ASSESSMENT OF INFORMAL E-WASTE RECYCLING ACTIVITIES IN MINNA NIGER STATE, NIGERIA

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Abstract

Electronic waste (e-waste) has become a major concern in today's environment, especially in developing nations such as Nigeria, which has given rise to a new environmental challenge and health problems. The study adopted a mixed research design. The targeted population for the study was 428 respondents. True Non-probability sampling techniques, snowball and convenient sampling techniques were used to draw 40 Refurbishers, 40 Recyclers, 30 collectors and 68 Environmental Protection Agency (NISEPA) staff, 49 National Environmental Standard and Regulations Enforcement Agency (NESREA) staff, and 11 Federal Ministry of Environment (FME) staff in Minna metropolis. Structured questionnaire titled "Assessment of Informal E-waste Recycling and Refurbishing Activities" and structured interviews questions were used for data collection. The instrument was validated by three experts, One from Niger State Environmental Protection Agency, and other two from Department of Industrial and Technology Education, Federal University of Technology, Minna. Cronbach Alpha was used to ascertain the extent of the internal consistency of the instrument and a reliability coefficient of 0.82 was obtained for the entire instrument. Data collected was analyzed using statistical package for social science (SPSS version 21). Mean and standard deviation were used to answer the research questions, while One-way Analysis of Variance (ANOVA) was used to test the hypotheses at 0.05 level of significance. Post-hoc (Tukey Honesty Significant Difference, HSD) was used to test the difference for the rejected hypotheses at ($p<0.05$). The research question one shows that the mean of all the items were within 4.28 – 4.46 which is an indication that the activities are actively carried out in the study area while hypothesis one shows the analysis of f-ratio (1.584) and a significance criterion (sig) of 0.196 which is greater than p-value of 0.05. The study revealed among others that, E-waste are dismantled and disassembled to remove the valuable materials and the non-valuable materials are disposed improperly and burnt within the environment. There is lack of proper awareness of health hazards associating with E-waste equipment amongst the stakeholders involved. Also, techniques in handling and improving recycling and refurbishing e-waste are not adequately aware of. The study recommended among others, that enlightment and sensitization programme on the activities of e-wastes should be organized for e-waste collectors, recyclers; Regulatory Agency should ensure regular orientation and skill acquisition programme for the personnel involved in informal E-waste

sector on proper handling method, awareness of health hazards and techniques for improving recycling and refurbishing of e-waste. Government should also ensure that the personnel involved in informal e-waste sectors are registered with the Regulatory Agency to ensure proper monitoring of their activities in the State

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Keywords: E-waste, collection activities, Informal Recycling activities, Assessment

Introduction

Electronic waste (e-waste) is a major environmental concern, especially in developing countries like Nigeria, and it requires careful attention. E-Waste is defined as electrical and electronic equipment, along with all of its parts, that has failed to perform properly or that has functional flaws (Abdelbasir et al. 2018; Kumar et al., 2017). Cell phones, videocassette recorders, scanners, fax machines, printers, tablets, Digital Video Disc (DVD) players, microwaves, x-ray machines, and some scientific equipment are among the electrical and electronic trash included in this (Abdelbasir et al. 2018). Copper, precious metals (gold, silver, and palladium), and other recyclable materials are found in e-waste (such as, ferrous metals, plastics, rubbers, etc.). Effective recycling has significant economic value and can reduce the need for natural resources. Additionally, dangerous compounds or components like lead, mercury, and brominated flame retardants are found in e-waste. Ineffective treatment will result in the discharge of pollutants into the air, water, and/or soil, which poses a serious threat to the environment and the general public's health. E-waste must be appropriately removed from the environment and collected.

End-of-life (Eol) equipment is gathered from users and business locations through e-waste collecting efforts in order to be properly disposed of. There are several alternative configurations for collection systems, In developed nations, e-waste collection is planned to be collected at a location where consumers are required to turn in their outdated and damaged devices (Mihai et al. 2019). The extended producer responsibility plan (EPR) takes care of the product manufactured by the manufacturers, and users of Electrical and Electronic Equipment (EEE) are intended to return the Eol equipment to the manufacturers. However, in Nigeria and Niger State in particular, the informal method of collection is used. EEE are utilized in residential areas, where they are eventually discarded and gathered by scavengers before being transported to small and medium-sized scrap metal yards where they are manually disassembled, sorted, stored, and sold to dealers. Un-useful fractions are thrown away or burned. This practice pollutes the environment and exposes the collectors to several health risks. Niger State Environmental Protection Agency (NISEPA) is responsible for managing the collection of electronic trash and its proper segregation. Individuals looking for work also go about collecting end-of-life (EoL) appliances and other metallic objects from homes and settings. Collection of E-waste is considered as a preceding stage to the recycling and refurbishment operation (Garlapati, 2016).

Recycling is the process of converting waste materials that can no longer meet its intended purposes into new materials and objects. Recycling involves dismantling i.e. removal of different parts of e-waste containing valuable and dangerous substances.

Informal e-waste recycling on the other hand is typically characterized as being beyond the reach of official governance, unregulated, lacking structure, unregistered and illegal association practice in the society. Where technology and oversight are lacking, a number of problematic techniques are used to recover valuable materials; techniques that can result in the emission of large amounts of toxic organic pollutants and heavy metals, exposing the surrounding inhabitants and environment to harm (Liebmann, 2015). Such activities are referred to as informal recovery and its treatment activities are being driven by convenience and cost efficiency (Tanner *et al.*, 2015). Informal recycling activities involve recycling craft villages where metal, plastic and electronic scraps are processed (Tran & Salhofer, 2018). For Printed Circuit Board (PCB) treatment, it involves not only the gold and copper recovery but also exportation (or dispose) of other electronic components (such as capacitors, transistors) mainly to China. E-waste collection and recycling processes (which may include combustion) are a source of environmental exposure to a mixture of compounds of known toxicity, such as lead, mercury, cadmium, chromium, polychlorinated biphenyls (PCBs), brominated flame retardants and polycyclic aromatic hydrocarbons, as well as unintentional persistent contaminants, such as dioxins and furans, among others. These compounds results to pollution and also a risk to the environment and public health. The consequences of the current collection, disposal practices, recycling and refurbishing activities of e-waste in Nigeria particularly in Minna Niger State involves toxic materials being exposed that has adverse effects on personal, public health and environment needs assessment.

Assessment involves gathering information on the events, traits, and results of a program or issue in order to form opinions and enhance the program's effectiveness (Peersman, 2014). E-waste collection and recycling operations have become more dangerous as a result of inadequate education, lack of awareness, and improper application of environmental rules and regulations. based on this note that this study assessed informal E-waste recycling activities in Minna, metropolis Niger State.

Statement of the Problem

The quickening pace of technological improvement, e-waste generation is rising in our environment. The fact that there is so much abandoned electronic debris lying around our settings is proof of this. According to (Lu, et al., 2015), e-waste handling procedures like collection, recycling, and reduction are insufficient and ineffective, posing a serious risk to the environment and human health. The Niger State Environmental Protection Agency (NISEPA), which is in charge of managing e-waste, focuses all of its efforts on collecting and getting rid of solid garbage. The regulatory bodies' efforts appear to have little to no impact on the operations

and management of e-waste. Given the growing amount of e-waste in our environment and the activities of e-waste recycling and refurbishing, it is clear that the regulations governing e-waste are not being properly followed. The goal of this study is to evaluate the informal e-waste recycling activities in Niger State, Nigeria.

Research Questions

1. What are the activities in informal e-waste collection in Niger State, Nigeria?
2. What are the activities in informal e-waste recycling in Niger State, Nigeria?

Hypotheses

H_{01}: There is no significant difference in the mean responses of e-waste collectors, recycler, electronic refurbishers and regulatory agency on the activities in informal e-waste collection in Niger State, Nigeria.

H_{02}: There is no significant difference in the mean responses of e-waste recyclers, electronic refurbishers and regulatory agency on the activities in informal recycling of e-waste in Niger State, Nigeria.

METHODOLOGY

The study's research method was a mixed-methods approach. The study's geographic focus was Minna Metropolis, Niger State Nigeria. The target population used for this study comprises of 428 subjects which includes Electronic collectors, Electronic Refurbishers, Electronic recycler, and Regulatory bodies. Snowball sampling was used to select 30 e-waste collectors, 40 Electronic Recyclers, 40 Electronic Refurbishers from the Association of Repairers in Minna metropolis, and 97 regulatory staffs which would be gotten from the nominal roll of the various establishment; 50 from Niger State Environmental Protection Agency (NISEPA), 7 from Federal Ministry of Environment (FME), and 40 from National Environmental Standard and Regulations Enforcement Agency (NESREA) in Minna. A simple random sampling was used to draw 80% of the entire population for this study which totals 166 respondents to respond to the questionnaire items, while a total of 41 persons which represent 20% of the entire sample size for the study will be interviewed. A structured questionnaire and interview validated by three experts from Federal University of Technology Minna, reliability coefficient of 0.82 was obtained using Cronbach Alfa. Statistical package for social sciences was used for data analysis (SPSS version 21). Mean and Standard deviation were used to answer the research questions. Analysis of Variance (ANOVA) was used to present null Hypotheses at 0.05 level of significance.

Results

Research Question 1

What are the activities in informal e-waste collection in Minna metropolis, Niger State?

Table 2: Below represents the Mean and Standard Deviation of Respondents on the activities in informal e-waste collection in Minna, Niger State.
N1=20, N2=30, N3=30, N4=156

S/N	ITEM	ELECTRONIC		ELCETRONIC		E-WASTE		REGULATORY AGENCY		AVERAGES		REMARK
		REFURBISHERS		**RECYCLERS**		**COLLECTORS**						
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	
1	The collection of e-waste in the informal sector is done by informal collectors also known as scavengers	4.3	0.53	4.37	0.49	4.5	0.51	4.51	0.5	4.44	0.51	Agreed
2	The scavengers normally operates door-to-door collection of e-waste	4.13	0.57	4.3	0.53	4.65	0.49	4.29	0.69	4.31	0.63	Agreed
3	The scavengers purchase obsolete EEE from private, corporate and institutional consumers at relatively low prices and bring them to the scrap yard	4.17	0.59	4.3	0.53	4.7	0.47	4.38	0.59	4.37	0.58	Agreed
4	Informal Collectors sometimes travel long distances and also sift through waste bins, visit landfills for waste collection	4.13	0.73	4.53	0.57	4.75	0.44	4.3	0.92	4.37	0.80	Agreed
5	Informal collectors of e-waste are mostly seen moving around with a pushcart and sacks.	4.33	0.66	4.6	0.5	4.7	0.47	4.32	0.84	4.42	0.72	Agreed
	Collectors engage in e-waste											Agreed

6	dismantling and metal recovery like cable burning.	4.2	0.66	4.5	0.57	4.55	0.51	4.45	0.5	4.42	0.56	
7	Informal collector uses crude method of separating e-waste equipment.	4.23	0.77	4.37	0.61	4.5	0.61	4.47	0.53	4.41	0.61	Agreed
8	Informal collectors do not pay anything for these items as they find them dumped at street corners and even at the dumpsites	3.93	0.78	4.27	0.64	4.45	0.51	4.37	0.73	4.28	0.71	Agreed
9	Collection of e-waste is undertaken with the most rudimentary technologies without the fear of health hazard.	4.13	0.51	4.2	0.71	4.55	0.6	4.51	0.68	4.38	0.67	Agreed
10	All e-waste collections done are brought to the scrap yard	4.3	0.6	4.33	0.61	4.55	0.6	4.43	0.6	4.40	0.60	Agreed
11	Scavengers also engages in selling of valuable recovered materials	4.27	0.64	4.37	0.61	4.65	0.59	4.51	0.64	4.46	0.64	Agreed
12	Scavengers also visit waste dumping grounds for e-waste collection	4.00	0.53	4.53	0.63	4.6	0.6	4.45	0.87	4.40	0.76	Agreed

KEY: SD = Standard Deviation, EEE= Electrical Electronic Equipment.

Result in Table 2 showed that the mean of all the items were within 4.28 – 4.46 which is an indication that the activities are actively carried out in the study area. The standard deviation values for the 12 items in Table 4.1 ranges from 0.51 - 0.80, which indicates that the responses of the respondents are not far from one another. The implication of this is that the respondents

have similar opinion on the collection activities in Minna metropolis, Niger State. The closeness of the responses added valve to the reliability of the mean. Hence, the mean of all the respondents signify that all respondents agreed with the collection activities of informal e-waste in Minna Niger State.

Interview conducted with collectors and regulatory agency based on collection activities shows that collection of e-waste is actively practiced and if not done, it makes our environments use air and pose threat to human existence. Some of the activities include; door to door collection of e-waste, picking of e-waste materials from dumpsite, separation of e-waste from other waste, purchase of obsolete Electrical/Electronic Equipment, dismantling e-waste to recover useful material, Selling of valuable recovered materials. Meanwhile, the more reason why the scavengers are actively involved is to earn a living.

Research Question 2

What are the activities in informal e-waste recycling in Minna metropolis, Niger State?

Table 3: Below shows the Mean and Standard Deviation of Respondents on the activities in informal e-waste recycling in Minna, Niger State N1=20, N2=30, N3=30, N4=156

S/N	ITEMS	ELECTRONIC REFURBISHERS		ELCETRONIC RECYCLERS		E-WASTE COLLECTORS		REGULATORY AGENCY		AVERAGES		REMARK
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1.	Recyclers in informal sectors disassemble obsolete e-waste to recover metals, such as aluminium, copper and steel.	4.23	0.57	4.63	0.49	4.25	0.44	4.64	0.51	4.51	0.54	Strongly Agreed
2.	Recyclers in informal sector shred e-waste into separate recyclable material such as plastic and metals	4.23	0.77	4.53	0.57	4.00	0.00	4.49	0.60	4.38	0.62	Agreed
3.	Recyclers produce quite a significant amount of wastes, as the devices contain many fractions that are of no economic value	4.00	0.74	4.37	0.56	3.90	0.45	4.36	0.96	4.23	0.82	Agreed
4.	Recyclers make use of primitive tools in dismantling obsolete electrical electronics equipment to retrieve valuable elements	4.17	0.83	4.43	0.63	4.00	0.56	4.49	0.58	4.35	0.66	Agreed
5.	Recycler uses open-pit acid baths to recover valuable metals	4.03	1.00	4.40	0.56	3.90	0.55	4.46	066	4.29	0.74	Agreed
6.	Separations of dismantled device into different fractions and units.	3.90	0.71	4.27	0.58	3.55	0.76	4.45	0.64	4.19	0.73	Agreed
7.	Treatment of e-waste materials to reduce plastic content	4.10	0.71	4.37	0.72	3.70	0.98	4.51	0.60	4.30	0.75	Agreed
8.	Recyclers also engage in the open incineration of cables and other plastic parts in order to remove copper and other metals.	4.00	0.87	4.20	0.81	3.65	0.88	4.49	0.64	4.23	0.80	Agreed
9.	Open burning of unwanted material and cables to access internal copper wires	3.80	0.71	4.27	0.64	3.60	0.99	4.58	0.52	4.24	0.76	Agreed

10.	Fractions are usually disposed of or burned in an uncontrolled manner in or around recycling clusters.	3.90	0.80	4.27	0.52	3.60	0.88	4.54	0.53	4.24	0.72	Agreed
11.	Sorting of the useful components from the dismantled e-waste devices and disposal of the non-valuables into riverbanks	4.10	0.71	4.23	0.63	3.25	1.25	4.47	0.70	4.20	0.87	Agreed
12.	Removal of toxic content from the disassembled e-waste equipments	4.10	0.76	4.17	0.65	3.40	1.19	4.39	0.61	4.17	0.80	Agreed
13.	Informal recyclers also engage in the activities of reselling the valuable disassembled components	4.07	074	4.23	0.68	3.35	1.09	4.50	053	4.23	0.78	Agreed

Table 3, showed the analysis of the responses of respondents on the activities of informal e-waste recycling in Minna. The mean score lies between 4.17 – 4.51. Also, the standard deviation ranges from 0.54 - 0.87. The closeness of the responses adds value to the reliability of the mean, which mean that the informal e-waste recycling activities are actively done. Meanwhile, the mean of all the respondents also signify that respondents agreed with the activities involved in e-waste recycling in Minna Niger State.

From the interview conducted with recyclers and the regulatory bodies showed that the recycling activities is carried out in Minna to reduce the e-waste in the environment and also dismantled e-waste into different categories, remove and sale the valuable materials. Some of the activities carried out are: disassemble obsolete e-waste to recover metals, such as aluminium, copper and steel, dump unwanted materials in fields and riverbanks. Recyclers also fixed the price of the recovery material, and also sold the recovery materials to the traders.

Hypothesis

H_{01}: There is no significant difference in the mean responses of E-waste collectors, Electronic recycler, electronic refurbishers and Regulatory agency on the activities in informal e-waste collection in Niger State, Nigeria.

Table 4: Below Shows the Analysis of variance of the mean responses of Respondents on the activities in informal e-waste collection in Minna, Niger State.

	Sum of Squares	df	Mean Square	F	Sig.	Remark
Between Groups	1.227	3	.409	1.584	.196	Accepted
Within Groups	39.254	152	.258			
Total	40.481	155				

The table 4 show the one-way between groups analysis of variance that was conducted for the mean responses of Regulatory Agency, Electronic refurbishers, Electronic recyclers, E-waste collectors as regards E-waste collection activities in Minna, Niger State. The result of the analysis showed an f-ratio of 1.584 and a significance criterion (sig) of 0.196 which is greater than p-value of 0.05. Therefore the null hypothesis was accepted. Hence, there is no significant difference in the mean response of Regulatory Agency, Electronic refurbishers, Electronic recyclers, E-waste collectors as regards informal E-waste collection activities in Minna, Niger State.

H_{02}: There is no significance difference in the mean responses of e-waste recyclers, electronic refurbishers and Regulatory Agency on the activities in informal recycling of e-waste in Niger State, Nigeria.

Table 5: Below Shows the Analysis of variance of the mean responses of Respondents on the activities in informal recycling of e-waste in Minna, Niger State.

	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between Groups	5.483	3	1.828	7.035	.000	Rejected
Within Groups	39.491	152	.260			
Total	44.974	155				

The table 5 shows the one-way analysis of variance between groups that was conducted for the mean responses of Regulatory Agency, Electronic refurbishers, Electronic recyclers, as regards informal E-waste recycling activities in Minna, Niger State. The result of the analysis showed an f-ratio of 7.035 and a significance criterion (sig) of0.000 which is less than p-value of 0.05. Therefore the null hypothesis was rejected. Hence, there is significant difference in the mean response of Regulatory Agency, Electronic refurbishers, Electronic Recyclers as regards informal E-waste recycling activities in Minna, Niger State. See Table 6 on Post-hoc comment.

Table 6: Below Shows the Post-hoc comparisons using Tukey HSD test on the difference of Respondents as regards informal E-waste recycling activities in Minna, Niger State.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
ELECTRONIC REFURBISHERS	ELECTRONIC REFURBISHERS	-.40000*	13161	.015	-.7419	-.0581
	E-WASTE COLLECTORS	-.01667	14714	.999	-.3989	.3656
	REGULATORY AGENCY	-.41140*	10990	.001	-.6969	-.1259
ELECTRONIC RECYCLERS	ELECTRONIC REFURBISHERS	.40000*	13161	.015	.0581	.7419
	E-WASTE COLLECTORS	.38333*	14714	.049	.0011	.7656
	REGULATORY AGENCY	-.01140	10990	1.000	-.2969	.2741
E-WASTE COLLECTORS	ELECTRONIC REFURBISHERS	.01667	14714	.999	-.3656	.3989
	ELECTRONIC RECYCLERS	-.38333*	14714	.049	-.7656	-.0011
	REGULATORY AGENCY	-.39474*	12810	.013	-.7275	-.0620
REGULATORY AGENCY	ELECTRONIC REFURBISHERS	.41140*	10990	.001	.1259	.6969
	ELECTRONIC RECYCLERS	.01140	10990	1.000	-.2741	.2969
	E-WASTE COLLECTORS	.39474*	12810	.013	.0620	.7275

*. The mean difference is significant at the 0.05 level.

Table 6 shows the result of Post-hoc comparisons using the Tukey HSD test on the difference in the mean responses of Regulatory Agency, Electronic refurbishers, Electronic recyclers as regards informal E-waste recycling activities in Minna, Niger State. The results indicated that the mean response for regulatory agency (whose mean difference was -.41140, and asignificance criterion (sig) of 0.001) was significantly different from the mean response for recyclers (whose mean difference was -.40000with sig of0.015). Also, the mean responses for the refurbisher differ significantly with mean responses of 0.40000 with sig of 0.015 to that of regulatory agency whose mean difference is -0.01140 with sig of 1.000.

DISCUSSION OF FINDINGS

Findings on research question one reveals the E-waste are collected by the collectors (scavengers) which are separated from other waste at the point of collection before disposal, these findings are in lines with the findings by Jackson (2018) who reported that recovery of metals and other perceived working parts such as memory chips, integrated Circuit (IC), Aluminum, Copper and Steels, from obsolete EEE needs to undergo dismantling and separation and the extracted materials are then sold to traders. The informal waste collectors (scavengers) move around the metropolis and pick the Eol equipments with either their sack or pushcarts. Most scavengers are able to purchase such e-waste from companies or individual households for tiny sums of money. The amount of rubbish that can be delivered to dumpsites each day is thus limited by the lack of vehicles utilized for waste transportation. The findings also showed that waste is collected every day and that waste collection facilities are located adjacent to commercial and government buildings as well as residential areas.. The findings goes in line with the report by Ndidi & Emmanuel (2018) cited Oteng-Ababio (2012) stated that despite the effectiveness of the formal sector, the informal sector operators dominate the e-waste sector and have very strong active networks, employ very cheap labour and are able to access areas, communities and door to door collection of e-waste. This statement is true because the waste collectors are everywhere on the street picking the waste without much control by any regulatory body. The result of the analysis in hypothesis 1 showed that there was no significant difference in the mean responses of E-waste regulators, Electronics repairers, Electronic recyclers, Electronic collectors as regards E-waste collection activities in Minna, Niger State. The non-differences in their opinions may likely be because legislation governing E-waste are not made within their reach.

Additionally, interaction with scavengers and regulatory agencies through interviews based on collection operations implemented in Minna metropolis demonstrates that collection activities are carried out routinely and every day and, if not done, constitute a threat to the environment and human health. "Collection operations are carried out on a regular basis, that they walk out to the household and street to pick up trash equipments," one of the scavengers stated. Door-to-door rubbish collection, buying outdated equipment, traveling far distances while also sorting through waste bins, and visiting landfills for waste collection are a few of the activities. (Interview with a Collector/Scavenger, May 5, 2021). In the same manner, interview with collectors/Scavengers revealed similar result. One of the Scavengers said: “Collection activities is done on regularly every day. Some of the activities carried out include: buying of e-waste for small amounts of money from businesses or private households, sift through waste bins, visit waste dumping grounds for e-waste, move around with a Pushcart and sacks for collection,

separation of e-waste equipment into different categories, e-waste collected are brought to the scrap yard for sale. (Scavenger Interview, May 05, 2021)"

The findings on the informal E-waste recycling activities in Minna metropolis Niger State revealed that E-waste is dismantled, disassembled and separated into different units after collection resulting in recoveryof fractions that are more valuable. This is in agreement with Gangwar*et al*., (2019) who reported that Recyclers disassemble obsolete e-waste to recover metals, such as aluminium, copper and steel. While some recyclers are specialized on e-waste recycling, others engage in the recycling of various types of metal-containing wastes in parallel. Some recyclers also engage in the open incineration of cables, acid baths and other plastic parts in order to liberate copper and other metals. Some informal recyclers may focus specifically on e-waste alone, others engage in recycling wastes containing all types of metals. Nnorom & Odeyingbo (2020) also argued that recyclable and reusable components such as the Printed wiring boards (PWBs) are separated, collected, and sold to traders. Recyclers are also active in the collection of waste components and lead solder, and then dip the stripped boards in acid baths to remove gold and copper. The residual toxic solution may then be dumped in surrounding areas. Uchida (2018) also observed informal treatment method performed is to burn the plastic coating from metal components such as PVC wires, to recover the valuable metal content, resulting in a harmful release of toxic dioxins and furans. The release of persistent organic pollutants and toxic metals causes serious and irreparable damage to the surrounding environment and inhabitants.

Based on an interview about e-waste recycling efforts in the unorganized sector, it is evident that valuable materials are recovered by disassembling and dismantling electrical and electronic equipment. Recycling efforts are made to lessen the amount of electronic trash that is harmful to both the environment and people. On May 14, 2021, regulatory bodies 1 were contacted. They stated that "In the recycling of e-waste in the informal sector, Electrical Electronic Equipments are dismantled and separated into different categories with rudimentary tools, without the use of PPE therefore subjecting themselves to health hazards.

Recyclers interviewed also contributed that recycling activities are done for the purpose of reducing the e-waste in the environment, and also to earn a living. Another recycler said "Recycling activities is done with the sole aim of earning a living and e-waste equipments are dismantle into fragments with tools like, hammer, pliers, screwdriver and dump unwanted materials in fields and riverbanks (May 05, 2021). One of the recycler further said:

Obsolete electrical and electronic equipment is recycled by disassembling it into its component parts, which are then sold to merchants who in turn sell them to manufacturers for the creation of new products. He added that the tools used for the tasks were a hammer, pliers, and screwdriver. Additionally, they faced difficulties including striking themselves with hammers while attempting to disassemble equipment, as well as fatigue (Recycler, May 05, 2021).

CONCLUSION

The global volume of electronic waste has increased significantly as a result of technological development, which indirectly endangers the environment and our health. Best handling techniques and reducing E-waste dangers have been attempted on numerous occasions, but without success. The informal e-waste recycling activities in Minna, Niger State, are the focus

of this study. According to the report, Niger State does not appropriately collect or treat e-waste.

RECOMMENDATIONS

The following recommendations were made based on the findings of the study:

1. Environmental protection organizations should make sure that E-waste is separated at the point of collection and that it is collected every day. Waste collection facilities should also be placed strategically throughout the environment.
2. Environmental agencies should organize regular enlightment and sensitization programme for the personnel involved in E-waste.

REFERENCES

Abdelbasir, S. M., Hassan, S. S., Kamel, A. H., & El-Nasr, R. S. (2018). Status of electronic waste recycling techniques: a review. *Environmental Science and Pollution Research*, *25*(17), 16533-16547.

Gangwar, C., Choudhari, R., Chauhan, A., Kumar, A., Singh, A., & Tripathi, A. (2019). Assessment of air pollution caused by illegal e-waste burning to evaluate the human health risk. *Environment international*, *125*, 191-199.

Garlapati, V. K. (2016). E-waste in India and developed countries: Management, recycling, business and biotechnological initiatives. *Renewable and Sustainable Energy Reviews*, *54*, 874-881.

Jackson, G. (2018). *Consumer Electronic Waste: Multiple-case Study of Environmental and Social Attitudes towards Recycling & Refurbishment* (Doctoral dissertation, Northcentral University).

Kumar, A., Holuszko, M., & Espinosa, D. C. R. (2017). E-waste: An overview on generation, collection, legislation and recycling practices. *Resources, Conservation and Recycling*, *122*, 32-42.

Liebmann, A. (2015). ICT Waste Handling: Regional and Global End-of-Life Treatment Scenarios for ICT Equipment.

Lu, C., Zhang, L., Zhong, Y., Ren, W., Tobias, M., Mu, Z., &Xue, B. (2015). An overview of e-waste management in China. *Journal of Material Cycles and Waste Management*, *17*(1), 1-12.

Mihai, F. C., Gnoni, M. G., Meidiana, C., Ezeah, C., & Elia, V. (2019). waste electrical and electronic equipment (WEEE): flows, quantities, and management- a global scenario. In *Electronic waste management and treatment technology,* (1-34). Butterworth-Heinemann.

Ndidi, O. M. & Emmanuel, R. (2018). Assessment of e-waste collection and disposal activities in government agencies, business and residential areas in Minna Metropolis, Niger State. *AU-eJournal of Interdisciplinary Research*, (ISSN: 2408-1906), 3(2).

Nnorom, I. C., &Odeyingbo, O. A. (2020). Electronic waste management practices in Nigeria. In *Handbook of Electronic Waste Management* (pp. 323-354). Butterworth-Heinemann.

Peersman, G. (2014). *Overview: Data collection and analysis methods in impact evaluation*. UNICEF Office of Research-Innocenti.

Tanner, T., Surminski, S., Wilkinson, E., Reid, R., Rentschler, J., & Rajput, S. (2015). The triple dividend of resilience: realising development goals through the multiple benefits of disaster risk management.

Tran, C. D., & Salhofer, S. P. (2018). Processes in informal end-processing of e-waste generated from personal computers in Vietnam. *Journal of Material Cycles and Waste Management*, *20*(2), 1154-1178.

Uchida, N., Matsukami, H., Someya, M., Tue, N. M., Viet, P. H., Takahashi, S., & Suzuki, G. (2018). Hazardous metals emissions from e-waste-processing sites in a village in northern Vietnam. *Emerging Contaminants*, *4*(1), 11-21.