the basis of the particular work that they were involved in. Some of the associations mentioned by the participants included Nanton Youth Association, Gushegu Association, Savelugu Association, Bipala lan'gu Association and Tolon/Kumbungu District Association. Memberships for these associations were completely voluntary. The benefits derived from these associations were generally limited to financial and moral supports in times of marriage, naming ceremonies, bereavement and when involved in police cases. The financial contributions by the members of the association were only done when the events occurred. The following were some of the responses:

"I belong to Nanton Youth Association. The association supports members when they are getting married or having a naming ceremony, also when a member is bereaved, they support." (E-waste scavenger).

"We don't have a particular group or association for only those who burn the electronic waste." (A person involved in e-waste burning).

The study also revealed that the e-waste workers did not contribute towards social security neither did they insure their businesses against burglary and fire outbreaks.

4.6.5 Working Hours and Days

The working hours and days were almost the same among all the participants interviewed. The working hours of the participants varied from 10 hours to 12 hours. The e-waste scavengers usually started the day's work as early as 5:00am and closed at about 5:00pm. The dealers (buyers) started their work at 6:00am and closed at about 5:00 pm whereas those who did the burning of the e-waste started work at about 6:00am and closed around 5:00pm.

"We usually start around 5am in the morning and close around 5pm. When we arrive from the bush we don't do any other job. We just rest." (E-waste scavenger).

"I was taught how to work here with electronic waste from 8:00am to 5:00pm." (E-waste dealer).

"I work from 6am – 5pm that is about 11 hours." (A person involved in e-waste burning).

The number of days a person worked in a week depended on the individual. Some worked throughout the week, while others worked six or five days in a week. Those who preferred staying away from work on some days usually did so on Sundays and Fridays. Friday was often used as a resting day because they were mostly Muslims and thus went for Friday prayers (juma'a). It was worthy of note that most of the workers usually chose to work continuously without rest unless they were sick.

"It is only Sundays that I don't work because I rest on that day." (E-waste dismantler).

"I work six days in a week, it is only Fridays that I don't work because I worship on this day." (E-waste dealer).

4.6.6 Accommodation

With regard to accommodation, two different arrangements existed. In the first place, majority of the e-waste workers passed the night with friends and relatives in wooden structures or kiosks at Komkomba market, which was closer to where they worked. The kiosks in most cases were owned by their colleagues. The remaining negligible number of e-waste workers rented rooms at the other suburbs in Accra where they lived with their wives and children.

"I pass the night with friends in kiosk at the Komkomba market." (E-waste scavenger).

"I have bought a kiosk at the market and that is where I sleep with my friends after every day's work." (E-waste dealer).

"I have rented a room at Sukrura that is where I live with my wife." (E-waste dismantler).

4.7 Knowledge of Potential Health Hazards

The study revealed that most of the respondents did not have any knowledge about the health hazards that were associated with the informal e-waste processing. Although during the past one year, some of the participants suffered from diverse symptoms of diseases they did not believe their work played any role. According to them, symptoms of diseases like coughing, fever and body pains that they suffered from were not limited to them. In addition, they used to suffer from such symptoms when they were not into e-waste processing. This was what one of the respondents said,

"This year I had catarrh which is still a problem for me, it makes me cough. I don't think this illness resulted from the nature of my job. I think I suffer from this because I bath chilled water." (A person involved in e-waste burning).

Few of the respondents associated the work they were doing with diseases such as malaria, eye pains, injuries and burns. The respondents were of the view that working under the scorching sun and heat from the burning process made them got malaria.

"This year I was seriously sick of malaria which I think was partly caused by the heat I experience whilst burning electronics." (A person involved in e-waste burning).

"You would get injured when you are hitting the computer to dismantle it. This is especially so when you are not well versed in how to do the dismantling of the electronic waste." (E-waste dismatler).

When the respondents were probed further to know what exactly they did when they fell sick, some said they went to the drugstore to tell them their problems and they were given medicines. This was what another respondent also said,

"On the few occasions I suffered stomach ache, I just smoked this "wee" and became fine." (A person involved in e-waste burning).

Most of the workers who were involved in the burning believed that the smoke from the burning of the e-waste was the major hazard associated with their work. According to them, the smoke did not disturb the people living around but rather the companies situated closely to the burning site. Sometimes the companies came to complain and when that happened the workers involved in the e-waste burning rescheduled large scale burning activities to the night after the companies had closed from work. Majority of the

dismantlers were also of the view that their activities had no effects on the health of people living around. These were some of the responses in this regard:

"Our work doesn't disturb people so it is only the companies around that complain. When they do, we try to reserve the large scale burning activities for the evening or night after those companies close." (A person involved in e-waste burning).

"I can't tell if my job affects the health of other people in the market who do not do the same electronic waste job." (E-waste dismantler).

4.8 Preferred Alternative Livelihood

The study revealed that most of the respondents wanted to stop the e-waste business and return home to do other works that would provide them with a more sustainable source of income. They were of the view that the e-waste business was difficult and had no future. The responses showed that some of the participants were engaged in some form of economic activity before migrating to Accra and their aim of being in the e-waste business was to mobilize some money for transport and capital to start a new business or learn trade when they return home. Some of the economic activities and trades that the participants wanted to engage in when they return home included driving, butchering, farming, tailoring, auto-mechanic, trading, and carpentry. Few of them also wished to go back to school. Conversely, a negligible number of the e-waste workers said they would continue to invest in the e-waste business if they had enough money.

"I used to be a butcher and so when I leave this job, I would go back and do the same job" (E-waste scavenger).

"Yes prefer to learn mechanic work, so I am saving to get money so that I will go back home to learn the apprenticeship in mechanic work." (E-waste dealer).

"I would prefer to farm, if I get money, I may be able to do the farming." (E-waste dealer).

CHAPTER FIVE

DISCUSSIONS

5.1 Overview

This study was undertaken with the primary objective of investigating and describing e-waste processing activities, the associated working conditions and their typology in order to generate baseline information, which will guide future interventions on e-waste management in Ghana. A descriptive qualitative study was carried out and the analyses of the findings were presented in the previous chapter. To make the findings meaningful, this chapter provides a discussion and relates the findings to empirical studies.

5.2 Characteristics of E-waste Workers

The e-waste processing at Agbogbloshie involved mainly male migrants from the Northern Region of Ghana who belonged to the Dagomba tribe. Perhaps, the harsh economic conditions in the Northern Region had compelled the youth to migrate to the South in search of better livelihood. This was revealed in the fact that most of the workers had the intention of accumulating money from the e-waste business and investing it in other businesses in the region where they came from. Even though both sexes migrated to the South, the strenuous nature of the e-waste processing made it quite difficult for the women to undertake such venture. All that the women did at the site was to sell food and sachet water to the workers. Most of the e-waste workers work independently, a situation which contrasts the findings of Chi et al (2011) in China where quite a number of e-waste recycling workers were hired at extremely low wages.

5.3 Processes involved in E-waste recycling at Agbogbloshie

The study had revealed that the e-waste recycling process at Agbogbloshie was sustained by the activities of the e-waste scavengers. The e-waste scavengers went to the various suburbs in Accra to look for the e-waste to recycle. This finding corroborates that of Chi et al (2011) where floating private collectors constituted one of the main channels of e-waste collection. Some of the scavengers usually tested the electronic gadgets that they collected at electronic shops to determine those that were functioning so that they could sell them at higher prices for more profits. This is to say that the economic value of the functioning electronic equipment far outweighed the individual components that were recovered for sale. The study identified new dimension of e-waste scavenging where the e-waste dealers tended to give the scavengers money to pre-finance the e-waste that would be collected. This served as a strategy to prevent other dealers from competing with them.

The main recycling methods discovered by the study were manual dismantling and open-air burning of the e-waste. These methods did not need highly skilled labour and were, therefore, even ideal for people with low educational background. The main problem that was associated with the e-waste processing was the smoke from the burning process. This smoke presumably contained extremely toxic dioxin and furans which were considered dangerous environmental toxins and pollutants (Noble, 2008). These toxic substances, in addition to others in the e-waste, were believed to have serious health consequences for both e-waste recyclers and the people living around. Apart from the populace inhaling the smoke directly, the smoke could also contaminate food sold in the nearby open market and rainwater, thereby making harvested rain unsafe for human consumption. The heavy

metals like copper, aluminium and cadmium which were released during the burning process into the air, soil and water bodies were also believed to have their health implications. To mitigate risks of this nature, Johnson (1999) proposed environmental remediation of hazardous waste sites whereby contaminated soil, chemical hazards, groundwater or surface water could be treated or removed from the area of the waste site. This was to help curb any human exposure and thereby prevent adverse health effects among persons living in the precincts of the site.

It was also revealed that the current methods of recycling e-waste at Agbogbloshie were prototype and only geared towards recovery of copper, aluminium and steel. Meanwhile according to SBC (2011), e-waste contains other valuable materials such as indium, palladium and precious metals such as gold and silver which could be recovered and recycled for other purposes. This implied that the current e-waste recycling methods at Agbogbloshie were not efficient for the resource recovery in terms of valuable components. The recyclers, therefore, did not get the full value for the e-waste that they recycle since some valuables could have been burnt off as airborne oxides.

5.4 Working Conditions of E-waste Scavengers

The e-waste workers worked under appalling conditions. Their place of work was close to a filthy and stinky drain which discharged into the Korle lagoon. In addition, wastes generated from the activities were left at the site together with other domestic wastes and human excreta. These conditions exposed the recyclers to sanitation-related diseases in addition to the chemical hazards in the e-waste.

Although the e-waste recyclers were exposed to poisonous smoke and piercing objects, majority of them did not use personal protective equipment. This put them at risk and they were, therefore, more likely to suffer from injuries and e-waste related conditions than the general population in the near future. Notwithstanding this, infants whose parents were living near the e-waste processing site were also likely to suffer from congenital malformations such as defects of the heart, neural tube and cleft palate as reported by Johnson (1999); and Croen, Shaw, Sanbonmatsu, Selvin, and Buffler (1997). The situation was likely to increase the disease burden of the country in the future thereby escalating government's medical expenses.

According to Prakash and Manhart, (2010), the income data for the workers of informal e-waste recycling sector revealed that collectors represented the most vulnerable group in terms of low income, as most of them received an income of only between US$ 2.3 to 4.6 per day. In the case of this current study, however, the most vulnerable group in terms of low income was those involved in the burning of the e-waste. But one thing that was common to all the categories of the e-waste workers was the irregular nature of the daily incomes across the different categories of e-waste workers. This sometimes compelled some e-waste workers who did the burning to enter into illegal agreement with the boys who sent their master's e-waste to them for burning. The agreement allowed those who did the burning to take part of the recovered products for sale without the knowledge of the owners and shared the proceeds with the boys.

As regards working hours and days, the participants mostly worked for 10 to 12 hours per day and six days in a week. These contradict the Labour Act (2003) of Ghana which

stipulates maximum working hours of eight per day and a weekly rest of forty-eight consecutive hours. Tucker and Folkard (2012) discovered that long daily hours tend to be associated with acute effects of fatigue and long weekly hours tend to be associated both with acute effects of fatigue as well as chronic fatigue, generating long-term negative health effects. The effects of fatigue may include workplace accidents and ergonomic disorders.

5.5 Knowledge of Potential Health Hazards

The e-waste workers seemed to have little knowledge about the health hazards that were associated with e-waste and its processing. In spite of the fact that the participants suffered from diverse diseases during the past one year, they did not believe their work contributed to it in any way. The participants demonstrated different misconceptions about health and sickness. Some felt malaria could be acquired by working in the scorching sun and stomach ache could be cured by smoking marijuana. Not a single one of them was able to mention the effects of the toxic metals in e-waste. These findings were consistent with that of Wasswa and Schluep (2008) where both consumers and collectors were unaware of the potential hazards of e-waste, crude recycling and other disposable practices to human health and the environment. These might be attributed to the low educational background of the participants coupled with the fact that the toxic effects of the metals in e-waste were long-term. This might have implications for the e-waste workers accepting new technologies to protect themselves and the general environment from contamination.

5.6 Preferred Livelihood Alternatives for E-waste Workers

Majority of the study participants did not like the e-waste processing business. They claimed the work was difficult and did not provide a regular source of income. However, they continued to do it with the simple reason of accumulating some money as transport and capital to invest in other future businesses. The responses showed that majority of them would like to return to the Northern Region of Ghana where they migrated from to engage in occupations like farming, butchering and trading. Others wanted to learn trades such as professional driving, tailoring, auto-mechanic, and carpentry. This implied that the majority of the e-waste workers were ready to stop their activities at Agbogbloshie if they found a reliable alternative source of income, preferably in the Northern Region of Ghana. Therefore, the Government and Non Governmental Organizations' social intervention programmes which aimed at solving the e-waste problem could be geared towards providing the workers with skills in the areas of agriculture and handicrafts.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The study identified four main processes of recycling e-waste at Agbogbloshie. These were scavenging (i.e. e-waste picking) from the communities; dismantling and burning the e-waste to recover valuable components (e.g. aluminium, copper, steel etc.) and disposing unwanted fractions and lastly, selling of recovered products.

The e-waste scavengers went to the various suburbs of Accra with trucks to collect electronic wastes and other metallic scraps from homes either at a very low price or no cost at all. The scavengers conveyed the wastes with trucks to Agbogbloshie scrap metal yard where they were sold to the dismantlers at relatively higher prices, particularly those that are functioning.

The e-waste dismantlers dismantled the wastes to remove vital components such as the computer mouse, power pack, wires, motherboard, keyboard, hard disk and transistor. Those components that were not functioning but contained valuable materials such as copper and aluminium were sent for burning. The dismantling of the gadgets was done using simple tools like hammers, screw drivers and cutters. The burning of the e-waste was done in the open thereby polluting the environment with the smoke laden with oxides of heavy metals and organic compounds.

During the dismantling and burning stages of the e-waste recycling processes, waste was generated. The study revealed that the waste was always left at the site either close to the drain leading to the Korle Lagoon or thrown into it, making the place unsightly.

The recovered products were weighed and sold to customers at the site or in the Agbogbloshie open market. The prices of the product were determined by the customers. When the customers were able to buy large quantities of the products, they sold them to companies at Tema.

With regard to working conditions of the e-waste workers, the study revealed that the e-waste workers at Agbogbloshie worked under deplorable conditions. They worked in the mist of piercing objects, refuse, human excreta and offensive drain. The atmosphere of the working area was heavily polluted with the poisonous smoke that emanated from the burning of the e-waste. Irrespective of these hazards, majority of them did not use any protective equipment.

Economically, the work did not provide the e-waste workers with regular source of income. On some days they made good money while on other days they went home with nothing. This made the workers to see the work as having no prospect compelling them to wish for a change of jobs, in particular to those with stable incomes in the Northern Region of Ghana when they have the opportunity. As coping mechanisms, the e-waste workers formed associations based on the various towns of origin to support one another in difficult times.

The study also revealed that the e-waste pickers worked for longer hours and days compared to workers in the formal sector and in addition, majority of them passed the night in wooden kiosks owned by their colleagues in the nearby Kokomba market.

The study further revealed that most of the e-waste pickers did not have any knowledge about the health hazards that were associated with the work they did. None of them was able to mention the effects of the toxic metals in e-waste and believed that they acquired malaria through working under the scorching sun and heat from the burning of the e-waste. Only few of the respondents were able to associate the work they did with eye pains, injuries and burns.

In view of the unfavourable working conditions, most of the e-waste workers wanted to stop the e-waste business and return home (Northern Region of Ghana) to do other works that would provide them with a more sustainable source of income. Some of the occupations mentioned by the participants included farming, driving, tailoring auto-mechanics and carpentry. Few of them wanted to go back to school.

6.2 Recommendations

Based on the findings of the research, the following recommendations are made to improve the working conditions of the electronic waste workers at Agbogbloshie.

6.6.1 Improved Technology for Processing E-waste

The current technologies used for processing e-waste at Agbogbloshie put the workers at risk of diseases, pollute the environment and was inefficient for the recovery of precious materials including gold and other valuable metals. It was therefore imperative for the

Ghana government and other parties interested in solving the e-waste problem to formalize the system and adopt e-waste processing technologies that would safeguard the health of the e-waste workers and minimize the pollution of the environment. The technologies should also be able to recover other valuable components of the e-waste in addition to the copper, aluminium and steel which are currently being the focuses of the process.

6.6.2 Provision of Refuse Containers and Latrines at the Site

The sanitation conditions of the site were appalling and there was the need for Accra Metropolitan Assembly to provide refuse containers and latrines for the workers to use. These would go a long way to protect the waste workers from biological, physical and chemical hazards which ultimately lead to diseases.

6.6.3 Education of Workers on Health and Safety Measures

The poor knowledge of health and safety measures among the e-waste workers could be addressed through education. The government should deploy Environmental Health Officers of the AMA to meet the workers at their free times for the education. This would increase the willingness of the workers to accept practices that protect them and the general environment from hazardous contaminants.

6.6.4 Equipping E-waste Workers with Employable Skills

Government and Non-Governmental Organisations that are interested in solving the e-waste problem through social intervention measures should focus their activities on equipping the workers with skills such as tailoring, carpentry, driving and auto-mechanics.

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APPENDIX 1

INTERVIEW GUIDE FOR E-WASTE WORKERS

Header Information

a. Archival #:

b. Site:

c. Interviewer:

d. Date:

e. Start:

f. End:

Questions

A. Background Information

1. Which Region of Ghana do you come from?
2. Which ethnic group do you belong to?
3. What is your level of education?
4. Sex ……
5. What is your date of birth? ……..
6. How old are you? ……..

B. Description of e-waste processing activities, working conditions and their typology

7. Could you tell me the kind of work you do here?
8. How long have you been doing this kind of work?
9. How did you get to know about the work?
10. Are there any groupings or associations here? If there are, what are their names?
11. Which of these associations do you belong to?

12. Do you derive some benefits from the associations? If you do, what are some of these benefits?
13. In case you work for someone, what form of agreement do you have with your employer? (formal or oral contract).
14. How do you get the waste to recycle?
15. What type of materials do you extract from the waste?
16. What methods do you use to extract the materials?
17. Where do you sell the extracted materials?
18. How do you discard the unwanted components of the e-waste?
19. Have you had any training purposely for this work? If you do not, how did you acquire the skills?
20. How much money do you make in a day? Are you satisfied with it? Why?
21. How long do you work in a day?
22. Are there any days of the week that you do not work? Why?
23. Do you do any other work in addition to this one? Why?
24. Do you foresee yourself doing this work for the rest of your life? Why?
25. What financial plans do you have towards your old age? Do you contribute towards social security?
26. When you fall sick, who pays for your medical bills?
27. After close of work, where do you pass the night?

C. Knowledge of e-waste scavengers on potential human health hazards associated with e-waste processing activities

28. What health problems have you encountered within the last one year?
29. Do you think these health problems are as a result of your exposure to e-waste and why?
30. What (other) specific health problems do you think you can develop from this work?
31. What do you do to protect yourself from these health problems? Probe further if they use protective clothing (nose mask, hand gloves, overall, safety shoes).
32. How does the equipment you use protect you from the health problems?
33. In which ways does your work affect the health of people living around?
34. What steps do you take to minimize the effects of your activities on people living around?

D. Ascertainment of e-waste scavengers preferred alternative livelihood

35. What challenges do you face in the course of the work?
36. You yourself, what plans do you have to better your working conditions? What about the Assembly?
37. Apart from this work that you do, would you have preferred any other one?
38. If yes, what is it?
39. What plans do you have towards changing your work?

APPENDIX 2

CONSENT FORM

Title: Electronic waste disassembling activities and reuse in agbogbloshie, Accra: Associated working conditions, typology and alternative livelihoods for e-waste workers

Principal investigator: Matthew Akormedi

Qualification: B.Ed. Health Science

Address: School of Public Health, University of Ghana, Legon

General information about the research

This research is being conducted to collect data on e-waste dismantling activities and reuse. It is also to know the working conditions of the e-waste scavengers as well as the alternative livelihoods that they would prefer if they were given the opportunity. The study is purely academic research which forms part of the researcher's work for the award of a Masters Degree in Public Health. The study is being funded by the researcher and has no room for any conflict of interest.

Possible risk discomfort

There are no risks associated with participating in this study. The procedures involved in this study are non invasive and will not cause any discomfort to the participants.

Description of level of research burden

Study participants would be asked to participate in an interview which will take up to a maximum of two hours.

Possible benefits

There will be no direct benefit to the participants except a token of GH¢5.00 per head for snack. However, the information given will guide government for any future interventions on e-waste management in Ghana.

Confidentiality

Data security

All study recordings and field notes will be under key and lock in the office of the principal investigator. The field notes will be expanded and typed into computer files. The tape recordings will also be transcribed into computer files. Both types of files will be protected by passwords which will be accessible to the researchers only.

Plans for record keeping

The study materials (cassettes, interview guide, inform consents) will not be labelled with participant's names but rather a unique identification number for each study participant.

Person responsible and phone number

The person responsible for the data storage will be Matthew Akormedi, a student of School of Public Health, University of Ghana, Legon. Mobile number – 0244145376.

Voluntary participation and the right to leave the research

Potential study participants will be told that participating in the study is entirely voluntary and that declining to enter the study, answer a question or terminating the interview will have no negative consequences.

Contacts for additional information

Please call the person responsible for this study, Matthew Akormedi, on 0244145376 if you have questions about the study.

If you have any questions about your rights as a research participant or feel you have not been treated fairly, call the Institutional Review Board (IRB) of the Ghana Health Service.

Your rights as a participant

This research has been reviewed and approved by the Ghana Health Service Ethical Review Board. If you have any further questions about your rights as a research participant, you may contact the chairman of the Board.

Volunteer agreement

The above document describing the benefits, risks and the procedures for the research title ("Electronic waste disassembling activities and reuse in agbogbloshie, Accra: Associated working conditions, typology and alternative livelihoods for e-waste workers") has been read and explained to me. I have been given the opportunity to ask questions and all the questions that I have asked about the research have been answered to my satisfaction. I agree to participate as a volunteer.

.....	.....
Date	Signature or mark of volunteer

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

....

Date Signature of witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

....

Date Signature of persons who obtained consent

APPENDIX 3

ETHICAL CLEARANCE