Assessment of the Health and Safety Culture at the E-Waste Facilities at the Greater Accra Metropolitan Area of Ghana.

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DOI: https://dx.doi.org/10.47772/IJRISS.2024.805040

31 March 2024; Revised: 19 April 2024; Accepted: 23 April 2024; Published: 31 May 2024

ABSTRACT

E-waste management remains a critical environmental and health issue, especially in developing regions like Ghana, where lax regulations and inadequate disposal methods exacerbate the risks associated with hazardous waste from discarded electronics. This research focuses on the e-waste management practices in the Greater Accra Region of Ghana, assessing the effectiveness of existing protocols at two e-waste management facilities and three recycling facilities. The study evaluates their compliance with both national and international health and environmental standards through a series of questionnaires targeting operational, health, and safety procedures. Our findings reveal significant gaps in health and safety policies, emergency preparedness, and quality management systems across these facilities, which can lead to serious health risks and environmental degradation. Despite the presence of regulatory frameworks, enforcement is weak, and practices are inconsistently applied, leading to substantial variations in the management of e-waste. The study highlights the profound disparities between the intended regulations under the Basel Convention and their practical implementation, particularly in developing countries. This research underscores the urgent need for comprehensive reforms in policy and practice to enhance health and safety, efficiency, and environmental sustainability of e-waste management in Ghana. Detailed analysis of current situation indicate that there are shortcomings in the area of health and safety policy and implementation framework; quality management system and emergency preparedness and response ,stakeholder engagement and regulatory oversight and enforcement . Recommendations provided are aimed at informing policymakers and e-waste management facilities intended to contribute towards the development of a robust management strategies that align with global standards and address local needs.

Keywords - safety culture, e-waste, health and safety policy, assessment; performance indicators;

INTRODUCTION

E-waste, comprising discarded electronic appliances, is one of the fastest-growing waste streams globally, driven by rapid technological advancement and ever-decreasing product lifecycles. Globally, the generation of e-waste is expected to reach 52.2 million metric tons by 2021, posing significant environmental and health challenges due to the hazardous materials they contain (Baldé et al., 2017). In developing countries,

the management of e-waste is particularly problematic due to inadequate regulatory frameworks, limited technological and financial resources, and insufficient public awareness about the dangers of improper e-waste disposal (Heacock et al., 2016).In Ghana, the situation mirrors these broader trends in developing countries, with e-waste management being a pressing issue. The country has become a dumping ground for

e-waste, primarily due to lax environmental regulations and the importation of second-hand electronics intended for reuse but often nearing the end of their useful life (Amoyaw-Osei et al., 2011). Urban areas like Accra and Kumasi see significant accumulations of e-waste, which are often burned openly or dismantled under unsafe conditions, releasing toxic substances such as lead, mercury, and cadmium into the environment, which pose severe health risks to local communities and the environment (Oteng-Ababio, 2012).Heacock et al. (2016) highlight that these substances can lead to severe health consequences including neurological damage, respiratory issues, and cancer, particularly under the unregulated and informal recycling operations prevalent in developing countries. Moreover, the environmental impact is profound as improper disposal techniques lead to significant soil, water, and air pollution, as detailed by Robinson (2009), who notes the harmful effects of toxic leachates and emissions from unsafely processed e-waste.

While e-waste presents substantial challenges, it also offers considerable economic opportunities through the recovery of valuable materials. Zeng et al. (2016) emphasize the potential for urban mining from e-waste, which is often more profitable than traditional mining due to the higher concentrations of precious metals found in electronic scrap. Despite these potential benefits, the disparity in e-waste management between developed and developing countries remains stark. Perkins et al. (2014) illustrate how developed nations employ stringent regulations and sophisticated technology to manage e-waste safely and efficiently, whereas less regulated environments struggle with inadequate systems that lead to public health crises and environmental degradation. The effectiveness of international regulations, such as those enforced under the Basel Convention, also varies, with Puckett et al. (2018) pointing out the challenges in enforcement that hinder the reduction of e-waste's negative impacts globally.Technological innovations in e-waste recycling are critical to mitigating these risks and enhancing the recovery of valuable materials. Wang et al. (2013) discuss new recycling technologies that promise safer and more efficient processing methods, crucial for reducing hazardous exposure. Global initiatives like the Solving the E-Waste Problem (StEP) Initiative play a pivotal role in fostering international collaboration, helping to share successful strategies and innovations across borders, as per Baldé et al. (2017). These collaborative efforts are essential for overcoming the complex challenges presented by e-waste.

Given the growing volumes of e-waste, its hazardous nature, and the disparities in management practices globally, there is a pressing need for further research to understand and improve e-waste recycling practices, especially in developing countries. Accordingly, the management of e-waste in Ghana not only calls for immediate attention due to these health and environmental risks but also offers an opportunity to improve resource efficiency and create economic value through the recovery of valuable materials. This research delved into the effectiveness of existing e-waste management practices at two e-waste management facilities and three recycling facilities in the Greater Accra Region of Ghana, examining their compliance with national and international environmental health and safety regulations and practices. Thisresearch identifies the gaps in health and safety policy and implementation framework what must be done to upgrade in existing situation Ghana aimed at contributing to the formulation of more effective regulations and health and safety practices in the e-waste management in the study area.

MATERIALS AND METHODS

Study Sites

The AgblogbloshieandAshaimanE-wastestudysites have been described fully in (Dogbatsey et al, 2023).

ISSNNo. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue V May 2024

The three registered e-waste recycling facilitiesin Ghana are:

Electro Recycling Ghana Ltd: Provides the following Services: E-Waste Recycling; Plastic Recycling: Battery Management; and Data Destruction ensuring that personal information is securely disposed of when electronic devices are discarded.

Neweco E-waste Recycling

Engages in e-waste recycling and the manufacturing of various materials, including Used Lead Acid Batteries, refined lead, lead alloys, lead products, Aluminium Alloys, Aluminium Scrap, and Plastic granules (PP, HDPE, ABS, and LDPE).

Agbogbloshie E-waste Recycling Centre:

Provides informal and improper recycling practices, leading to environmental and health challenges.

Health and Safety Culture Assessment

Safety culture of a practice is an assembly of characteristics and attitudes in individuals and organizations that gives priority to health and safety warranted by its significance. They are aimed at maintaining a self-disciplined approach to the enhancement of health and safety beyond legislative and regulatory requirements (IAEA, 1998). Some basic indicatorssuch as safety policy statement and management commitment to safety, safety practices at the facility with clear procedures and clear lines of communication, defined responsibilities, training of staff, emergency preparedness and response plan, procedures and the physical structure of the facility itself could be used to assess the safety culture of an organization(Faanu et al. ,2010)

A questionnaire was designed and administered to solicit for information in the following key performance areas:

- Availability and use health and safety policy document
- Health and Safety Programme
- Assignment of Responsibilities
- Lines of Authority and communication
- Procedures
- Education and training
- Quality Management System
- Emergency preparedness and response
- Record Keeping
- Staffing
- Authorization

Health and Safety Policy document andprogrammes

An organization pursuing activities with a bearing on Helath and safety makes its responsibilities well known and understood in a safety policy statement.This statement is provided as guidance to staff and to declare the organization's objectives and the public commitment of corporate management to health and safety.The policy document clearly defines individual roles and responsibilities for ensuring health and safety. The facility avoids issuing too many additional policies, which could weaken the clarity and importance of its health and safety policy.

Discharge of individual responsibilities is facilitated by unique and clear lines of authority.Roles and responsibilities are formally documented and signed by all individuals involved. Supervisors ensure that work on matters related to health and safety are carried out in a rigorous manner

Management ensures that their staff are fully competent for their dutiesthounginitialtraining and continuous training .There must commitmnet to health and saety at the policy level ,managers and individual levels. Every work done which has an impact on helath and safety must be done correctly, with alertness, with due throught,withfullknowledge and a proper sence of accountability.

Deatails of our findings are discussed in the results section

RESULTS

Table 1 shows the outputs of the questionnaire used for assessing the two e-waste management facilities.

Table 1: Outputs of the questionnaire for the two e-wate facilities

Assessment area	Questions	E-waste Facility	
		Agblogloshie Site	Ashaiman Site
Policy	Is there a policy document prescribing e-waste facility commitment to Health and safety?	No formal document exists	No formal document exists
Health and SafetyProgrammed	Is there a Health and Safety programmed in Place?	Not complete	Not complete
Assignment of Responsibilities	Are responsibilities of management,managersand individuals for safety well defined?	Yes	Yes
Procedures	Are procedures developed and used to ensure that activities are carried out safely?	Yes	No
Lines of Authority and communication	Are lines of authority and communications well defined?	Yes	Yes
Education and training	Are Staff adequately trained and retrained regularly?	Yes	Yes
Quality Management System	Is there an appropriate Quality Management system in place	No formal programmed Exists	No formal programmed Exists
Emergency preparedness and response	Has hazard assessment been done with appropriate emergency preparedness and response plan in place?	Not availble	Not available
Record Keeping	Is there a system of record keeping and preservation in place?	Yes	Yes
Staff	What is the number of staff working at the	Staffing	Staffing level

	Facility? Collectors Dismantlers Assemblers Repairers	level adeqaute for the workload	adeqaute for the workload
Authorization	Is the facility duly authorized to operate by the Regulatory Authority?	Yes ,by EPA of Ghana under Act 917 and LI2250	Yes ,by EPA of Ghana under Act 917 and LI 2250

Policy and Management Systems

This indicated very significant health and safety framework gaps, respectively, at the Agblogloshie and Ashaiman e-waste facilities, according to findings from policy and management systems assessments conducted. Specifically, neither of the facilities has an established policy document outlining in a formal manner the commitment to health and safety in their respective governance structures, hence raising a fundamental gap. The two sites also have not implemented an integrated Health and Safety programme, which is necessary for the management of safety risks and the assurance of compliance with health standards systemically. The lack of a formal Quality Management System in the two facilities, therefore, would mean non-standardization of procedures towards maintaining quality in operations that could have an effect on overall effectiveness and efficiency. This thus provides an indication that the two sites might not be well-prepared to handle some of the crucial challenges that might likely come as a health, safety, and quality measure and thus impacting their workers and the environment in general.

Operational Practices and Safety Procedures:

Roles and responsibilities of operational practice and safety procedures at Agblogloshie and Ashaiman are well laid down with proper lines of authority and communication. This kind of structured organizational framework has great importance to make sure all staff knows their roles and channels through which safety concerns and information get communicated. Though there is a lot of difference seen in the management of safety procedures on each site. Developed procedures at Agblogloshie are used with an active approach in ensuring that the activities are safely carried out. In contrast, Ashaiman does not have the same standard procedures developed and implemented there, which is, on its own, a signal of the weak point of operation safety in such an environment and further risk for accidents or procedure failures. This difference tends to imply that, although the structural organization is strong, the practical implementation of the safety measures at the sites is only fluctuating—a position that may pose some effects on the overall safety performance within the facilities.

Training and Staff Management:

A strong practice in the analysis of training and staff management was evident in the employee development and record management of the Agblogloshie and Ashaiman e-waste facilities. Training is one of the most emphasized areas in any of the named sites, and it is provided for their employees on a regular basis. This helps ensure high standards in the operation of the workplaces and the ever-changing developments in both workplace safety and environmental regulations allow for training to be re-emphasized or retaken if necessary. Besides, the two institutions maintain and conserve records in effectual systems critical in the tracing of outputs of operation and ensuring conformity with regulatory requirements. Further staffing levels at either site were reported to be sufficient to the workload, thereby indicating that the facilities are well equipped to meet their demands of operational requirements without overloading its personnel. These two elements together seem to create strong scaffolding, managing people and operations efficiently, reflecting resolve by the two organizations to hold a workforce competent enough and supportable.

ISSNNo. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue V May 2024

Regulatory Compliance and Emergency Preparedness and response :

Regulatory compliance and preparedness of the Agblogloshie and Ashaiman e-waste facilities provide a picture of mixed readiness and lack of preparedness in handling emergencies. Clearly, both facilities meet the national regulatory standards as both are duly authorized to operate by the Environmental Protection Agency of Ghana. However, the two sites significantly lag in the areas dealing with safety and crisis management, since none of them has been able to carry out a hazard assessment or laid down proper preparedness on emergencies and how they should be managed. This unpreparedness for eventual emergencies clearly threatens, apart from the safety of facility stuff and surrounding community and environment. The foregoing, therefore, the absence of these critical safety assessments and planning from overall strategies of risk management constitutes a gap that can bring about dire consequences in the occurrence of an emergency.

Table2 shows the outputs of the questionnaire used for the recycling facilities

Table 2: Outputs of the questionnaire for Recycling Facilities

Assessment Area	Questions	Electro Recycling Ghana Ltd	Neweco E-waste Recycling	Agbogbloshie E-waste Recycling Centre
Policy	Is there a policy document prescribing recycling facility commitment to Health and safety?	No formal document exists	No formal document exists	No formal document exists
Health and Safety Programmed	Is there a Health and Safety programmed in Place?	Yes	Yes	Yes
Assignment of Responsibilities	Are responsibilities of management,managersand individuals for safety well defined?	Yes	Yes	Yes
Procedures	Are procedures developed and used to ensure that activities are carried out safely?	Yes	Yes	Yes
Quality Management System	Is there an appropriate Quality Management system in place	No formal programmed Exists	No formal programmed Exists	No formal programmed Exists
Emergency preparedness and response	Has hazard assessment been done with appropriate emergency preparedness and response plan in place?	Not available	Not available	Not available
Record Keeping	Is there a system of record keeping and preservation in place?	Yes	Yes	Yes
Staff	What is the number of staff working at the Facility?	Staffing level adeqaute for the workload	Staffing level adeqaute for the workload	Staffing level adeqaute for the workload
Authorization	Is the facility duly authorized to operate by the Regulatory Authority?	EPA,under Act 917 and LI2250	EPA,under Act 917 and LI2250	EPA,under Act 917 and LI2250

Policy and Quality Management:

There is a significant gap in both policy and quality management across three recycling facilities: Electro Recycling Ghana Ltd, Neweco E-waste Recycling, and Agbogbloshie E-waste Recycling Centre. Notably, none of these facilities has a formal policy document to express a commitment to health and safety. This absence significantly hampers effective organizational governance and proactive measures to safeguard employee welfare. Additionally, the lack of a formalised Quality Management System (QMS) at these sites indicates their inability to maintain consistent quality standards, potentially leading to variability in service and operational inefficiencies. This situation urgently calls for structured quality control measures to enhance overall performance and compliance.

Health and Safety Program and Procedures:

All three facilities—Electro Recycling Ghana Ltd, Neweco E-waste Recycling, and Agbogbloshie E-waste Recycling Centre—are actively managing health and safety issues. They have established comprehensive Health and Safety programs that are fundamental to ensuring a hazard-free working environment. The responsibilities tied to safety are clearly defined for both management and staff, thereby enhancing accountability. The active development and implementation of safety procedures across all sites demonstrate a robust commitment to maintaining safe operational practices. These measures are crucial not only for minimising risks but also for ensuring the wellbeing of all employees, reflecting the organisations' serious commitment to health and safety standards.

Emergency Preparedness and response and Record Keeping:

Despite robust health and safety management practices, there is a notable deficiency in emergency preparedness and response across all facilities. They lack both developed emergency preparedness and response plans and hazard assessments, key components essential for effectively managing unforeseen events and emergencies. This significant gap poses risks to employee safety and threatens operational continuity during crises. However, a strong aspect of these facilities is their record-keeping practices. They maintain rigorous systems for preserving operational and safety records accurately and methodically, which is vital for monitoring performance, meeting regulatory requirements, and enhancing safety measures.

Staffing and Authorization:

Each facility—Electro Recycling Ghana Ltd, Neweco E-waste Recycling, and Agbogbloshie E-waste Recycling Centre—reports having adequate staffing levels to meet their operational demands. This balance is crucial not just for maintaining operational efficiency but also for upholding safety standards, as appropriate staffing levels reduce the risks of accidents and errors due to overwork or insufficient oversight. Moreover, all facilities have secured the necessary authorisation from the Environmental Protection Agency of Ghana, affirming their compliance with national environmental regulations. This authorisation ensures that the facilities adhere to prescribed standards and practices, contributing to sustainable environmental management and bolstering their legitimacy within the recycling industry.

Comparatively, the foundational governance at both the E-waste facilities (Agbogbloshie and Ashaiman sites) and the E-waste recycling facilities (Electro Recycling Ghana Ltd, Neweco E-waste Recycling, and Agbogbloshie E-waste Recycling Centre) shows significant shortcomings, primarily due to the absence of formal health and safety policy documents and Quality Management Systems. However, the recycling facilities exhibit more robust Health and Safety programs compared to the E-waste facilities, where such programs are not well developed. Despite well-defined safety responsibilities and procedures at all facilities, Ashaiman exhibits deficiencies in its safety procedures. A common vulnerability across all facilities is the lack of emergency preparedness and response plans, although they maintain strong record-keeping systems. Staffing levels are satisfactory, and all sites are duly authorised by the Environmental Protection Agency of

Ghana, ensuring compliance with national standards. This analysis highlights the urgent need for improved policy implementation and better emergency preparedness and planning to ensure worker wellbeing and environmental safety.

Stakeholders' Engagement

Globally sharing best practices from other regions helps improve health and safety culture. Effective stakeholder engagement is crucial for promoting and enforcing sound practices. In some countries government bodies play a central role in setting regulations, standards, and policies related to e-waste management.

Establishment of stakeholders forum can facilitate active participation of identifiable stakeholder to undertake the following activities ; ensuring compliance with health and safety guidelines; awereness creation on health for policy makers . Stakeholders should promote the proper use of personal protective equipment (PPEs) such as gloves, masks, and goggles and encourage regular health check-ups and surveillance programmes to ensure workers' well-being. Local communities around e-waste facilities should be made aware of the hazards they are exposed to and how to deal with the associated risks . Networking with international bodies involved in e-waste management can assit in adopting the best health and safety practices. They can also provide technical expertise, funding, and capacity –building support.

Our findings indicte that there is a significant gap in fulfilling the requirement for stakehonder involvement in e-waste management which needs immediate attention by the policy makers,regulatory authorities and Greater Accra Regional Metroplitan Assembly.

DISCUSSIONS

Policy and Management Systems:

The Agblogloshie and Ashaiman e-waste facilities demonstrate significant gaps in their health and safety frameworks, particularly the lack of formal policy documents, comprehensive health and safety programs, and standardized Quality Management Systems. These deficiencies compromise operational effectiveness and pose risks to worker welfare and environmental safety. This situation reflects broader issues identified in the literature, where e-waste facilities, especially in developing countries, often operate under inadequate regulatory oversight and lack standardized practices, leading to substantial health risks from exposure to hazardous substances such as lead, mercury, and cadmium (Grant et al., 2013; Lundgren, 2012; Robinson, 2009). The absence of structured health and safety policies and programs at these facilities leads to insufficient safety measures and poor management of hazards, potentially resulting in ineffective responses to accidents and environmental challenges (Heacock et al., 2016; Sepúlveda et al., 2010). Additionally, the lack of a formal Quality Management System may result in inconsistent processing standards and adverse environmental impacts (Kiddee et al., 2013). To enhance safety and sustainability in e-waste management, the literature advocates for the implementation of stringent regulations, comprehensive training for workers, and clear environmental and health safety guidelines (Borthakur and Govind, 2017). Addressing these critical deficiencies is essential for improving the safety and efficiency of e-waste recycling operations, particularly in less regulated environments.

Operational Practices and Safety Procedures:

The operational practices and safety procedures at the Agblogloshie and Ashaiman e-waste facilities highlight both strengths and notable inconsistencies, reflecting broader challenges within e-waste management, especially in developing countries. These challenges are often exacerbated by variable regulatory and operational oversight that can compromise both worker safety and environmental protection. The facilities have structured organizational frameworks with clearly defined roles and authority lines as

identified by Windapo & Oladinrin (2016), which are essential for effective health and safety practices. However, these frameworks are applied inconsistently. While Agblogloshie exhibits proactive risk management with well-developed and utilized safety procedures, Ashaiman falls short, lacking these rigorous practices, which leads to potential safety risks as supported by findings from Grant et al. (2013) and Lundgren (2012). This disparity highlights broader systemic issues, such as varying levels of training and management commitment. Without uniform enforcement of safety measures, the effectiveness of these organizational structures is significantly limited, as noted by Heacock et al. (2016). To mitigate these risks, literature by Sepúlveda et al. (2010) recommends not only establishing comprehensive health and safety policies but also ensuring their consistent application and increasing regulatory oversight to enhance safety across the industry.

Training and Staff Management:

The training and staff management practices at the Agblogloshie and Ashaiman e-waste facilities exemplify a strong commitment to employee development and operational efficiency, which is essential in handling the hazardous materials associated with e-waste recycling. Emphasizing effective training and retraining, these practices are crucial for minimizing the risk of workplace accidents and enhancing safety. Heacock et al. (2016) underscore the importance of regular training as a key strategy to mitigate health risks. Further supporting this approach, Kiddee, Naidu, and Wong (2013) highlight the necessity of continuous education to stay updated with the evolving industry standards. Moreover, maintaining adequate staffing levels, as observed at these facilities, helps prevent overwork and ensures safe operations, aligning with findings by Perkins et al. (2014), who note that sufficient staffing is associated with lower accident rates and improved worker health. Effective record-keeping at both facilities, as noted by Puckett et al. (2018), ensures regulatory compliance and aids in performance evaluation and ongoing improvement. Collectively, these practices demonstrate a dedication to operational excellence and adherence to safety and environmental regulations, which are vital for managing the risks associated with e-waste processing.

Regulatory Compliance and Emergency Preparedness and response :

The Agblogloshie and Ashaiman e-waste facilities are officially recognized for regulatory compliance, as evidenced by their authorization from the Environmental Protection Agency of Ghana. However, they exhibit significant deficiencies in safety and emergency preparedness, highlighting a prevalent issue in e-waste management in developing countries. Here, formal compliance does not necessarily translate into effective safety and emergency protocols. This gap between regulatory compliance and actual safety practices is concerning, especially considering the hazardous nature of e-waste materials such as lead, mercury, and cadmium, which pose substantial risks to both workers and nearby communities if mishandled or in the event of accidents. Research by Grant et al. (2013) and Lundgren (2012) emphasizes the need for comprehensive hazard assessments and emergency plans to adequately protect workers and the environment. The current lack of such measures is alarming and underscores the potential dangers, as discussed by Heacock et al. (2016). Kiddee, Naidu, and Wong (2013) further reinforce the importance of thorough hazard assessments and robust emergency plans for effective risk management and long-term health protection. Additionally, Puckett et al. (2018) document the severe consequences of inadequate emergency preparedness, illustrating the critical need for integrated safety measures that extend beyond mere compliance to ensure comprehensive environmental and human safety in e-waste management operations.

Policy and Quality Management:

The three e-waste recycling facilities reveal substantial gaps in policy formulation and quality management, reflecting broader challenges within the e-waste management industry, particularly in regions with underdeveloped regulatory frameworks. These facilities lack formal policy documents and Quality Management Systems (QMS), which are essential for setting clear health and safety guidelines and ensuring

operational consistency, as highlighted by Kiddee, Naidu, and Wong (2013). The absence of these policies can lead to inconsistent safety practices and heightened occupational hazards, as Pinto (2008) emphasizes. Furthermore, without a formal QMS, there are risks of operational inefficiencies and variability in product quality, which can cause financial and environmental damage (Zeng et al., 2016; Baldé et al., 2017). The literature supports the need for structured quality control measures and safety policies to enhance operational effectiveness and environmental compliance, thereby building a positive reputation and fostering trust with stakeholders and the community, a crucial aspect underscored by Grant et al. (2013). This synthesis aligns with existing research advocating for robust governance structures and quality management to ensure safety, efficiency, and compliance in e-waste recycling operations.

Health and Safety Program and Procedures:

The three e-waste recycling facilities demonstrate exemplary health and safety practices, characterized by structured Health and Safety programs, well-defined roles, and proactive safety procedures. These practices align with best practices in workplace safety, crucial for managing hazardous materials found in e-waste. Heacock et al. (2016) stress the importance of comprehensive health and safety programs in reducing exposure to hazardous substances. Lundgren (2012) highlights the significance of clarity in roles and responsibilities, which enhances compliance with safety protocols and effective implementation of safety measures, ensuring all employees are aware of their duties in maintaining a safe environment. Moreover, Perkins et al. (2014) show that the active and consistent application of developed safety procedures can significantly reduce workplace accidents and health issues, reinforcing a strong safety culture within the organization. Overall, these practices demonstrate a robust commitment to ensuring a safe working environment, crucial for protecting workers and maintaining operational efficiency and regulatory compliance in the challenging field of e-waste recycling.

Emergency Preparedness and Record Keeping:

The three e-waste recycling facilities—Electro Recycling Ghana Ltd, Neweco E-Waste Recycling, and Agbogbloshie E-Waste Recycling Centre—demonstrate strong record-keeping capabilities, essential for both safety and regulatory compliance. However, they significantly lack in emergency preparedness, a crucial aspect of safety management in the high-risk sector of e-waste recycling. This gap is a major oversight, as the absence of comprehensive hazard assessments and emergency plans undermines their ability to effectively handle incidents that could impact human health and operational stability. Salhofer et al. (2016) emphasize the importance of emergency preparedness in identifying potential threats and developing structured responses. This deficiency suggests that the facilities are ill-equipped to manage emergencies, potentially leading to uncontrolled hazardous incidents. Nevertheless, their proficient record-keeping practices, which facilitate the tracking and analysis of incidents for ongoing safety improvements as highlighted by Tibbetts (2005), lay a foundation for enhancing safety measures. This disparity underscores the need for an integrated safety management approach that incorporates both proactive and reactive strategies to ensure comprehensive safety and operational continuity.

Staffing and Authorization:

The operational practices of the three e-waste recycling facilities reflect a commitment to environmental regulation and appropriate staffing levels. Adequate staffing is essential for effective oversight and reducing accident rates, particularly in industries handling hazardous materials like e-waste, where precise management is crucial to minimize risks, as noted by Marquez and Blanchar (2009). Furthermore, compliance with national environmental standards, evidenced by authorization from the Environmental Protection Agency of Ghana, ensures that these facilities are reducing pollution and responsibly managing toxic substances, a crucial aspect underscored by Kiddee, Naidu, and Wong (2013). This compliance not only helps to mitigate environmental impact but also enhances the legitimacy and operational sustainability of the facilities, contributing to building trust within the community and among stakeholders, as discussed

by Perkins et al. (2014). These practices are not merely about fulfilling regulatory requirements but are strategic elements vital for the overall effectiveness and sustainability of the recycling operations, highlighting the integration of human resources management and environmental compliance in the e-waste recycling sector

The notable absence of formal health and safety policy documents at both e-waste management and recycling facilities highlights a significant governance gap. Formal policies are essential for establishing clear frameworks for action and accountability, crucial for ensuring safety and regulatory compliance as emphasized by Puckett et al. (2018). This gap is evident in the disparities between the health and safety programs of recycling facilities compared to e-waste facilities, which may reflect differences in program maturity influenced by organizational priorities or resource availability, as Townsend (2011) noted, comprehensive health and safety programs can significantly reduce workplace accidents and enhance compliance with environmental laws.

Additionally, the absence of Quality Management Systems (QMS), as noted by Zeng et al. (2016), is particularly problematic in hazardous waste management where such systems are vital for consistent quality and risk mitigation. The variability in safety procedures, especially the deficiencies at the Ashaiman site, and the overall lack of emergency preparedness across all facilities, underscore critical oversights that could lead to increased workplace injuries and environmental safety risks, aligning with the concerns raised by Grant et al. (2013) and Heacock et al. (2016) about the necessity of preparedness to prevent harm to human health and the environment.Despite these challenges, the strength in record-keeping practices across the facilities, crucial for tracking performance and incidents as highlighted by Kiddee, Naidu, & Wong (2013), enhances safety and operational efficiency. Finally, the authorization from the Environmental Protection Agency of Ghana across all sites confirms compliance with national standards, reinforcing the importance of regulatory engagement in maintaining safety and environmental stewardship.

In the context of enhancing e-waste management and recycling facilities in Ghana, it is vital to engage a broad range of stakeholders to ensure the successful implementation of recommended policies and practices. Key stakeholders include regulatory bodies, facility management, employees, and the local communities that might be impacted by e-waste operations. As Kiddee, Naidu, & Wong (2013) highlighted, the Environmental Protection Agency of Ghana plays a crucial role in enforcing compliance and should collaborate closely with facility managers to effectively implement new health, safety, and quality management policies. Additionally, as Townsend (2011) suggested, training programs need to be developed in partnership with educational institutions to boost employee competencies and ensure they adhere to safety standards. Engaging the community is equally important; communities must be informed and consulted on issues affecting their environment and health, fostering transparency and building trust. Perkins et al. (2014) noted that such engagement can enhance the legitimacy and sustainability of operations. This comprehensive approach to stakeholder engagement ensures that the policies are not only implemented but also supported by those affected, leading to more sustainable and effective e-waste management practices.

CONCLUSION

The assessments of e-waste management facilities in Agblogloshie, Ashaiman, and three other recycling centers in Ghana—Electro Recycling Ghana Ltd, Neweco E-waste Recycling, and Agbogbloshie E-waste Recycling Centre—reveal significant deficiencies in health and safety management. These gaps include a lack of formal health and safety policies, inadequate Quality Management Systems and insufficient emergency preparedness, which collectively compromise worker safety, community health, and environmental integrity. These issues highlight systemic problems prevalent in less regulated environments, particularly the inconsistency in the application of safety practices, with some sites like Agblogloshie showing better compliance than others. These findings underline a critical need for standardized safety

procedures, structured health and safety programs, and the formalization of quality management across all e-waste recycling operations. To effectively address these challenges, enhanced regulatory oversight by bodies such as the Environmental Protection Agency of Ghana is imperative, along with the implementation of robust management systems and ongoing staff training to ensure that e-waste management practices evolve in line with safety and environmental standards. This approach is essential not only for improving the immediate operational deficiencies but also for securing the long-term sustainability and efficiency of e-waste recycling in Ghana.

RECOMMENDATIONS FOR POLICY ACTION AND FUTURE RESEARCH

The conclusions from this study suggest several policy actions to improve operations and safety at the Agblogloshie and Ashaiman e-waste facilities in Ghana. Firstly, the Environmental Protection Agency (EPA) of Ghana should mandate the creation and enforcement of formal health and safety policies and programs, including regular audits and semi-annual training workshops in collaboration with international organizations to ensure worker safety and community health. Secondly, to tackle the issue of emergency preparedness, the Ministry of Environment, Science, Technology, and Innovation should develop comprehensive emergency response plans, including risk assessments and quarterly drills, in partnership with the Ghana National Fire Service and National Disaster Management Organization. Thirdly, the Ghana Standards Authority should implement and enforce Quality Management Systems like ISO 9001 to standardize and elevate product quality and operational efficiency. Lastly, the Labour Department should initiate ongoing training programs that adhere to national and international standards, enhancing worker skills and regulatory compliance through biannual educational sessions facilitated by certified professionals. These measures collectively aim to bolster safety, efficiency, and compliance at e-waste recycling facilities.

Following these conclusions, several recommendations for future studies are proposed, including conducting longitudinal studies to assess long-term health impacts on workers exposed to hazardous materials, investigating the effectiveness of implemented health and safety policies and quality management systems, and exploring technological innovations that reduce exposure to harmful substances. Additionally, comparative international studies are suggested to identify best practices across different regulatory environments, along with community impact assessments to evaluate environmental and health effects on surrounding areas. Studies on the effectiveness of emergency response plans and the cost-effectiveness of safety investments are also recommended to improve operational standards, enhance worker safety, and provide economic validation for safety protocols, aiming to foster a safer and more efficient e-waste management system.

ACKNOWLEDGEMENT

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

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