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Assessment of Informal E-Waste Refurbishing Activities in Niger State, Nigeria

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Abstract

Electronic waste (e-waste) has become a growing concern in today's environment, particularly in developing countries like Nigeria, which has given rise to a new environmental challenge and health problems. This study assessed the activities of informal E-waste refurbishing in Minna, metropolis, Niger State. The study adopted a mixed method research design. The targeted population for the study was 428 respondents. True Non-probability sampling techniques, snowball and convenient sampling sampling techniques was used to draw 40 EEE Repairers/Refurbishers, 40 EEE local Recyclers, 30 collectors and 79 regulators taken from (NISEPA 50, NESREA 40, FME 7) in Minna metropolis Niger State. Structured questionnaire items and structured interviews questions were used for data collection. The instrument was validated by three experts and 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 was collected and analyzed using statistical package for social science (SPSS version 21). Mean and standard deviation were used to answer the research questions, while ANOVA was used to test the hypotheses at 0.05 level of significant. The study found that E-waste is discarded indiscriminately along streets, those that generate E-waste are liable for disposal, and E-waste refurbishing activities are carried out

without the use of personal protective equipment. E-waste is dismantled and disassembled to extract valuable materials, while non-value materials are inappropriately disposed of and burned in the environment. The study recommended, among others, that that residents and e-waste workers should be enlightened and sensitized on how to handle e-waste; the government should set up an effective monitoring system for proper e-waste handling in Niger State, Nigeria.

Keywords: *E-waste, collection activities, Refurbishing activities, Techniques for improvement, Assessment*

Introduction

Electronic waste (e-waste) has become a growing concern in today's environment, particularly in developing nations such as Nigeria which needs proper attention. E-Waste is define as an electrical and electronic equipment, including all its components, which has stopped working or suffered from functional defects during its production (Abdelbasir *et al.* 2018; Kumar *et al.*, 2017).These include electrical and electronic scrap of several equipment such as cell phones, videocassette recorders, scanners, faxes, printers, tablets, Digital Video Disc (DVD) players, microwaves, x-ray machines, and some scientific equipment (Abdelbasir *et al.* 2018). E-waste contain valuable materials, including copper, precious metals (gold, silver, palladium), and other recyclable materials (such as, ferrous metals, plastics, rubbers, etc.). Effective recycling is of great economic value and can offset the consumption of natural resources. E-waste also contains hazardous components or materials, for example, lead, mercury and brominated flame retardants. Inappropriate treatment will lead to emission of pollutants to the air, water and/or soil, posing great risk for environment and the public health. There is need for E-waste to be properly collected from the environments.

E-waste collection activities is the way End of Life (Eol) equipment are collected from the users and business areas for proper disposal. There are various possible ways of organizing collection systems, In developed countries, e-waste collection is organized to be collected at a point, where consumers are obliged to hand

in their obsolete and damaged devices (Mihai *et al.* 2019), the extended producer responsibility plan takes care of the product manufactured by the manufacturers, the users of Electrical and Electronic Equipment's (EEE) are meant to return the Eol equipment to the manufacturers, but in Nigeria and Niger State in particular the informal method of collection of E-waste is still in operation. At the residential areas EEE are being used and at the end of their life cycle are discarded and collected by the scavengers and finally brought to small and medium-sized scrap metal yards, where they are manually dismantled, sorted, stored and sold to traders. Fractions without value are discarded or burned. This practice exposes the collectors to a lot of health hazard and causes environmental pollution. Collection of e-waste and its proper segregation is a huge task and Niger State Environmental Protection Agency (NISEPA) is in charge of handling this great task, also individuals seeking for livelihood go about to pick End of life (Eol) gargets and other metallic objects from homes and environments. Collection of E-waste is considered as a preceding stage to the recycling and refurbishment operation (Garlapati, 2016). 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. Informal recycling activities involve recycling craft villages where metal, plastic and electronic scraps are processed (Tran & Salhofer, 2018).

Refurbishing is the act of repairing and rebuilding of old and/or non-functioning electronic devices; turning them into second-hand and functioning equipment either by replacing or repairing defective components. It also involves performing cleaning and repair activities in defective products in order to make the second hand equipment appealing to the customers. The actual benefits to the consumer in the new-for-old exchange practice are notional once seen commercially (Ari, 2016). In addition to refurbishing and repair activities/operations, most refurbishers also engage in marketing and sales of the refurbished products. For the scope of this study, this activity is included in the profile of refurbishers. Each refurbisher typically focuses on a distinct group of products such as cooling and freezing equipment, air-conditioners, small household equipment, TVs, computers or mobile phones (Osibanjo *et al*., 2016). Refurbishing has a significant contribution to play in the End–of-Life (EOL) management of Electronic Waste (E-waste) (Pathak *et al*., 2017). E-waste management consists of the effective and proper recovery of all reusable

materials from WEEE and the safe disposal of the hazardous and toxic substances in them to prevent their contamination of the environment (Ilankoon *et al*., 2018).There is therefore need for E-waste proper collection, handling practices and techniques for refurbishing activities.

The common refurbishing practices and techniques are Avoidance, reduction, Reuse and repair. However, the most practicable option for e-waste refurbishing technique in the recent time is the re-use and repair method. Avoidance is the first of the waste management method which is the absence of waste. Avoiding the production, consumption, and disposal of devices all together, for example through technological developments making a device obsolete, eliminates the use of rare resources and exposure to harmful waste flows. Reduction is similar to avoidance, limiting the volume of waste generated is the next most effective option toward lowering environmental and/or human health impacts from end-of-life treatment. Reuse and repair gives a further reduction of environmental and human health impacts is the reuse of products. As it relates to consumption of raw materials and energy, Cooper & Gutowski (2017) discuss that the demand for virgin materials decreases by a third with a substantial secondhand market, and the energy used throughout the useful life of a computer is just one quarter of what is required to manufacture the computer. Choosing to re-circulate a used product back into the market extends its lifetime and decreases volume of problematic waste generated. Repair, included in the category of reuse, is the replacement or fixing of a broken component, bringing a device back to working order for further use. E-waste handling processes and refurbishing techniques (which may include combustion, Replacement) 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, handling practice 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 is also the process of collecting facts about the happenings, characteristics and outcomes of a programme or issue in order to make judgment, improve the effectiveness of the program (Peersman, 2014).

Inadequate enlightment, awareness and also Lack of proper implementation of the laws and regulations for environmental legislations especially in E-waste have made collections and refurbishing activities of E-waste more hazardous. Based on this note that this study assessed informal E-waste recycling and refurbishing activities in Minna, metropolis Niger State.

Statement of the Problem

E-waste generation is on the increase in our environment due to the rapid advancement in technologies. The fact of this is proved with lots of discarded E-waste being littered around our environments. E-waste handling practices such as collection, recycling, refurbishing and minimization according to (Lu, *et al*., 2015) are inadequate and inefficient, and hence pose a huge risk on human health and environment. Niger State environmental protection agency (NISEPA) is charged with the responsibility of managing e-waste channels their efforts only in collection and disposal of solid waste. Effort by the regulatory authorities seems to have little or no effect in the e-waste activities and management. E-waste regulation seems not to be adequately adhered to, enlightment campaign and sensitization programme are not effectives, this is obvious going by the increasing amount of e-waste in our environment, the activities of e-waste recycling and refurbishing, hence this study is set out to assess the informal E-waste recycling and refurbishing activities in Niger State, Nigeria.

Research Questions

1. What are the activities in informal e-waste refurbishing in in Minna metropolis, Niger State?
2. What are the techniques for improving informal e-waste refurbishing in in Minna metropolis, Niger State?

Hypotheses

H_{01}: There is no significance difference in the mean responses of e-waste recyclers, electronic refurbishers and environmental protection agency on the activities in informal refurbishing of e-waste in Niger State, Nigeria.

H_{02}: There is no significance difference between the mean responses of e-waste recyclers, electronic refurbishers and environmental protection agency on the techniques for improving informal e-waste refurbishing in Niger State, Nigeria.

METHODOLOGY

A mixed research design was used for this study. The area of this study was Minna Metropolis Niger State, Nigeria. The target population used for this study comprises of 428 subjects which includes EEE collectors, EEE Refurbishers/Repairers, EEE recycler, and Regulatory bodies. Snowball sampling was used to select 30 e-waste collectors, 40 EEE local Recyclers, 40 EEE 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 refurbishing in in Minna metropolis, Niger State?

Table 2: Mean with standard deviation of EEE Refurbishers, EEE Recyclers, EEE Collectors, and Regulatory bodies on E-waste refurbishing activities.

S/N	ITEMS	EEE REPAIRERS		EEE RECYCLERS		EEE COLLECTORS		REGULATORY AGENCY		AVERAGES		REMARK
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
	Refurbishers transform old and/or non-functioning electric and electronic	4.30	.65	4.30	.53	3.70	.66	4.36	.56	4.17	.60	Agree

	equipment into second-hand and functioning equipment											
	Refurbishers in informal sector are engaged in hand soldering using lead containing solder paste.	4.27	.45	4.27	.45	3.35	.88	4.32	.55	4.05	.58	Agree
	Refurbishing activity is done either by replacing or repairing defective components	4.37	.56	4.27	.45	2.80	.83	4.37	.51	3.95	.59	Agree
	Refurbishers bow over the solder gun for quite long time periods per day working on defective components	4.20	.71	4.27	.64	2.70	.80	4.28	.58	3.86	.68	Agree
	Refurbishers engages in transforming, replacing and sales of products such as TVs, computers and mobile phones	4.33	.76	4.10	.61	2.65	.93	4.33	.72	3.85	.76	Agree
	Small household equipment, TVs, and computers are also part of products refurbished.	4.27	.83	4.00	.74	2.60	.88	4.28	.79	3.79	.81	Agree
	Refurbishers also engage in marketing and sales of the refurbished products.	4.30	.60	3.67	.66	2.45	.94	4.37	.63	3.70	.71	Agree
	Refurbishers use handy tools and have low overheads so the price from their repair services is quite acceptable.	4.23	.63	3.83	.75	2.55	.94	4.31	.66	3.73	.75	Agree
	Refurbishing sector are self-employed and thus do not have any kind of written or oral labour contract	4.30	.66	4.10	.76	2.75	.85	4.39	.57	3.89	.71	Agree

	Refurbishers make second hand equipment appealing to the customers.	4.17	.65	4.20	.85	2.70	.92	4.49	.50	3.89	.73	Agree
	In the refurbishing sector, professional development in the form of apprenticeships is very common	4.13	.51	4.23	.63	2.55	.83	4.51	.50	3.86	.62	Agree
	In refurbishing sector, one or more apprentices stay with one refurbishing enterprise for two to five years to learn the technical skills required for the business	3.97	.61	3.93	.83	2.55	.94	4.43	.74	3.72	.78	Agree
	Most shops and workshops located in the major refurbishing clusters are subject to various types of taxes to be paid to the local government and to State Government therefore contributing to national economy	4.03	.89	4.07	.64	2.40	1.05	4.50	.66	3.75	.81	Agree
	In refurbishing sector, refurbishers usually start work at 8am and finish around 5 or 6pm, with a lunch break of about 30 minutes, having their Sundays as off days	4.03	.61	4.13	.57	1.95	1.19	4.45	.66	3.64	.76	Agree
	In refurbishing sector, many workshop owners can be found working in their business for more than ten years	4.23	.50	4.03	.96	2.45	1.05	4.51	.55	3.81	.77	Agree
	GRAND MEAN	**4.21**	**.60**	**4.09**	**.67**	**2.51**	**.92**	**4.39**	**.58**	**3.80**	**.69**	**Agree**

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

Table 2 shows the analysis of the responses of Refurbishers, Recyclers, Collectors and Regulatory bodies on the activities of informal e-waste refurbishing in Minna. The respondents agreed to the whole items with mean score ranging between 3.64 – 4.17. The standard deviations of all items are within the ranges of .58 - .81, which indicate that respondents were not far from the mean of their responses on the activities of informal e-waste refurbishing. Hence, the grand mean of all the respondents is 3.80 which signify that all respondents agree with the refurbishing activities of informal e-waste in Minna Niger State.

Interview with repairers/refurbishers shows that refurbishing involved repairing of non-functioning electric and electronic equipment into second-hand and functioning equipment and is usually done when electrical electronic equipment fails to perform it designed function. Some of the activities includes: transform old and/or non-functioning electric and electronic equipment into second-hand and functioning equipment, replacing or repairing defective components, sales of products such as TVs, computers and mobile phones.

Research Question 2

What are the techniques for improving informal e-waste refurbishing in in Minna metropolis, Niger State?

Table 3: Mean with standard deviation of EEE Refurbishers, EEE Recyclers, EEE Collectors, and Regulatory bodies on E-waste refurbishing techniques.

S/N	ITEMS	EEE REPAIRERS		EEE RECYCLERS		EEE COLLECTORS		REGULATORY AGENCY		AVERAGES		REMARK
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1	Simple design of components for easy repair, cleaning and replacement (innovation design)	3.90	.55	3.40	.62	2.80	.89	4.34	.58	3.61	.66	Agree
2	Avoiding the production, consumption, and disposal of devices all together	3.83	.53	3.23	.50	2.75	.79	4.39	.52	3.55	.59	Agree
3	Encouraging longer life of products and slower obsolescence (optimized lifetime)	3.67	.61	2.97	.67	2.45	.69	4.43	.55	3.38	.63	Disagree
4	Replacing hazardous content with non-hazardous materials helps to avoid the impacts that would otherwise be present when dealing with waste equipment.	3.60	.77	3.00	.69	2.55	.76	4.49	.64	3.41	.72	Disagree

5	Avoiding glues that make sorting difficult (low-impact of materials)	3.57	.68	2.93	.78	2.25	1.02	4.53	.64	3.32	.78	Disagree
6	Encouraging and promoting the green package (innovation design)	3.20	.61	3.20	.85	2.25	.79	4.55	.60	3.30	.71	Disagree
7	Introducing refurbishing facilities.	3.47	.78	2.87	.90	2.00	.73	4.50	.79	3.21	.80	Disagree
8	Design, production and packaging of IT products by environmentally sound methods	3.20	.89	2.87	.78	2.15	.93	4.53	.72	3.19	.83	Disagree
9	Training local manpower to ensure adequate reverse flow of components/modules.	3.40	.97	2.83	.87	2.35	.93	4.58	.55	3.29	.83	Disagree
10	Creating a readily available market for the refurbished components for local consumption and export.	3.40	.81	2.70	1.06	2.45	1.05	4.49	.76	3.26	.92	Disagree
11	Reduction in the volume of waste generated through a decrease in production and consumption volumes	3.53	.68	2.80	.92	2.40	.88	4.63	.59	3.34	.77	Disagree
12	Replacing toxic content for less harmful materials reduces potential impacts from discarded equipment	3.43	.77	3.10	.88	2.65	.67	4.45	.76	3.41	.77	Disagree
13	Replacement or fixing of a broken component by bringing a device back to working order for further use	3.57	.73	3.23	.82	2.55	.83	4.47	.81	3.46	.80	Disagree
14	Extraction of parts or components for reuse or refurbishment of other units (cannibalization)	3.43	.90	2.97	.93	2.25	.97	4.46	.62	3.28	.86	Disagree
15	Upgrading a device to achieve a higher quality through refurbishment and remanufacturing (Reparation)	3.27	.74	3.17	.70	2.35	.93	4.55	.64	3.34	.75	Disagree
	GRAND MEAN	**3.50**	**.73**	**3.02**	**.80**	**2.41**	**.86**	**4.49**	**.65**	**3.36**	**.76**	**Disagree**

Table 3 shows the mean and standard deviations of responses of the respondents on the techniques for improving in informal e-waste refurbishing. The result showed that items 1 and 2 are within the ranges of 3.55 – 3.61, two items which are agree. This shows that there are techniques for improving in the study area. Items 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15 where disagree because their means lies between 3.26 – 3.46, these are practiced but at low level. Meanwhile, the standard deviation value of the 15 items in the Table 4.5 ranges from .59 - .92 which means that the respondents were closer to each other in their responses. Therefore, the closeness of the responses adds value to the reliability of the mean.

From the interview conducted with the repairers/refurbishers and the regulatory bodies shows that techniques for improving informal e-waste refurbishing is carried out but at the low level, in which is to reduced the volume of e-waste in the circulation. It involved reduction of e-waste material to avoid environmental and health hazards impact to the reuse of product. Some of the techniques includes: Replacement and fixing of a broken component by bringing a device back to working order for further use, Extraction of parts and components for reuse, training local manpower, sales of refurbished products.

2.2 Hypothesis

H_{01}: There is no significance difference in the mean responses of e-waste recyclers, electronic refurbishers and environmental protection agency on the activities in informal refurbishing of e-waste in Niger State, Nigeria.

Table 4

Analysis of variance of the mean responses of E-waste regulators, EEE refurbishers, EEE recyclers, EEE collectors as regards informal E-waste refurbishing activities in Minna, Niger State.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	**7.042**	**3**	**2.347**	**6.834**	**.000**
Within Groups	**52.208**	**152**	**.343**		
Total	**59.250**	**155**			

The table 4 shows the one-way between groups analysis of variance that was conducted for the mean responses of E-waste regulators, EEE refurbishers, EEE recyclers, as regards informal E-waste refurbishing activities in Minna, Niger State. The result of the analysis showed an f-ratio of 6.834 and a significance criterion (sig) of .000 which is less than p-value of .05. Therefore the null hypothesis was rejected. Hence, there is significant difference in the mean response of E- waste regulators, EEE refurbishers, EEE recyclers, EEE regards informal E-waste refurbishing activities in Minna, Niger State.

Table 5

Post-hoc comparisons using Tukey HSD test on the difference on the of E-waste regulators, EEE refurbishers, EEE recyclers as regards informal E-waste refurbishing activities in Minna, Niger State.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
EEE REPAIRERS	EEE RECYCLERS	0.00000	.15132	1.000	-.3931	.3931
	EEE COLLECTORS	.60000*	.16918	.003	.1605	1.0395
	REGULATORY AGENCY	-.05526	.12637	.972	-.3835	.2730
EEE RECYCLERS	EEE REPAIRERS	0.00000	.15132	1.000	-.3931	.3931
	EEE COLLECTORS	.60000*	.16918	.003	.1605	1.0395
	REGULATORY AGENCY	-.05526	.12637	.972	-.3835	.2730
EEE COLLECTORS	EEE REPAIRERS	-.60000*	.16918	.003	-1.0395	-.1605
	EEE RECYCLERS	-.60000*	.16918	.003	-1.0395	-.1605
	REGULATORY AGENCY	-.65526*	.14729	.000	-1.0379	-.2727
REGULATORY AGENCY	EEE REPAIRERS	.05526	.12637	.972	-.2730	.3835
	EEE RECYCLERS	.05526	.12637	.972	-.2730	.3835
	EEE COLLECTORS	.65526*	.14729	.000	.2727	1.0379

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

Table 5 shows the result of Post-hoc comparisons using the Tukey HSD test on the difference in the mean responses of E-waste regulators, EEE refurbishers, EEE recyclers, EEE regards informal E-waste recycling activities in Minna, Niger State. The results indicated that the mean response for regulatory bodies (whose mean difference was -.65526, and asignificance criterion (sig) of 0.000) was significantly different from the mean response for collectors (whose mean difference was .65526 with sig of0.000). However, the mean responses of the repairers did not differ significantly from that of regulatory bodies or recyclers.
H_{02}: There is no significance difference between the mean responses of e-waste recyclers, electronic refurbishers and environmental protection agency on the techniques for improving informal e-waste refurbishing in Niger State, Nigeria.

Table 6
Analysis of variance of the mean responses of E-waste regulators, EEE refurbishers, EEE recyclers, EEE collectors as regards techniques for improving in informal E-waste refurbishing in Minna, Niger State.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	46.481	3	15.494	39.116	.000
Within Groups	60.205	152	.396		
Total	106.686	155			

The table 6 shows the one-way between groups analysis of variance that was conducted for the mean responses of E-waste regulators, EEE refurbishers, EEE

recyclers as regards techniques for improving in informal E-waste refurbishing in Minna, Niger State. The result of the analysis showed an f-ratio of 39.116 and a significance criterion (sig) of .000 which is less than p-value of .05. Therefore the null hypothesis was rejected. Hence, there is significant difference in the mean response of E-waste regulators, EEE refurbishers, EEE recyclers, EEE regards techniques for improving in informal E-waste refurbishing in Minna, Niger State.

Table 7

Post-hoc comparisons using Tukey HSD test on the difference on the of E-waste regulators, EEE refurbishers, EEE recyclers as regards techniques for improving in informal E-waste refurbishing in Minna, Niger State.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
EEE REPAIRERS	EEE RECYCLERS	.50000*	.16250	.013	.0779	.9221
	EEE COLLECTORS	1.10000*	.18168	.000	.6281	1.5719
	REGULATORY AGENCY	-.44211*	.13570	.007	-.7946	-.0896
EEE RECYCLERS	EEE REPAIRERS	-.50000*	.16250	.013	-.9221	-.0779
	EEE COLLECTORS	.60000*	.18168	.006	.1281	1.0719
	REGULATORY AGENCY	-.94211*	.13570	.000	-1.2946	-.5896
EEE COLLECTORS	EEE REPAIRERS	-1.10000*	.18168	.000	-1.5719	-.6281
	EEE RECYCLERS	-.60000*	.18168	.006	-1.0719	-.1281
	REGULATORY AGENCY	-1.54211*	.15816	.000	-1.9530	-1.1312
REGULATORY AGENCY	EEE REPAIRERS	.44211*	.13570	.007	.0896	.7946
	EEE RECYCLERS	.94211*	.13570	.000	.5896	1.2946
	EEE COLLECTORS	1.54211*	.15816	.000	1.1312	1.9530

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

Table 7 shows the result of Post-hoc comparisons using the Tukey HSD test on the difference in the mean responses of E-waste regulators, EEE refurbishers, EEE recyclers, EEE regards techniques for improving in informal E-waste refurbishing in Minna, Niger State. The results indicated that the mean response for regulatory bodies (whose mean difference was -.94211, and asignificance criterion (sig) of 0.000) was significantly different from the mean response for repairers (whose mean difference was0.44221 with sig of0.07). Which also differ significantly for recyclers (whose means difference was 0.5000 with sig

of 0.013. However, the mean responses of the repairers differ significantly from that of recyclers.

DISCUSSION OF FINDINGS

Findings on the informal E-waste refurbishing activities in Minna metropolis, Niger State, research question 1, revealed that E-waste is transformed from old to new. These findings are in consonance with Ari (2016) states that refurbishers or repairers transform old and/or non-functioning electric and electronic equipment into second-hand and functioning equipment either by replacing or repairing defective components and/or by performing cleaning and repair activities in order to make the second-hand equipment appealing to the customers.

The findings also show that most refurbishers also engage in marketing and sales of the refurbished products. Osibanjo *et al*., (2016) also reported that each refurbisher typically focuses on a distinct group of products such as cooling and freezing equipment, air-conditioners, small household equipment, TVs, computers or mobile phones. The activities of the refurbishers pose threat to both human health and environment due to the discharge toxic fume.

An interviewed based on refurbishing activities shows that most of the repairers/refurbishers said refurbishing activities are done to prolong the life of an Electrical Electronic Equipment. Some of the activities includes: repairing of non-functioning equipment, transforming of old equipment to new, replacing of damage components (Repairer, May 05, 2021).

Refurbishers/Repairers interviewed also contributed that Refurbishers or repairers transform old and/or non-functioning electric and electronic equipment into second-hand and functioning equipment either by replacing or repairing defective components and/or by performing cleaning and repair activities in order to make the second hand equipment appealing to the customers, also engage in marketing and sales of the refurbished products (Refurbisher, May 6, 2021).

The findings on the techniques for improving in informal e-waste refurbishing in Minna, Niger State shows that there should be adequate electronic waste refurbishing in Niger State, research question 2 revealed that refurbishing and repairs are carried out to minimize E-waste and manufacturers employ the principle of reuse in their product to minimize E-waste. Also, limiting the volume of waste generated is the next most effective option toward lowering environmental and/or human health impacts from end-of-life treatment. Again, this can be seen as a literal reduction in the volume of waste generated through a decrease in production and consumption volumes, or a reduction of hazardous materials embedded in the equipment used. Cooper & Gutowski (2017) discuss that the demand for virgin materials decreases by a third with a substantial

secondhand market, and the energy used throughout the useful life of a computer is just one quarter of what is required to manufacture the computer. Choosing to re-circulate a used product back into the market extends its lifetime and decreases volume of problematic waste generated.

Also, the findings shows that Repair, included in the category of reuse, is the replacement or fixing of a broken component, bringing a device back to working order for further use. With the principle of refurbishing which is avoidance, reduction, reuse and repair, E-waste will be minimized and Niger State will be able to achieve true and better handling method. The finding revealed the need for an established guideline from regulatory bodies that will improve the refurbishing practices in Niger State.

With regards the interview section with repairers/refurbishers and regulatory bodies based on the techniques for improving in informal e-waste refurbishing reveals mainly the method adopted to reduced e-waste environmental and health impacts. One of the refurbishers said: "refurbishing techniques involved the replacement or fixing of a broken component and also, bringing a device back to working order for further uses (refurbisher, May 6, 2021).

Regulatory bodies also attest that techniques for improvement in informal e-waste refurbishing involved replacement of damage component. One of the regulatory interviewed said: "Techniques for improving informal e-waste refurbishing involved method adopted by the technicians to bring back the life of damage equipment putting into consideration the health and environmental impact of e-waste hazards; methods like avoiding the use of hazardous materials, replacing damage part and making them work again, repair and reuse (Regulatory body, June, 17 2021)".

CONCLUSION

Technological advancement has contributed greatly to large increase in volume of electronic waste globally, which indirectly pose threat to the environment and health. Several attempts has been made towards best handling practices and minimizing E-waste hazards but have not yielded positive result. However, this study investigates the informal e-waste recycling and refurbishing activities in Minna, Niger State. The study found out that E-waste is not properly collected and adequately handled in Niger State.

RECOMMENDATIONS

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

1. Technology of new to sort valuable materials from E-waste should be provided by the Government. Principle of reuse in a product should be employ by the manufactures to minimize e-waste, and also electrical and

electronic equipment supplier should be adequately encouraged to implement the minimization practices of e-waste regulation.

2. Environmental protection agencies should ensure that E-waste is separated at the point of collection and e-waste collection should be on daily basis, also waste collection centres should be kept at every strategic place in the environment.
3. Environmental agencies should organize regular enlightment and sensitization programme for the personnel involved in E-waste.

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