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ORIGINAL PAPER

Menace of informal waste electrical and electronic equipment recycling at MTN phone village, Rumukurushi, Port Harcourt, Nigeria

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Abstract
Waste electrical and electronic equipment has become a thing of great challenge in the city of Port Harcourt, Nigeria, and globally. Informal recyclers appear to be the key actors in this recycling sector in the location, but they lack the right skills and knowledge. This study sheds light on the consequences of informal recycling in the mobile telephone network phone village at Rumukurushi (a location believed to accommodate about 30 informal recyclers) in Port Harcourt. The level of education, health, and safety awareness of the informal recyclers, their willingness to obey government guidelines, and their knowledge of waste electrical and electronic equipment management were investigated. Data collection was achieved with the help of questionnaires and the analysis was done graphically. The outcome of the questionnaires administered to twenty-five (25) participants shows that the informal recyclers are more conversant with their primitive style of practice. They lack knowledge and awareness on waste electrical and electronic equipment management best practices. Other findings include the informal recyclers' lack of awareness on the use of personal protective equipment and the application of health and safety in the discharge of their duties. They are willing to obey government guidelines on waste electrical and electronic equipment management. Informal recyclers are willing to quit other waste electrical and electronic equipment management processes if they can be paid by the government for gathering them. The study recommends that the activities of the informal recyclers should be restricted to gathering only.

Keywords Informal recyclers · Waste · Port Harcourt · Dismantling

Introduction

Port Harcourt, a major city in the southern part of Nigeria experiences a rise in population, consumption of materials, waste electrical and electronic equipment, and several environmental contaminants due to the large number of individuals moving to the location to gain from the oil and gas companies financially. Consequently, there is a constant increase in the amount of WEEE generated in the location (Konya et al. 2015). The WEEE recyclers in the mobile telephone network (MTN) phone village at Rumukurushi (a location believed to accommodate about 30 informal recyclers) in the city of Port Harcourt, Nigeria do not adopt the formal technique of WEEE recycling. The informal technique of WEEE recycling is the main method in operation, and it is done mainly in the dumpsites where WEEE undergoes services, such as sorting, dismantling, treatment, etc. (Amadi and Chijioke 2018). In Ohajinwa et al (2017), the informal recycler is ignorant of their right or the protection available to them. They offer WEEE recycling services at a low price, their working method is not safe; hence, the health of individuals and the surrounding environment are not safe. Charles (2018), opined that WEEE serves as a good source of important raw materials, but it has to be properly managed to avoid its associated challenges.

The disposal of WEEE or e-waste, which appears to be a general practice in developing countries results in numerous consequences, for example, environmental pollution, which results in chronic and acute health challenges (Ferronato and Torretta 2019). Several hundreds of chemical substances that are toxic can be contained in a single computer and these are Polyvinyl chloride, brominated flame-retardant,

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cadmium, mercury, and lead (Aas 2015). When WEEE that comprises toxic elements is landfilled, there is a high probability that groundwater will be affected through leaching (Bożym, Król and Mizerna, 2021). In Vaccari et al (2019, p. 15), individuals who walk through the pathways and means of transportation along the dumpsites are usually affected by the "spread of pollutants" from the facilities utilised by the informal recyclers in the location. It was mentioned in several studies that a great amount of inorganic and organic contaminants exist "in the bodies" of individuals who reside or work in such areas. Njoku et al. (2019), put forward that those who reside close to the landfill site and the individuals passing through the site experience severe air contamination due to the bad odour from the site. Residents are exposed to illnesses like weakness of the body, eye irritation, and flu. Similarly, those who passed through the site are at risk of contracting airborne diseases, etc. During the burning of debris, smoke tends to cover some part of the location, this affects the inhabitants. Besides, the decomposing WEEE gives out an offensive smell, especially in the wet season when the location tends to be filled with flies and other insects (Ferronato and Torretta 2019). Furthermore, the recyclers make use of crude recycling techniques, hence they lack the right infrastructure that can guarantee the safety of life and the environment (Yu et al. 2010). Waste electrical and electronic equipment, WEEE, and its associated challenges have become an issue with increasing concern as it comprises several toxic elements (for example, cadmium, mercury, lead, brominated flame retardants, and polyvinyl chloride) capable of causing severe harm to human beings and the environment. In developing countries, recycling is done in such a poor manner that it results in serious pollution to the environment. Hence, sediments, water, soil, and air in locations where informal recycling is carried out are associated with a great accumulation of organic and inorganic pollutants. The exposure of individuals and the environment to these pollutants puts them at risk. If urgent measures are not put in place, the situation will get worse (Al-Rahmi et al. 2018; Cesaro et al. 2019).

Globally, the need to utilise electrical or electronic devices is increasing, hence it has necessitated the development of new devices (Ohajinwa et al. 2019). The challenges associated with WEEE are aggravating due to the increase in the manufacture of electronic or electrical devices coupled with the exportation of WEEE to developing countries from those that are developed (JK et al. 2017). In Herat (2018), it is almost certain that the amount of WEEE generated in countries that are still developing exceeds that of countries that are developed and equipped with the technology required to manage them. Amadi and Chijioke (2018), opined that the challenges associated with the style of execution of the duties of the informal recycler put their recycling system against "modern waste management practices" besides, the formal WEEE recycling system does not exist in Nigeria at the moment.

Okorhi et al (2020), posit that services such as e-waste gathering, processing, and refurbishing are performed by recyclers in the informal sector, and these groups of individuals lack experience, they are usually of low standards, and are illiterates. Furthermore, the informal recyclers are generally "undocumented-business" persons, they operate without investment and standard training. They move from one street or waste dump to another "with their handcarts to collect" or buy in rare occasions abandoned e-waste and other metal scraps that "contain" useful elements such as aluminium, brass, iron, copper, etc. Ohajinwa (2018), explains that a lot of toxic elements are released into the environment since the recycling of the majority of WEEE generated is done in a manner that is informal/unsafe. In a related study by Mihai et al (2019), it was gathered that the informal WEEE method of recycling dominates the Nigerian WEEE sector. In developing countries, for example, Nigeria, WEEE management is carried out by informal recyclers in a manner that is not professional, they tend to dispose of e-waste in a manner and location that are not regulated thereby exposing individuals and the environment to health challenges (Adeola 2018). Some countries are more environmentally friendly and advanced technologically than others as regards the WEEE management approach adopted yet it is difficult for the recycling process to be achieved without any form of impact on the environment (Arif and Afroz 2013).

Challenges of informal recycling in the selected location in Port Harcourt, Nigeria

Informal recycling in MTN phone village at Rumukurushi (a location believed to accommodate about 30 informal recyclers), faces a lot of challenges, and this is because the strategies in place for WEEE management are affected by many factors identified in Okorhi et al (2014, p 11). These factors are:

a. WEEE declaration at the entry point is usually done in an incorrect manner for instance "second-hand goods" labelled as a donation/gift for "individuals or groups"
b. It is difficult to differentiate WEEE from near end-of-life electrical and electronic equipment.
c. A localised standard recycling system is absent.
d. It is difficult to initiate and "pursue take-back programmes" as regards WEEE
e. There is an absence of general awareness of the toxicity of WEEE.
f. The weakness of the government to declare a complete "ban on importation of" used electrical & electronic equipment (UEEE) or formulate long-standing "guidelines" on used EEE imported into Nigeria, to equip the

importers with the required information to differentiate used EEE and WEEE.

g. The loading together of WEEE, "near E.O.L. EEE", and second-hand vehicles.
h. There is an absence of localised statistics on WEEE.

The need to reduce or stop the activities of informal recyclers in Port Harcourt

In Lenz et al. (2019, P. 25), Individuals who carry out WEEE "treatment" usually exposed themselves to "hazardous substances" via soil, food, dust, and water. This is capable of endangering their life. In Alabi and Wohlmuth (2019), informal recyclers lack awareness of the associated risks with informal recycling and this gives rise to several health challenges such as brain and liver damage, skin irritation, decreased nerve conduction velocity, brain swelling, etc. In Wideman (2019, p 29), the various challenges associated with WEEE management "are man-made, and need man-initiated, man-volunteered solutions". In terms of competency, Ogbuanya and Afeez (2019, p 93), put forward that informal recyclers lack the right skills, they have little or no exposure to a state-of-the-art "technology, and personal protective equipment among others". Informal recyclers usually referred to as scavengers, according to Popoola et al (2019, p 5), do not like participating in a study involving WEEE management voluntarily, due to "the illegal status of their operation". Some of the activities associated with WEEE recycling, for example, "dismantling of electrical devices" as mentioned in Osaretin (2018) expose recyclers to injuries. In Herat (2018, p 39), the services of "informal recycling" are carried out by individuals who are usually poor, hence, the government cannot ask them to pay heavy tax since they won't be able to afford it.

The study carried out by Alabi and Wohlmuth (2019), shows that despite the effort made by informal recyclers to manage WEEE, they do not get any form of intervention or support from the government and private sector to create a conducive environment. Some of the discouragements are:

i. They do not get any form of financial aid or recognition from the government
ii. Their activities and effort are not supported with "basic amenities"
iii. No form of safety gadgets is provided to them to prevent them from exposure to health-related risks and "hazardous materials".
iv. They lack the opportunity for training on "environmental conditions", finance, technologies, kinds of waste, and materials.
v. No opportunity for "adequate medical facilities".
vi. No formal education, orientation, and training on the application of "first-aid treatment" in times of emergency.

WEEE contains several elements that are harmful to life and the environment which are usually not properly managed by the informal recycler. Some of those elements/substances, their sources, and harmful effects on life and the environment, according to Ilankoon et al (2018, p 266) and Lenz et al. (2019) are as shown in Table 1.

This study sheds light on the consequences of informal recycling in the MTN phone village at Rumukurushi (a location believed to accommodate about 30 informal recyclers), Port Harcourt, Rivers State, Nigeria, and other locations affected with similar challenges. The level of education, health, and safety awareness of the informal recyclers, their willingness to obey government guidelines, and their knowledge of WEEE management were investigated. Data gathering was achieved with the help of questionnaires administered to informal recyclers in the study location. The study was carried out on MTN phone village, Rumukurushi, Port Harcourt Nigeria in August 2020.

Materials and methods

The methodical concept used for this study is based on reviews of past works of literature on problems associated with informal recycling, WEEE management strategies, and the outcome of questionnaires administered to informal recyclers in MTN phone village at Rumukurushi in the city of Port Harcourt, Nigeria. The survey strategy was adopted in this study since, it is usually associated with "deductive research approach" (Rahi 2017, p 2). The questionnaires were used for data collection because the study requires quantifiable data that exist in a manner that is numeric (Queirós et al. 2017).

Study site

MTN phone village at Rumukurushi (a location believed to accommodate about 30 informal recyclers) in the city of Port Harcourt in Rivers State, Nigeria was the chosen site for this study. This is because of the extent of WEEE disposal in the location, the challenges faced by residents due to poor WEEE management system in practice, the activities of the informal recyclers which exposed the life of the residents and the surrounding environment to risk. It is a very small location in Port Harcourt. Conversely, Port Harcourt formerly referred to as Rivers state garden city several years ago is currently faced with the challenges of WEEE management (Okoli et al. 2020). Waste in this part of the country is not properly managed and forms part of the environmental

Table 1 Element/substance in WEEE, their sources, harmful effects, source of exposure and their routes to exposure

Element/substance	Sources of element/substance	Harmful effects of element/substance	Source of exposure	Route to exposure
Beryllium (Be)	Parts of electronics made of ceramic, X-ray machines, computers, power supply boxes	It may cause acute beryllium disease or beryllium sensitization. It attacks vital parts of the body, such as the lymphatic system, nervous system, heart, kidneys, and liver	Water, food, and air	Ingestion, transplacental, and inhalation
Zinc, (Zn)	Batteries, coatings of metal, Cathode ray tubes	It results in a heightened "risk of copper" shortage which can result in "neurological abnormalities "as well as anaemia	Soil, water, and air	Inhalation and ingestion
Barium (Ba)	Fluorescent lamps, cathode ray tubes (which usually comprises 2–9 percent of Ba)	It causes an elevation in blood pressure, twitching of muscles, paralysis, gastrointestinal disorder, respiratory failure, cardiac arrhythmias, and low potassium content in the blood	Dermal contact, ingestion, and inhalation	Dermal contact, ingestion, and inhalation
PVC	Cables and wire insulation	Furans and chlorinated dioxins are produced during PVC incineration. Their effects on the environment are persistent when produced, they are harmful even when it is of low concentration		
Lithium (Li)	It is present in Lithium batteries	It causes daze feeling, fatigue, weakness of the muscles, dizziness, diarrhoea, and nausea	Food (plant), water, soil, and air	Dermal contact, ingestion, and inhalation
Persistent organic pollutants (POPs), this also includes brominated flame retardants	They are found in devices, e.g. Mobile phones, connectors. They are also present in electric motors, dishwashers, ceiling fans, fluorescent lights, generator coolants, lubricants, as "dielectric fluids in transformers and capacitors, as casings for cables and computers. They are also found in circuit boards	The womb's exposure to POPs is recently linked to behavioural challenges, it "interferes with thyroid and oestrogen hormone system". Memory and learning activities are usually impaired after a long period of exposure, it is extremely "resistant to breakdown"	Soil, water, food, duct, and air	Transplacental, inhalation, and ingestion
Lead (Pb)	Lamps, light bulbs, printed circuit boards (PCBs), monitors of personal computers, Television, CRTs (made of 4–22 percent Pb), and batteries	It causes kidney damage, anaemia, severe neurotoxicity, "intellectual impairment in children". It also causes damage to the blood, reproductive and nervous systems, especially in adults	Soil. Water, dust, and air	Ingestion, dermal contact, and inhalation

Table 1 (continued)

Element/substance	Sources of element/substance	Harmful effects of element/substance	Source of exposure	Route to exposure
Nickel (Ni)	"Electron gun" in cathode ray tubes, batteries made of Ni–Cd	It increases the risk of cardiovascular diseases, high blood pressure, cancer of the lungs, developmental deficit during childhood stage, and neurological deficits	Food (plant), water, soil, and air	Transplacental, dermal contact, inhalation, and ingestion
Mercury (Hg)	Monitors, sensors, thermostats, "lighting devices for flat screen displays", PCBs, CRTs	It causes damage to the central nervous system and brain, "neurobehavioral development" in children. Conversely, it also causes kidney damage, anaemia, and severe neurotoxicity	Food (bioaccumulative in fish), soil, water, vapour, and air	Dermal contact, ingestion, and inhalation
Chromium (Cr)/hexavalent chromium	"Production of metal housings (anticorrosion coatings), data tapes, floppy disks"	It is extremely toxic, it has effects on neonates, endocrine, and reproductive functions	Soil, water, dust, and air	Ingestion and inhalation
Cadmium (Cd)	Mobile phones, CRTs, switches, connectors, springs, batteries, "older" printed circuit boards (PCBs), CRTs, infrared detectors, toner or ink photocopier, semiconductor chips	It affects bones and kidneys, it causes damage to the lungs as well as the reproductive system. It is extremely toxic and extremely resistant to breakdown	Food (particularly rice and vegetables), water, soil, dust, and air	Inhalation and ingestion

challenges, the pathogens present in the waste are mainly carried by the scavengers (Amadi and Chijioke 2018).

Questionnaires

The questionnaires comprise of items shown below:

- Demographic information.
- Responses on waste electrical and electronics equipment awareness and behaviour towards good sustainable practice.
- Responses on waste electrical and electronic equipment, health, safety, and environmental issues

Demographic information

This covers several key information on the participants, and this includes the state of origin, gender, age, educational qualification, and years of working experience in the informal recycling business.

The state of origin of the participants The respondents in this study are residents of the city of Port Harcourt, Nigeria who does the business of informal WEEE recycling. The participants were drawn from MTN phone village at Rumukurushi in the city of Port Harcourt. This is because the MTN phone village in the city of Port Harcourt in Rivers State, Nigeria was chosen as the research location for the study.

The gender of the participants In this study, an effort was made to gather responses from both men and women involved in the informal WEEE recycling business. Out of the twenty-five (25) participants, which took part in the study, only three (3) ladies are involved. This accounts for 12% of the population while the remaining 88% are men.

The age of participants The respondents were grouped into various age categories as shown in Table 2.

Educational qualification of the participants The result gathered from the study shows that twenty-three (23) participants (which accounts for 92%) attended only primary school while the remaining two, 2 (i.e. 8%) attended high school.

Table 2 Age category of the participants

Age category of participants	Men	Ladies	Number of participants
Under 20	1	0	1
21–25	3	1	4
26–35	4	2	6
36–40	5	0	5
41–50	8	0	8
50 and above	1	0	1

Table 3 Number of years of working experience of the participants

Working experience (years)	Number of participants
1	1
2	2
3	2
4	6
5 and above	14

Years of working experience in the informal recycling business of WEEE The number of years of working experience in WEEE management achieved by each of the participants was put into consideration in this study. Details of the years of working experience of the informal recyclers are as shown in Table 3.

Analysis

This study adopted a quantitative research approach. Ragab and Arisha (2017), opined that the deductive approach allows for quantitative data collection while the inductive approach allows for qualitative data collection, this implies that a quantitative research approach was adopted in this study. The data collection for this study was achieved with the help of questionnaires. The positivist research philosophy was adopted since, it required quantitative data collection (Rahi 2017). Several responses were gathered from the participants on many issues that bother on WEEE management, and the results were analysed graphically.

Results and discussion

In order to gather information on the level of awareness of the informal recycler on waste electrical & electronics equipment, and their behaviour towards good sustainable practice, some questions were asked. This includes the main reason the informal recyclers engage in WEEE management. The knowledge of the level of awareness is essential. This is because several environmental hazards are caused by informal WEEE dumping, and these are water pollution, land pollution, increase in disease vectors, air pollution, etc. It is also essential to ascertain the extent of awareness as the informal recyclers are faced with the following health risk: long-term cumulative poison, reproductive system damage, liver and brain damage, peripheral and central nervous system damage, etc.

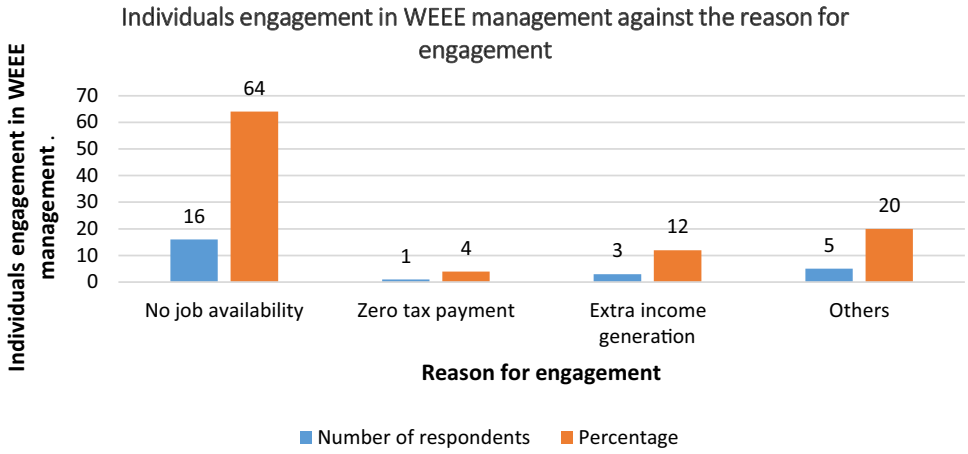

Fig. 1 A plot of individuals' engagement in WEEE management against the reason for engagement

According to this study, informal recyclers have several reasons for engaging in WEEE management. The numerous reasons are classified into four (4) different categories, namely: no job availability, zero tax payment, extra income generation, and others as shown in Fig. 1. Out of 25 participants who responded, 64% of the participants, which appears to be the majority, admitted that the main reason they engage in WEEE management is that, there is no job availability.

To ascertain the frequency at which WEEE, and its associated components, are dismantled and disposed of on the site by informal recyclers, several questions were put forward to them. As regards the question, if WEEE is frequently dismantled or disposed of on the site. Those who agree with the idea amount to 48%, those who strongly agree amount to 32%, while those who are unsure amount to 8%. On the other hand, 4% disagree and 8% strongly disagree. The proportion of respondents who are in support of the idea that WEEE is frequently dismantled and disposed of on the site outweighs those who are not in support. The frequency at which the refrigerator, electrical cables, and electronic circuit boards are dismantled and disposed of on-site was also investigated. Find details in Fig. 2. As regards the refrigerator, 8% of the respondents disagree that the refrigerator is frequently dismantled and disposed of on the site without the use of PPE. 8% also strongly disagree, those who are unsure recorded 4% while 40% agree. The remaining 40% strongly agree. In JK et al (2017) and Touni (2019), "large household devices like refrigerators can be a potential source of chemicals, for example, hydrochlorofluorocarbons, which serves as a threat to the informal recycler whose job is to dismantle refrigerators.

Dismantling of refrigerators has to be carried out using the appropriate guidelines as it contains refrigerants such as CFC-12, HCFC-22, HFC-410A, HFC-32, ammonia solution containing chromium-VI, critical blowing agents such as CFC-11, HCFC-141b. Conversely, it contains mercury, printed circuit boards (containing Lead, Cadmium, Hexavalent chromium), etc. (Lenz et al. 2019). As regards the frequency at which electrical cables are frequently disposed of or burnt on the site. 4% of the respondents are not sure if electrical cables are frequently disposed of or burnt on the site. Conversely, 4% and 8% strongly disagree and disagree respectively, while 36% agree and 48% strongly agree.

An effort made to ascertain if electronic circuit boards are frequently disposed of or burnt on the site produced the following result. Respondents who strongly disagree, disagree and unsure recorded 4% each. 44% agree and 44% also strongly agree. This shows that those in support of disposing or burning electronic circuit boards on the site outweigh those who are against it. JK et al (2017) and Cesaro et al (2019), put forward that, the burning of WEEE to recover some valuable elements from electronic circuit boards usually provides an avenue for toxic chemicals, to be released into the environment. Hence, the practice should be discouraged.

A conscious effort was also made via the questionnaires to understand what the informal recyclers understand as WEEE management, hence several definitions of WEEE management were offered in the questionnaires. The outcome of the various interpretations of WEEE management gathered are as shown in Fig. 3. As regards the first idea, WEEE management implies throwing WEEE into an open dump. 16% of the participants each disagree and strongly disagree with the definition. Those who are unsure recorded 8% while 20% and 40% agree and strongly agree, respectively.

As regards the second idea, WEEE management means the burning of WEEE. 12% and 8% of the participants disagree and strongly disagree with the definition, respectively. Those who are unsure recorded 4% while 40% and 36% agree and strongly agree. Another idea suggested was that WEEE management means keeping WEEE in the storerooms. 20% of the participants each disagree and strongly disagree with the definition. Those who are unsure recorded

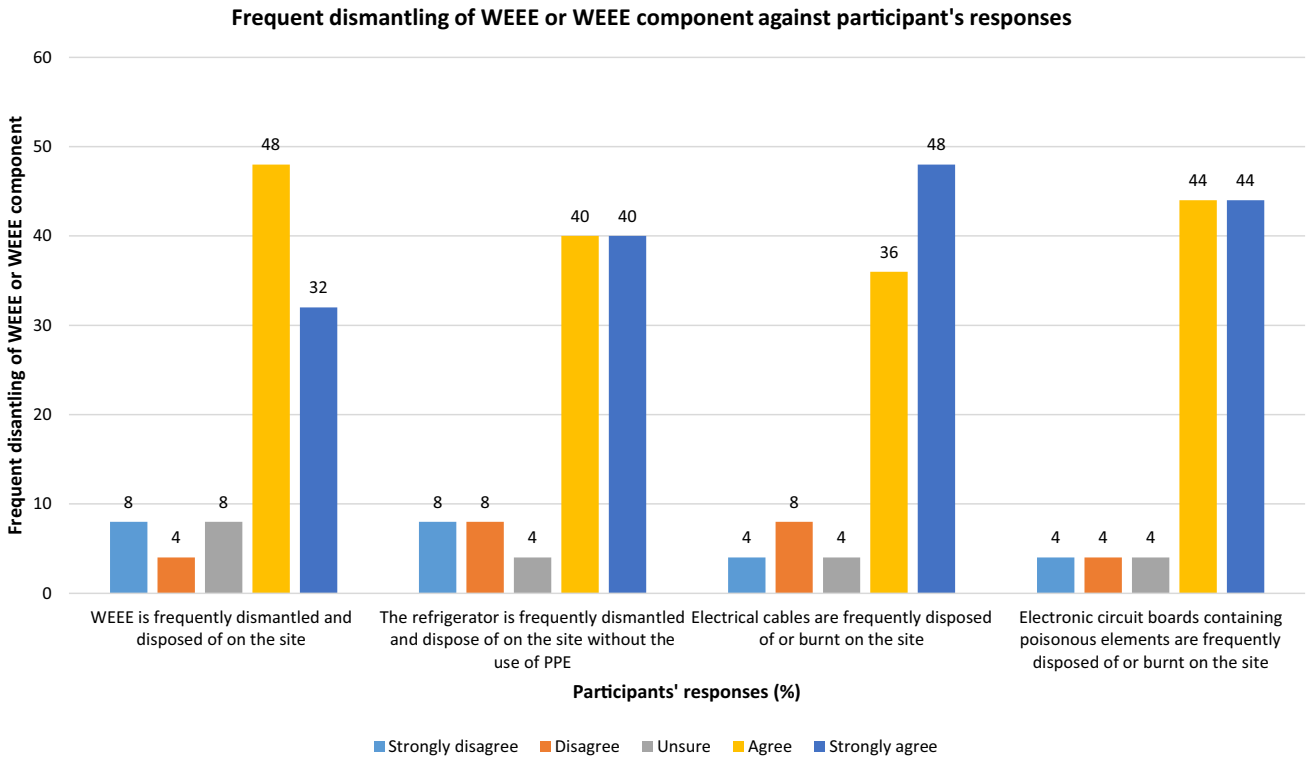

Fig. 2 A plot of frequent dismantling of WEEE or WEEE components against participants' responses

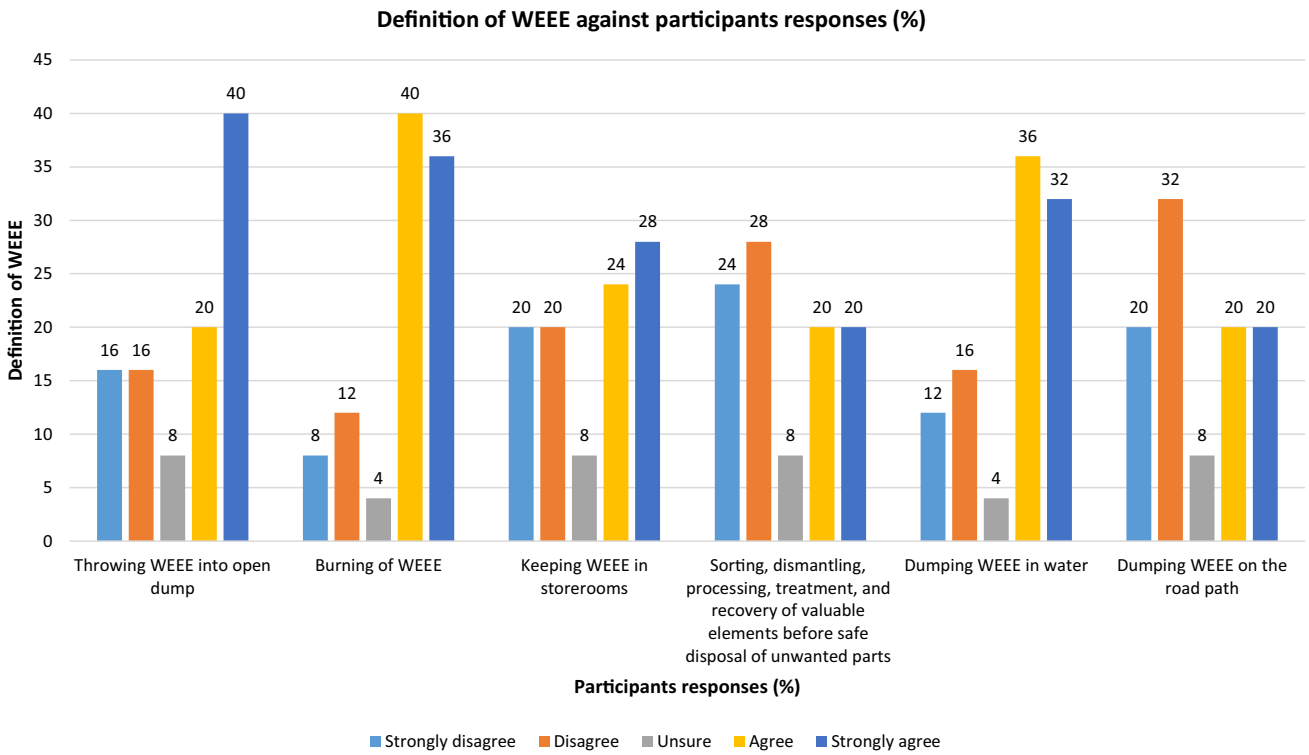

Fig. 3 A plot of the definition of WEEE against participants' responses

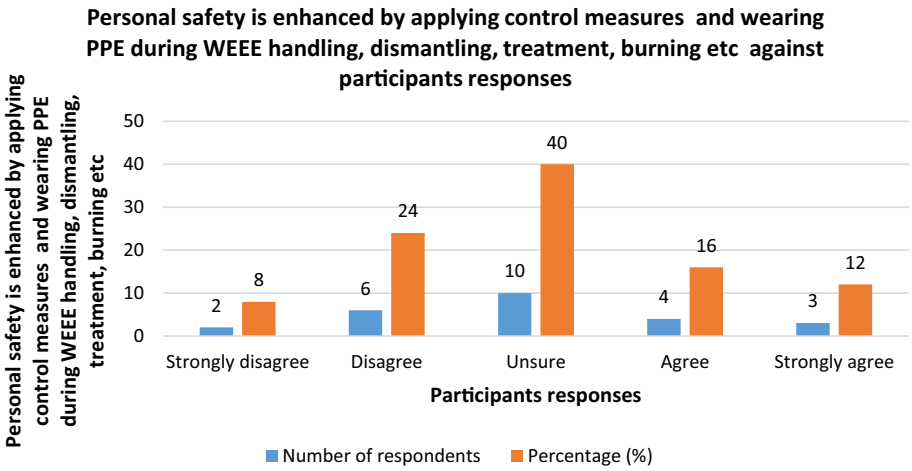

Fig. 4 A plot of personal safety is enhanced by applying control measures and wearing PPE during WEEE handling, dismantling, treatment, burning, etc., against participants' responses

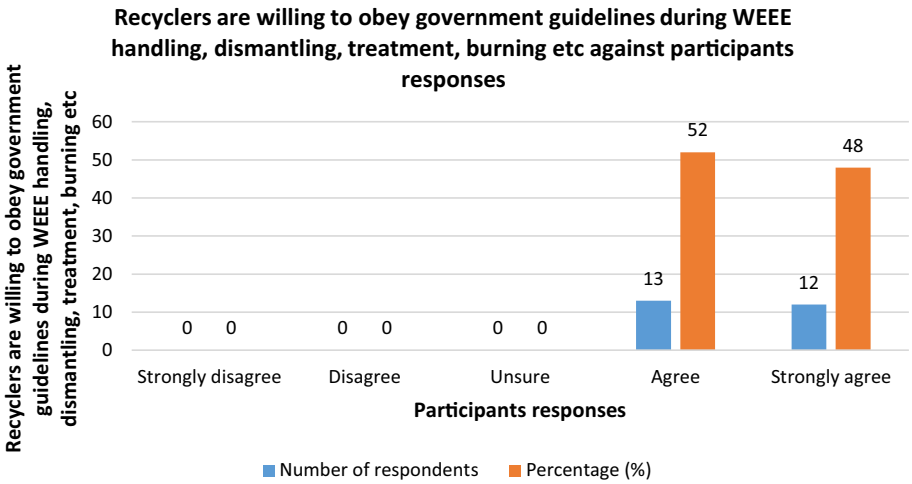

Fig. 5 A plot of recyclers are willing to obey government guidelines during WEEE handling, dismantling, treatment, burning, etc., against participants' responses

8%, 24% agree while the remaining 28% strongly agree. In one of the definitions offered, WEEE management means sorting, dismantling, processing, treatment, and recovery of valuable elements before disposal of the unwanted parts in a manner that allows for the safety of life and the environment. 24% of the participants strongly disagree with the definition. 28% disagree, 8% was unsure while 20% each agree and strongly agree.

Conversely, the responses gathered from the definition, WEEE management means dumping WEEE in water show that 16% and 12% disagree and strongly disagree with the definition, respectively. Those who are unsure recorded 4%, 36% agree while the remaining 32% strongly agree. Finally, 32% and 20% disagree and strongly disagree respectively, with the definition that WEEE management means dumping WEEE on the road path. Those who are unsure recorded 8% while 20% each agree and strongly agree with the definition. The outcome shows that the definition that WEEE management means throwing WEEE into an open dump has the highest percentage of those who strongly agree with the definition. While the definition, WEEE management implies burning of WEEE recorded the highest percentage of participants who agree with the idea. As regards the definition which appears appropriate, 28% strongly disagree. This implies that the exact definition of WEEE management is not clear to the informal recyclers.

The administered questionnaires were also fashioned to help identify if the informal recyclers know about health & safety and if they appreciate the concept of safety in the discharge of their duties. In Fig. 4, the question seeks to find out if personal safety is enhanced by applying control measures and wearing personal protective equipment (PPE) during WEEE handling, dismantling, treatment, burning, etc. The outcome shows that 8% of the participant strongly disagree with the idea, 24% disagree. 40%, which appears to be the majority was unsure. 16% agree and 12% strongly agree. This could be as a result of low level of awareness on the use of PPE and the application of health & safety in the discharge of their WEEE-related duties.

An effort was made as shown in Fig. 5 to ascertain the willingness of informal recyclers to adhere to government guidelines in the discharge of their WEEE-related duties.

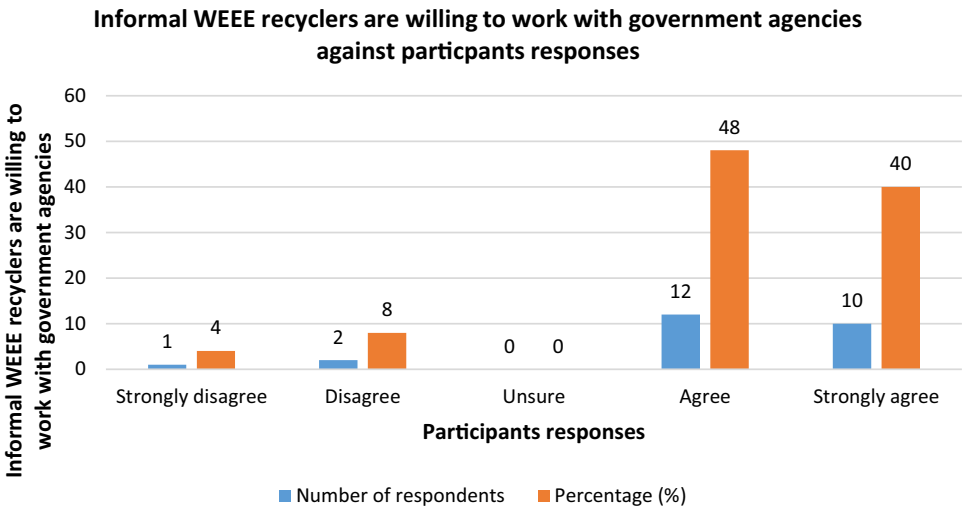

Fig. 6 A plot of informal WEEE recyclers are willing to work with government agencies against participants' responses

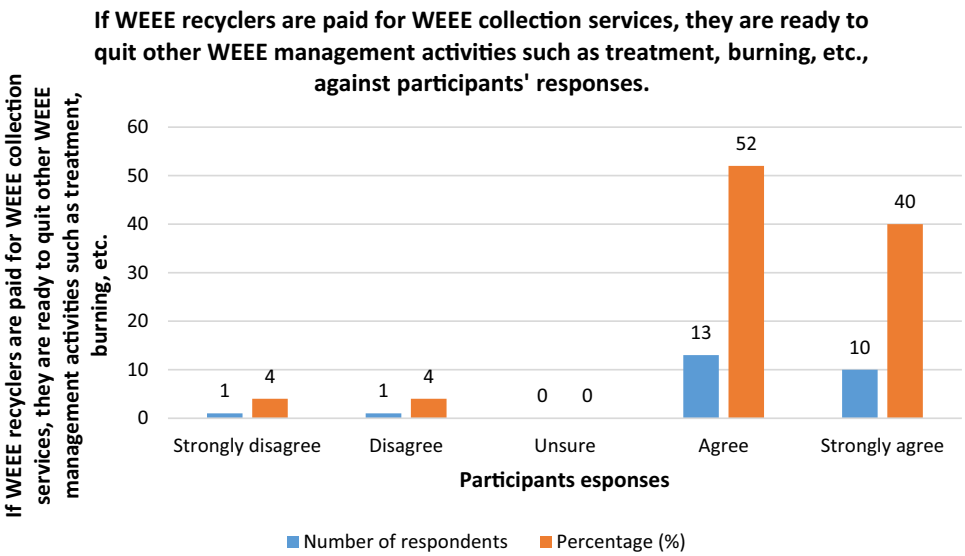

Fig. 7 A plot of if WEEE recyclers are paid for WEEE collection services, they are ready to quit other WEEE management activities such as treatment, burning, etc., against participants' responses

The outcome signifies that 52% agree, 48% strongly agree with no form of disagreement recorded. The informal recyclers declared their willingness to obey government guidelines in the discharge of their WEEE-related duties.

The idea in Fig. 6 was introduced into the questionnaires to ascertain the willingness of the informal recycler to partner with government agencies in the discharge of their WEEE-related activities. The outcome indicates that 4% of the participants strongly disagree with the idea, 8% disagree. 48% agree while 40% strongly agree. The percentage of participants willing to partner with government agencies in the discharge of their WEEE management-related activities outweighs those that are not in support. This shows that the informal recyclers in the location are ready to work with government agencies in the discharge of their duties.

Conversely, an effort was made in the questionnaires to ascertain the willingness of informal recyclers to get payment for WEEE gathering or collection while they quit other aspects of WEEE management such as treatment, burning, etc. The result shows that 4% strongly disagree, another 4% also disagree. 52% agree while 40% strongly agree as shown in Fig. 7. This shows that the percentage of informal recyclers that are willing to quit all other activities involved with the process of WEEE management if they can be paid by the government for the gathering and collection of WEEE, outweighs those who are against the idea.

Conclusion

This study sheds light on the consequences of informal recycling in the MTN phone village at Rumukurushi (a location believed to accommodate about 30 informal recyclers), Port Harcourt, Rivers State, Nigeria, and other

locations affected with similar challenges. The level of education, health, and safety awareness of the informal recyclers, their willingness to obey government guidelines, and their knowledge of WEEE management were investigated. The informal recyclers in the location were found to be more conversant with their usual primitive style of practice. They lack knowledge and awareness of WEEE management best practices. Notable among the findings is that the informal recyclers in the research location:

- Lacks awareness on the use of PPE and the application of health & safety in the discharge of their WEEE activities. 40% of the participants was unsure of the use of PPE to enhance personal safety during the discharge of their duties. 8% strongly disagree with the use of PPE to enhance personal safety. 24% also disagree with the use of PPE to enhance personal safety. The remaining fraction supported the use.
- Are willing to obey government guidelines in the discharge of their WEEE activities as only 4% and 8% strongly disagree and disagree, respectively. 48% agree while 40% strongly agree to obey government guidelines in the discharge of their WEEE activities.
- Are willing to quit all other activities involved with the process of WEEE management if they can be paid by the government for the gathering or collection of WEEE. This is because the percentage of the participants who strongly disagree and disagree amounted to 4% each. On the other hand, 52% agree while the remaining 40% strongly agree

Finally, the study recommends that the activities of the informal recyclers in the research location, and other locations faced with similar challenges, should be restricted to WEEE gathering or collection only while the other services are handled by government trained and approved individuals. To ensure the safety of informal recyclers, the study recommends that the government should organise sensitization workshops and training regularly for informal recyclers. This is to increase their level of awareness of the dangers associated with their business and the importance of the use of PPE.

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Declarations

Conflict of interest The authors declare there is no conflict of interest.

Ethical approval All procedures performed in studies involving animals were in accordance with the ethical standards of the institution at which the studies were conducted and ethical approval was obtained from the Ethics Committee of the School of Computing Engineering & Physical Sciences, University of the West of Scotland (reference number 21-8607-3338).

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