International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(REVIEW ARTICLE)

Check for updates

Review of the health and safety awareness of e-waste management activities at two sites inthe Accra metropolitan area, Ghana

Louis Dogbatsey [1,*], Peter Billson Obour [1], Alex Owusu Barima [1] and Cyril Schandorf [2]

1 Department of Geography, College of Humanities and Social Sciences, University of Ghana, Legon, Ghana.
2 College of Basic and Applied Sciences, School of Nuclear and Allied Sciences, University of Ghana, Legon, Ghana.

International Journal of Science and Research Archive, 2023, 10(01), 374–386

Publication history: Received on 29 July 2023; revised on 14 September 2023; accepted on 17 September 2023

Article DOI: https://doi.org/10.30574/ijsra.2023.10.1.0727

Abstract

This work sought to review the awareness of e-waste dealers of the health and safety issues related to the processes associated with e-waste management in two selected sites in Greater Accra Metropolitan Area of Ghana. The review used a structured questionnaire, and focused group interviews to solicit for information from collectors, dissemblers, repairs and recyclers, and to assess the potential health and safety risks faced by e-waste dealers. Health and safety culture practices were not well established leading to very low usage of the full complement of safety equipment to effectively manage health and safety risks associated with their daily work.Health surveillance programmed were not established to ensure the continuing fitness of workerswho engage e-waste management activities at the study sites. Government agencies and all stakeholders should work together to promote and enforce sound health and safety culture to govern the e-waste management activities at the study sites.

Keywords: Review; E-waste; Health and safety; Awareness; Stakeholders

1. Introduction

Globally e-waste has become a health and safety issue in many developed and developing countries and cities in the world. E-waste generated must be tackled using cradle to grave approach. E-waste (also known as waste electrical and electronic equipment [WEEE]) refers to discarded electrical and electronic materials that enter the waste stream and are destined for reuse, resale, recycling, or disposal. It contains secondary raw materials such as copper, steel, plastic, etc. (Oteng –Ababio, 2012)

The UNEP 2007 classification scheme for electronic waste (e-waste) entails the categorization of such waste into three distinctive types, namely: household/domestic equipment or appliances, information technology and telecom equipment, and consumable products or equipment. In 2012, the Solving the E-waste Problem Initiative published a set of steps. The global electronic waste (e- waste) generated during the calendar year of 2012 amounted to approximately 45.6 metric tons. This pertains to the weight of one Empire State Building, which measures approximately 6.8

Kilograms per individual. In conformity with the report published by the United Nations in the year 2012, China emerged as the foremost producer of electronic waste, amounting to 11.1 million tons, followed by the United States with a corresponding figure of 10 million tons. (UNEP, 2012)

Ghana has been a dumping ground for old electrical and electronics (Koranteng and Darko, 2011) making e-waste an alarming and growing problem in the country. This type of e-waste is managed poorly in the country because the country lacks proper technology for recycling and disposal of these computerized devices (Darko, 2010). According to

* Corresponding author: Louis Dogbatsey

(Amoyaw-Osei et al, 2011) hundreds of tons of e-waste are finally dumped at the two e-waste sites, Ashaiman and Aglobloshie in the Greater Accra Region of Ghana every month. The health and safety challenges and environme ntal impacts of these e-waste activities have not been well resolved in Ghana (Agyei-Mensah and Oteng-Ababio, 2012; Asante et al 2012; Riederer et al 2012;).

E-waste has become an emerging challenge as well as a business opportunity of tremendous significance. This is due to the volumes being generated and the content of both toxic and valuable materials in them. The fraction of iron, copper, aluminium, gold and other metals in e-waste is over 60% while plastics account for about 30%, with hazardous pollutants comprising about 2.7% (Widmer et al, 2005).

The main aim of this study is to examine the e-waste management practices in Ghana in relation to the health and safety impact on the e-waste workers. The study sites chosen were Ashiaman Agblogbloshie, the hub of e-waste deposits in the capital city Accra of the Greater Accra Region of Ghana.

2. Material and methods

2.1. Study Sites

The Aglogloshie and Ashaiman E-waste study sites are show in Figures 1 and 2 respectively.

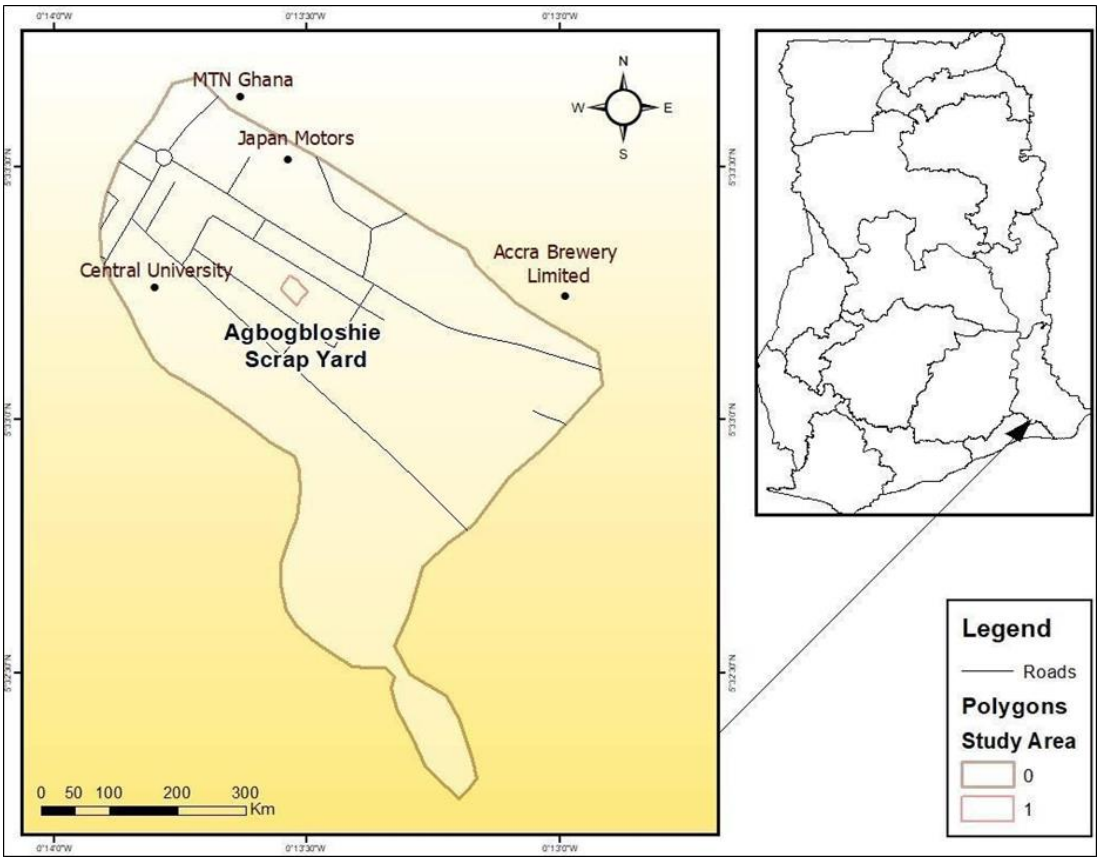

Figure 1 Agblogbloshi e-waste site

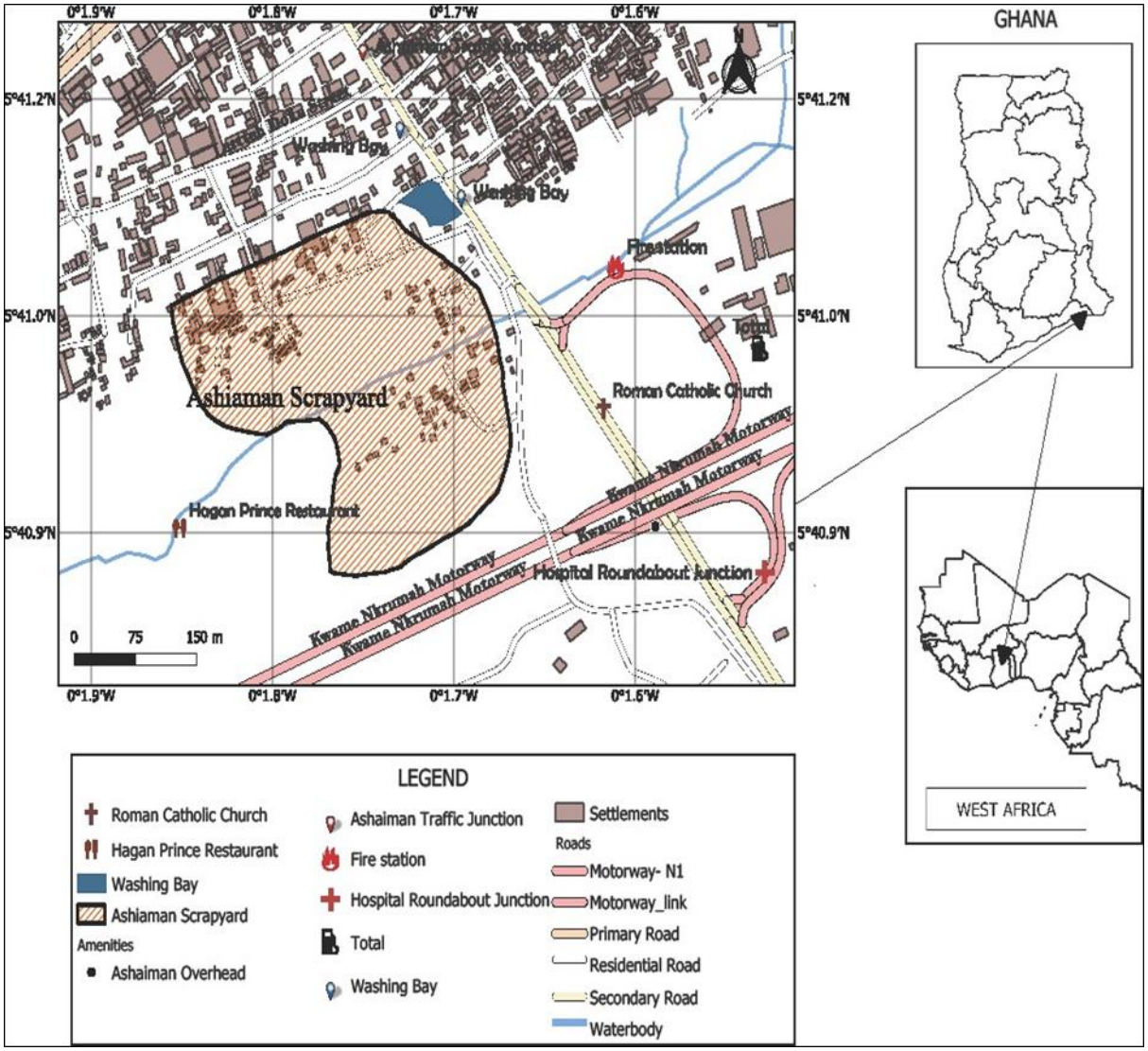

Figure 2 ASHIAMAN E-WASTE SITE

2.2. Sampling and sample size estimation

Stratified inspecting was utilized to gather data from the two e-waste sites. The Slovene's formula was used (Slovene, 1960) to estimate representative samples for the two sites taking into accounting the category of e-waste workers undertaking collection, dismantling, assembling scrap buying and recycling activities (Figure 3). The total sample was 260 E-waste workers, 107 for Ashiaman and 153 for Agblogbloshie. The respondents rate was 28.0% and 19,6 % respectively.

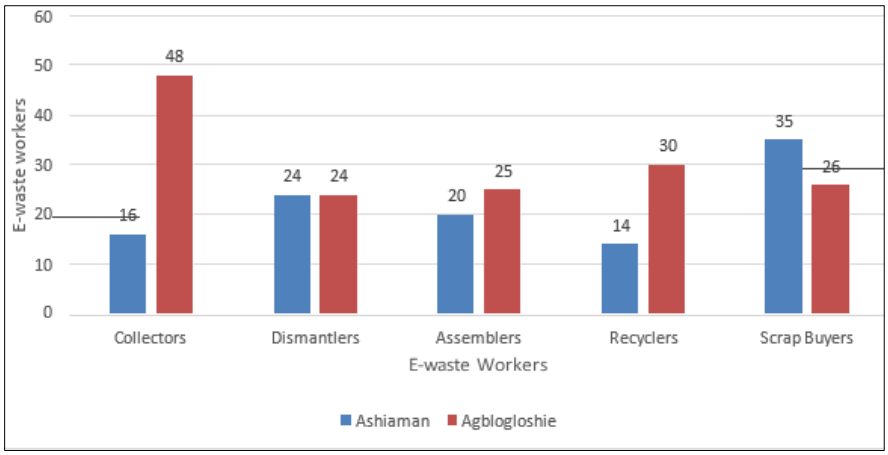

Figure 3 Category of E-waste workers

2.3. Ashiaman site

Ashaiman's latitude is 5.692858, and the longitude is -0.029869; with the GPS coordinates of 5° 41' 34.2888'' N and 0° 1' 47.5284'' W. Covering a total area of 45 sq. km; It is bound to the North and East by Kpone-Katamanso District and, on the South and West by the Tema Metropolis with an estimated population of 217,717. The e-waste activities in area involve scrap picking, reuse, recycling and burning.

2.4. Agblogbloshie, site

Agbogbloshie, the biggest e-waste recycling site in Ghana with an area of about 313sq.km, and currently less than a kilometer from Central Business District (CBD) of Accra. The GPS coordinates are: Latitude: 5° 33' 3.9276". Longitude: -0° 12' 49.8528". Latitude: N 5° 33.0655'.

Longitude: W 0° 12.8309'. Latitude: 5.551091°. Roughly 40,000 Ghanaians inhabit the area, most of whom are migrants from rural areas.

According to Prakash et al and Oteng-Ababio, informal e-waste operations occur in different parts of the country, but the hub of recycling operations in the Greater Accra Region at the scrapyards at Agbogbloshie as well as at Gallaway all in the Greater Accra metropolitan area and Ashiama n, in the Tema Metropolis. In their studies and found that the e-waste economy in this area is highly stratified and made up four main activities which are: collection, recycling, repair and refurbishment, and trading of metals. (Prakash et al., 2010; Oteng-Ababio ,2011)

Studies in 2009 by Amoyaw-Osei et al.,2010 have revealed that almost all of the annual volume of e-waste (171,000 tonnes) handled by recyclers in 2009, which came directly from consumers, from consumers via communal collection, from consumers through repairers and directly from waste imports, was handled by the informal recyclers (Amoyaw-Oseiet al.,2010). Between 10,000 and 13,000 metric tons of e-waste are treated annually in Ghana by the informal sector (Prakashet al.,2010).

2.5. Method

Structured questionnaires, observation check lists, structured interview, and focus group discussions were used to collect data on-site for analysis. The questionnaire covered the follow ing essential areas: demographic information on the two sites, assessment of the knowledge on risk, review and explore the factors that influence the use of PPEs and the review of the institutio nal arrangement for education and training on the effective use of PPEs. The analytical tools used for data reduction and descriptive and quantitative analysis were; SPSS version 20 and Microsoft Excel.

3. Results and discussion

3.1. Age distribution and work profile of E-waste workers

The age profile of the e-waste work force who responded to the questionnaire is shown in Figure 4

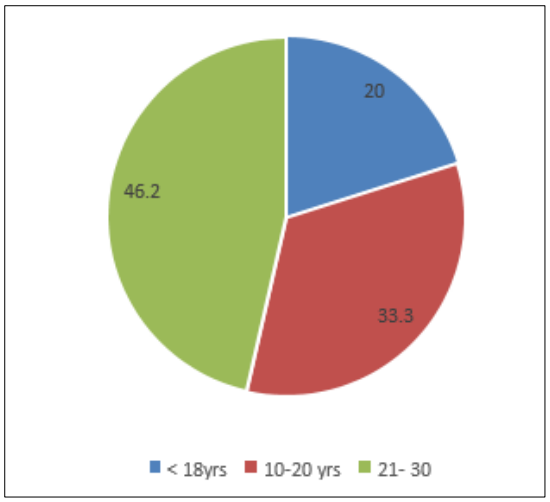

Figure 4 Age profiles of Respondents

The demographic profiles of the e-waste dealers indicate that most of these e-waste dealers are under 18 years old and some are above 18 and 20 years of age. Most of the respondents agree that e-waste activities are beneficial due to income generation for their livelihood.

Thirty –three point 4 percent (33.4%) of the respondents were within the age bracket of 23 to 30 while 46.6%, were within 18 to 20 years.

Twenty-nine (29) respondents out of 30 said they got involved in the e-waste recycling activit ies due to unemployment. The reasons for pursuing this business are; to take care of their families , pay school fees and arrest unemployment . The income accruing from this work range from Ghc 20-50 per day to Ghc 100-150 per day. This translates to GhC80 to Ghc 600 per month. In dollar terms roughly USD 8 to 60 USD. This estimation falls far below the official estimate for infor mal e-waste workers; collectors earn US$70-140/month, refurbishers, U$190-250 & recyclers, US$175-285/month (EPA, 2013).

Due to the job uncertainty the length of service at the job sites range from 2yesrs (6.7%), 3-4 years (53.3%); 5-6 years (13.3%) and 8-10 years (26.7%).

3.2. Health and safety awareness

The health and safety awareness and perception were reviewed by soliciting for information from respondents on the risk perception on dismantling activities, contamination risk perception, chemical pollution risk perception, health screening practices, awareness of occupational safety, types and level of usage of personal protective equipment and why the e-waste workers do not use PPESs.Workers at Ashaiman and Agblogbloshie study sites face significa nt health risks including pollution from burning e-waste which releases toxic chemicals into the environment and presents significant hazardous exposure to collectors, dismantlers and assemblers and recyclers.

Most of the respondents are of the view that PPEs are necessary 18 (60% of the respondents), while 12 (40% of the respondents) have no PPEs because they were of the opinion that they are not necessary. The type of PPEs in use included; googles, gloves and overall (48.5%), nose mask s only (16.1%), overall, gloves with no nose mask (16.1%) and overall, overall, boots and nose masks (18.9%) . Regarding the frequency of usage of PPEs the responses were as follows; every time work is to be done (26.7%), only when dismantling is to be done (26.7%), when dismant ling or work is to be done (45%) and not always (6.6 %).

Factors that influenced workers not using of PPEs identified by the respondents are; too expensive to purchase (20%); it slows down work (23.3%) ; not available to be used (23.3%) and do not have them (33.4%).

The awareness of the risks associated with their work was poor. Most of them did not undergo periodic health surveillance at a designated Hospital.

Health surveillance should have two components:

- Based on the general princip les of occupational health; and
- Designed to assess the initial and continuing fitness of e-waste workers for their intended tasks of collection, dismantling, assembling, recycling and open burning.

ILO , 2019 document on " Action manual for improving health and Safety of E-waste workers " will be useful resources material worth adoption for operational health and safety at the two study sites and Ghana .

3.3. Comparison of health Awareness among Ashaiman and Agblogbloshie Using Levenes test

In statistics, Levene's test (Levene,1960) is an inferential statistic used to assess the equality of variances for a variable calculated for two or more groups. Some common statistical procedures assume that variances of the populations from which different samples are drawn are equal. Levene's test assesses this assumption. Levene'test was used to compare the health awareness among e-waste dealers at Ashiaman and Agblogblosie. Table 1 shows the results obtained.

Table 1 Health Awareness comparison among Ashiaman an Agblogbloshie e-waste workers using Levene's Test

Issue	Groups	N	Mean	Std. deviation	Std Error of the Mean
Health Awareness	Ashiaman	30	1.3333	0.447946	0.08754
	Agblogbloshie	30	1.4000	0.49827	0.09097

Based on this statistical analysis, it can be asserted that the levels of health awareness among the two groups of e-waste dealers are not significantly different, as indicated by a p-value of 0.305, which is greater than the standard level of significance of 0.05.

3.4. Comparison of PPE usage in ASHAIMAN AND AGBOGBLOSHIE Using Levene T test

Table 2 shows a Levene's test for the comparison of PPEs usage at Ashaiman and Aglogloshie e- waste dealers

Table 2 PPEs usage comparison among Ashiaman an Agblogbloshie e-waste workers using Levene's Test

Issue	Groups	N	Mean	Std. deviation	Std Error of the Mean
Use of PPEs	Ashiaman	30	1.9383	0.78492	0.14331
	Agblogbloshie	30	2.3000	0.83666	0.15275

The utilization of Personal Protective Equipment (PPE) among e-waste dealers in Ashaiman and Agbogbloshie demonstrates no statistically significant difference, as evidenced by the observed p- value of 0.246 which exceeds the standard level significance level of 0.05.

According to Dodd et al,2023 the potential health risks of toxic metals concentrations at the Aglogloshie e-waste site were high exceeding international environmental soil quality guidelines.

3.5. Health and Safety

Workers engaged in e-waste treatment are exposed to hazardous substances in e-waste through water, air, soil, dust, and food. This exposure can even put lives at risk, especially of those involved in Worst Practices.

According to Atiemo et al. (2016) and Sepúlvedaet al. (2010), the burning of e-waste to recover metals releases heavy metals such as lead, mercury, cadmium and others, halogenated compounds, polybrominated diphenyls ethers (PBDEs), and dioxins. Moreover, the uncontrolled manual dismantling of used lead-acid batteries (ULAB) releases nickel, lithium and lead. Health impacts associated with these substances have been of particular interest for occupational health research.

Also, according to Chen et al. (2011), cumulative exposures are predictably high where infor mal recycling sites have operated for more than a decade. For example, rice and dust samples collected from homes close to e-waste sites had concentrations of lead, cadmium, and copper that were nearly twice the maximum permissible concentrations (Zheng

et al. 2013). An exposure of contaminated food such as rice combined with inhaling lead through house dust puts workers and people living close to the areas and especially children at high risk for neurotoxicity and adverse developmental effects (Zheng et al. 2013).

Changes in lung function, thyroid function, hormone expression, birth weight, birth outcomes, childhood growth rates, mental health, cognitive development, cytotoxicity, genotoxity are some of the adverse health effects of exposure to e-waste (Frazzoli et al. 2010 ;Chen at al. ,2011).

3.6. Institutional arrangements for the e-waste Management

Coordination of E-waste Management Initiatives in Ghana is the responsibility of the multi- stakeholder Technical Committee on E-Waste Management (TCEWM) that coordinates the various initiatives aimed at improving E-waste control and management in Ghana.

The TCEWM is chaired by EPA-Ghana and comprises representatives of

- Ministry of Environment (MESTI)
- Ministry of Local Government (MoLGRD)
- University of Ghana,
- Ghana Standards Authority,
- Customs,
- Ghana Atomic Energy Commission,
- Ghana Health Service,
- Scrap Dealers Association,
- Ministry of Trade & Industry,
- Ports & Harbours Authority

In 2016, Ghana passed the Hazardous and electronic waste control and management act (Act 917,2016) and the Hazardous and electronic waste control and management regulations (LI 2250.2016). These two legal documents require producers and importers to register with Ghana's Environmental Protection Agency (EPA) and pay a preemptive eco-tax for imported electronics, which finances the enforcement of the legal framework for e-waste management and the formalization of informal actors.

Ghana in collaboration with European Union is undertaking a project entitled "E-Waste management in Ghana: from cradle to the grave" launched in 2018.

The project was to improve e-waste management in Ghana through an integrated multi- stakeholder approach. The project aims at promoting sustainable growth, alleviating poverty, increasing human wellbeing, and preventing environmental pollution, by supporting the effective implementation of Ghana's legal framework for e-waste management, through measures such as:

- Fostering the formalization of informal micro, small, and medium-sized enterprises (msmes) collecting, dismantling, and recycling electronics
- Launching a formal e-waste collection mechanism
- Disseminating best practices through capacity building and training
- Raising awareness on e-waste risks and related issues among all actors involved: informal msmes, but also formal sector associations, manufacturers, wholesalers, distributors, e-waste workers, public officials, local communities etc.
- Supporting decision- makers with research and policy dialogues

Currently there is a draft E-waste management bill in the process of being enacted.

The Bill covers control and management of hazardous waste in general with the Part two of the Bill that addressing E-Waste.

Key issues addressed by the Bill are:

A manufacturer or importer of electronic equipment is required to register with the EPA and pay electronic waste levy in respect of electronic equipment that is imported into the country or manufactured in the country.

3.7. E-Waste Fund

The sources of money for the Fund include:

- The levies collected;
- Moneys received from other sources or that may in any manner become lawfully payable and vested in the fund; and
- Moneys approved by parliament

A manufacturer, distributor or wholesaler of electronic equipment is required to take back used or discarded electronic equipment manufactured or sold by it for recycling purposes.

Government Agencies are however exempted from registration and payment of an electronic waste levy:

- The levy is to cater for the costs of the collection, treatment, recovery and environmentally sound disposal and recycling of electronic waste
- Provides for the establishment of an Electronic Waste Recycling Fund to provide financefor the management of electronic waste and reduce the adverse impact of electronic waste on human health and the environment.

Moneys from the Fund shall be used for

- The construction and maintenance of electronic waste recycling or treatment plants;
- To support research into methods of electronic waste prevention, control and management
- Research into electronic waste treatment and recycling;
- Publication of reports;
- Education of the public on the safe disposal of electronic waste and the negative effects of electronic waste; and
- Offer incentives for collection and disposal of electronic waste

The Fund shall be managed by a seven-member Board of Trustees.

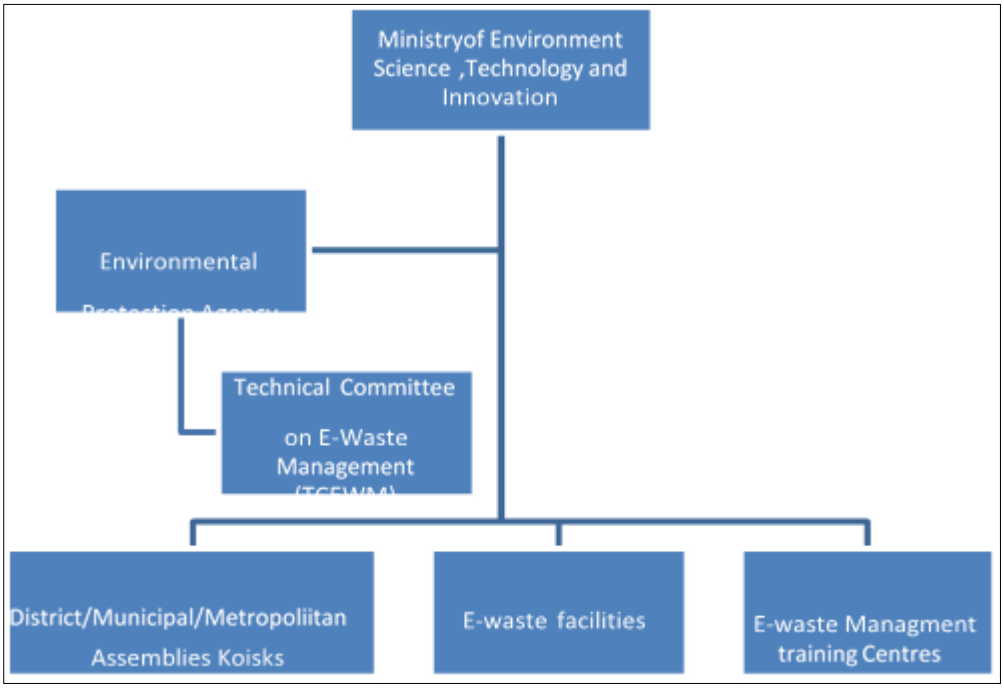

Figure 5 E-waste Management Model to promote Health and Safety Culture

Local Authorities shall:

- Designate points at which electronic waste shall be deposited by importers, manufacturers, wholesalers, distributors, retailers, refurbishes or repairers in accordance with recycling classifications determined by the Agency; and
- Ensure that importers, manufacturers, wholesalers, distributors, retailers, refurbishes or repairers of electronic equipment comply with procedures for the disposal of electronic waste by delivering collected electronic waste to the designated assembly points.

In view of the findings made from this work, the authors are proposing a simple model for managing e-waste which focuses on health and safety culture to govern e-waste management in Ghana, shown in Figure 5.

Health and Safety culture means the characteristics and attitudes of individuals and organisations that gives priority to health and safety over the business of e-waste management activities warranted by its perceived significance to the health and safety of e-waste workers.

The oversight ministry is the Ministry of Environment, Science, Technology and Innovation.

EPA will implement the Hazardous and electronic waste control and management Act (Act 917,2016) and the Hazardous and electronic waste control and management regulations (LI 2250,2017). EPA will register all e-waste dealers, administer the E-Waste Fund and undertake enforcement actions applicable to the e-waste legislation and regulations with the support of the multi-stakeholder Technical Committee on E-Waste Management (TCEWM) who will coordinate the various initiatives aimed at improving E-waste control and management in Ghana.

Each District/Municipal /Metropolitan assemblies will be required to establish kiosks for the collection of e-waste and their transfer to e-waste management facilities with approved health and safety procedures followed.

The E-waste Management Training Centres will develop training packages and offer training courses/seminars to meet training needs of all groups in the formal and informal sectors of the e- waste activities. Health and Safety Culture training will be an integral point of all education and training events.

The Solving the E-waste Problem (StEP) initiative guiding principles to develop e-waste management systems and legislation is worth considering in the Ghanaian context (Global E- Waste Monitor, 2020). The principles include:

- Establish a clear legal framework for e-waste collection and recycling.
- Introduce extended producer responsibility to ensure producers finance the collection and recycling of e-waste.
- Enforce legislation for all stakeholders, and strengthen monitoring and compliance mechanisms across the country to ensure a level playing field.
- Create favorable investment conditions for experienced recyclers to bring the required technical expertise to the country.
- Create a licensing system or encourage certification via international
- Standards for collection and recycling.
- If an informal collection system exists, use it to collect e-waste, and ensure e-waste is sent to licensed recyclers through incentives.
- When no local end-processing facilities exist for an e-waste fraction,
- Ensure good and easy access to internationally licensed treatment facilities.

3.8. E-waste Management Training Manual

E-waste management activities involves hazards associated with collection, dismantling , assembling , open burning and disposal of residual waste . Recognizing the need for effective professional training to manage the hazards and mitigate the health and safety consequences a training manual has been developed. This training manual about safe and sound handling of electric and electronic waste (e-waste) was developed within the framework of the German Cooperation programme for “Environmentally Sound Disposal & Recycling of E-Waste” (E- Waste Programme, 08/2016 – 01/2020), with its objective to support the Ghanaian Ministry of Environment, Science, Technology and Innovation (MESTI) to improve the conditions for sustainable management of e-waste in Ghana. (Katharina Lens at al ,2019)

The training programme includes capacity development for actors in the informal sector, promoting individual skills and organisational structures of those directly involved in the collection and resource recovery. In order to avoid health

and environmental risks, the programme supports e-waste collectors and recyclers who are willing to change their methods.

The collaborating National organisations and International partners that were involved in development of the manual are:

- WRF-World Resources Forum,St,Gallen ,Switzerland
- Environmental Protection Authority, Ghana
- National Youth Authority, Ghana
- DRZ-Demontage und Recycling Zentrum, Vienna Austria
- Chance for Children
- SAEWA-Southern African E-Waste Alliance, Cape Town South Africa
- RECLITE- Waste Electronic and Electrical Equipment Recycling Germiston South Africa
- GUR – GWR- gemeinnützige Gesellschaft für Wiederverwen- dung und Recycling mbH) The thematic areas of the Manual are:
- E-waste Global and Local Implications
- Manual dismantling
- Output fractions
- Management of a Small Scale Dismantling Facility
- How to Organize Trainings
- Literature, References and Link
- Annex- Tools list and Record Template for Group work

3.9. Rationale for the training manual

The manual emphasizes the need for training to address worst practices so that there is a paradigm shift towards good practices.

Worst Practices is practices is defined as "known or suspected to have severe (typically multip le) negative impacts on the environment, worker's/community health and safety, and quality and quantity of recovered secondary metals, when applied by any economic operator in any of the processes concerned (collection, manual and mechanical processing, metallur gical processing and disposal)."

These undesirable practices are globally widespread and typically take place in economic environments and political climates that show an absence of control mechanisms; such as legislative enforcement of minimum standards to ensure the protection of both human health and environmental systems integrity. Individuals and local communities might be forced to engage in Worst Practices in subsistence activities due to the lack of other local income opportunities and despite their often-tangible negative human health impacts.

The highlighted worst practices in Ghanaian Context are:

- Poor education and lack of training which contribute to engaging in risky practices in the informal sector with insufficient protection for the workers or the receivingenvironment. Often there is a complete lack of awareness found in people engaged in e- waste management activities.
- Trading and transportation activities where operators are Selling on processed fractions to a down-stream vendor who is operating in a non-compliant and dangerous manner, with dire consequences to worker safety and the receiving environment ; Violating the applicable global (Basel Convention)or local (WEEE Directive) legislation that limits and prescribes the modus operandi for acceptable trading and transportation practices; Non- existent or incomplete documentation of accurate shipping records and/or forgery of the relevant export and import permits, where the latter are typically obtained by bribing of officials; Trading of cargo that is deliberately falsely labelled and wrongly declared to avoid local costly and legally prescribed waste treatment obligations(such as safety disposal costs) and import duties; Improperly packaged cargo that does not comply with the required minimum standards set , facilities and transportation vessels that are unsound and unsafe to use with regards to structural integrity and the technical standard required, such as unroad worthy trucks and unseaworthy ships; Utilization of fly-by-night types of transportation services that typically employ an untrained, unprotected workforce operating in a non-compliant (e.g. unlicensed), unprotected(accident-prone) and unins ured manner.
- Manual Dismantling Practices (Fridges) where is a forced opening of refrigerators (by smashing and/or breaking the plastic or metal encasing structures), instead of using safer devices to facilitate their controlled opening (e.g., a screwdriver) and breaking and crushing the inside parts without wearing PPE and without the proper separation

and containme nt of hazardous constituents being released. By doing so, extremely harmful gases such as Freon R-12, HCFC R123a, and Isobutene R600a are released to the atmosphere. These gases can be on average 3000 times more damaging than CO2and contribute significantly to global warming as well as depletion of the ozone layer. For example, a single kilogra m of Freon R-12 has the same impact on global warming as 10,900kg of CO2; a refrigerato r's foam insulation contains 'blowing agents' (which is a type of gas used to make cellular or spongy products contained in the foam insulation in fridges) which escape into the atmosphere when the housing (the white outer casing of the refrigerators) is dismant led foam insulation is highly flammable and is often burned deliberately as a means to control the temperature of the fire.

- Treatment of cables to recover copper where recovering copper involves burning off waste cables in open fires that incinerates the outer insulating plastic covering leaving copper as a residue which is then collected. Copper is then recovered as the desired product. Insulation makes as an average 38% of cables and is composed of Polyvinyl Chloride or PVC (66.3%) and Polyethylene (31.2%) as well as other materials (2.5%). By burning the insulation dioxins and mercury (Hg), as well harmful Chlorine (Cl)compounds, such as Polychlorinated Biphenyls (PCBs), and about 1.6 kg of CO2-eq per kg of recovered copper are released (Safaei et al., 2018).
- Recycling of Printed Wiring Boards where wet chemical leaching is done extract precious metals such as gold or silver immediately with wet chemical processes. Such processes include dissolving the metals in acids and precipitating them with cyanide salts or mercury. All these processes are highly hazardous and must be conducted by professionals in a laboratory; another potentially hazardous practice is to de-solder certain components on a PWB by heating the solder. If this process is not performed under controlled conditions (heat regulation), very hazardous substances are released (e.g. dioxins, gaseous lead).

The proposed e-waste management training Centres can adopt/adapt the outputs of this Training Manual and performing needs assessment to design and execute tailored District/Municipa l/ Metropolitan level training programmes.

4. Conclusion

E-waste workers operating at the Ashaiman and Agblogbloshie study sites are exposed to considerable health hazards, including carcinogenic fumes emanating from toxic polluta nts generated through the incineration of e-waste. This process releases harmful chemicals into the surrounding environment, posing a grave risk to those involved in the dismantling, collectio n, recycling, assembly, and repair of such materials. The level of awareness regarding health hazards was notably inadequate, with a sizable proportion of individ uals not availing themselves of regular health assessments at a prescribed medical facility. During the interview exploring participants' knowledge of their health status, it was revealed that e-waste processing activities present significant health hazards at the study sites, including processes such as dismantling, burning, and recycling.

The majority of participants report infrequent utilization of healthcare facilities. The prevalence of disease in individuals who lack personal protective equipment (PPE) in contaminated environments is exacerbated by poor use of PPEs. Some of the e-waste workers contract illness with some fatalities due to poor e-waste management practices.

Some individuals involved in the scavenging of electronic waste have engaged in acid bathing, as well as undertaking the dismantling of certain components to extract valuable substances such as gold, silver, tin and copper. Due to lack of awareness among e-waste facility managers regarding the potential health and implications associated with e-waste processing activities, many e-waste dealers have failed to prioritize the purchase of the full complement of safety equipment to effectively minimise, external exposure, internal exposure and chemical pollution hazards associated with their daily work.

It is expected that when the E-waste Bill is passed into law Government agencies and all stakeholders will work together to promote sound health and safety culture to govern the e-waste management activities in Ghana including the two study sites operations.

Compliance with ethical standards

Acknowledgments

Funding for this project was provided by Andrew Mellon Establishment scholarship plot,University of Ghana Legon (Grant /Project no G-31700720).

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Agyei-Mensah S, Oteng-Ababio M (2012) Perceptions of health and environmental impacts of e-waste management in Ghana. Int J Environ Health Res 22(6):500–517.

[2] Amoyaw-Osei Y, Opoku Agyekum O, Pwamang JA, Mueller E, Fasko R (2011) Ghana e-waste country assessment. United Nations Environment Programme (UNEP). http://ewasteguide. info/files/Amoyaw-Osei_2011_GreenAd-Empa.pdf.

[3] Asante KA, Agusa T, Biney CA, Agyekum WA, Bello M, Otsuka M, Itai T, Takahashi S, Tanabe S (2012) Multi-trace element levels and arsenic speciation in urine of e-waste recycling workers from Agbogbloshie, Accra in Ghana. Sci Total Environ 424:63–73

[4] Asante KA, Agusa T, Biney CA, Agyekum WA, Bello M, Otsuka M, Itai T, Takahashi S, TanabeS (2012) Multi-trace element levels and arsenic speciation in urine of e-waste recycling workers from Agbogbloshie, Accra in Ghana. Sci Total Environ 424:63–73

[5] Chira Frezzoli,Oris Eere Orisakwe ,Roberto Dogone and Aberto Mantovani. Diagnostic health risk assessment of electronic waste on the General population in developing Countries.Environmental Impact Assessment Review , 80(6):399-399 (2010)

[6] Chen, A., Dietrick, K.N., Huo, X., Ho, S.. (2011). Developmental neurotoxicants in e-waste: an emerging health concern. In Environ Health Perspective 119:431–438

[7] Darko R (2010) Electronic waste dumping on Ghana still continues. http://www.ghanaweb.com/ GhanaHomePage/features/artikel.php?ID=188950.

[8] Dodd, M., Amponsah, L.O., Grundy, S. et al. Human health risk associated with metal exposure at Agbogbloshie e-waste site and the surrounding neighbourhood in Accra, Ghana. Environ Geochem Health 45, 4515–4531 (2023). https://doi.org/10.1007/s10653-023-01503-0.

[9] EPA, LI 2250, Hazardous, Electronic and other wastes (classification) control and management regulations, 2016.

[10] International Organization for Standardisation (ISO) International Workshop Agreement (IWA) (2017), Guidance Principles for the Sustainable Management of Secondary Metals Secretariat of the Basel Convention (2012), E-waste Inspection and Enforcement Manual, available at http://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-EWASTE-MAMUAL-INSPEnforcement.English.pdf

[11] John A. Pwamang EPA (2013) . 3rd Annual Global E-Waste Management (GEM) Network Meeting, July 15th – 19th , 2013,California Government Policy and Initiatives on E-Waste in Ghana.

[12] Global E-Waste Monitor, 2020. Quantities, flows, and the circular economy potential. Hazardous and Electronic Waste Control and Management Act, 2016. Act 917.

[13] Koranteng SS, Darko DA (2011) The e-waste menace in Ghana. Information note: 000. Institute for Environment and Sanitation Studies, University of Ghana. http://www.ug.edu.gh/iess/post Senyo_e-waste_info-brief 5B15D.pdf.

[14] Katharina Lenz (DRZ – Demontage- und Recycling- Zentrum, Vienna, Austria)Richard Afoblikame (GIZ E-Waste Programme, Accra, Ghana) Susanne Yvonne Karcher (SAEWA – Southern African E-Waste Alliance,Cape Town, South Africa) ,Lawrence Kotoe (EPA – Environmental Protection Agency, Accra, Ghana), Mathias Schluep (WRF – World Resources Forum, St. Gallen, Switzerland)Elisabeth Smith (DRZ – Demontage- und Recycling- Zentrum, Vienna, Austria).Patricia Schröder (RECLITE – Waste Electrical and Electronic Equipment Recycling,Germiston, South Africa) Sonia Valdivia (WRF – World Resources Forum, St. Gallen, Switzerland) .E-waste Management Training Manual (2019).

[15] Magallini, F. (2018). Refrigerators production and end-of-life disposal. Internal report available at the Sustainable Recycling Industries programme.

[16] Oteng-Ababio M (2012) When Necessity Be gets Ingenuity: Scavenging for survival in Accra, Ghana. African Studies Quarterly, 13(1&2):1-22.http://www.africa:ufl.edu/asq/v13/v13i,l-2al.pd f assessed 10July 2023.

[17] Safaei, A., Symeonidis, A., Valdivia, S., Ottiger, F. (2018). Life Cycle Assessments of Selected Worst Practices in Secondary Metals Recovery and Recommendations to Move Towards Good Practices, available at https://www.sustainable-recycling.org/wp-content/uploads/2018/09/LCI- Worst-Practices_180831_.pdf accessed 16 July 2023

[18] Slovin Formula , 1960

[19] SPSS Version 20.0 (Levene's Test)

[20] Tusyoshi Kawakami. ILO, 2019 Action manual for improving health and Safety of E-waste workers.

[21] United Nations Environmental Programme, UNEP Annual Report 2007.

[22] Widmer, R., Oswald-Krapf, H., Sinha-Khetriwal, D., Schnellmann, M. and Boni, H. (2005). Global Perspective on E-waste. Environmental Impact Assessment Review. 25 (: 436– 458.