

A Descriptive Analysis of Electronic Waste Management among Electronic Repair Vendors in Mwanza City, Tanzania

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ABSTRACT

Electronic waste (e-waste) is a rapidly growing global problem, with Africa generating 2.9 million metric tons of e-waste in 2019. In Tanzania, Mwanza faces a significant amount of e-waste and poor management of e-waste collection and disposal. This study conducted a descriptive analysis of e-waste management practices among electronic repair vendors in Mwanza City, Tanzania. The objective was to describe their current e-waste management practices, identify challenges, and highlight areas for improvement. The lack of awareness and inadequate practices among electronic repair vendors hinder effective e-waste management, contributing to the environmental and health risks associated with the improper disposal of hazardous materials. A literature review revealed the importance of stakeholder engagement, improved awareness, and sustainable e-waste management practices in various African countries. This study employed a descriptive research design, utilizing both quantitative and qualitative methods. Data will be collected through questionnaires, interviews, and observations targeting a sample of electronic repair vendors in Mwanza City. Data analysis involved descriptive statistics and thematic analysis. The findings indicate that using e-waste as a spare part of other products and selling non-repairable e-waste to third parties are current e-waste management practices. Moreover, e-repair vendors have been found to contribute to e-waste management, particularly repair, collection, and storage. Based on these findings, the study recommends that an e-waste awareness campaign be instituted in the e-repair industry, that e-waste management be undertaken sustainably to combat unnecessary disposal, and that the deposition of e-waste and e-waste collection equipment(s) be provided to e-repair vendors for proper e-waste collection and management. Also, there is a need to conduct further studies to assess strategies used by local authorities to support e-repair vendors in e-waste management.

Keywords: Electronic Waste, Management, Repair Vendors

I. INTRODUCTION

Electronic waste (e-waste) is one of the fastest-growing types of waste worldwide (Ilakoon et al., 2018; Maes & Whyte, 2022). It consists of discarded electronic devices or appliances, including computers, televisions, radios, mobile phones, and other electronic equipment used at various locations in our day-to-day lives, such as homes and offices (Kitila & Woldemikael, 2019; United Republic of Tanzania [URT], 2019; Dhas et al., 2021). E-waste is a global problem, but the local impacts of hazardous materials such as lead, mercury, and cadmium can threaten the environment and people's health if not properly handled (Bimir, 2020; The Citizen, 2021). The world generated 53.6 million metric tons of e-waste in 2019 (United Nations Environment Programme [UNEP], 2020); 59.4 million metric tons of e-waste in 2022 (Tieso, 2023); and this number is expected to rise to 74.7 million metric tons by 2030 (UNEP, 2020; Tieso, 2023). E-waste accounts for 5% of all municipal solid waste worldwide (Vijara and Savale, 2019).

E-waste comes in many forms; approximately 31 percent is generated by small electronic products such as microwaves, shavers, and cameras, and approximately 28 percent is produced by large electronic products such as washing machines, refrigerators, smart devices, smartphones, computers, and televisions (Gibbons, 2021). The apex influx of population, technology, and auspicious growth in personal disposable income are coupled with people's increasing reliance on electronic products for work and at home (URT, 2019). When these electronic products become inoperable, out-dated, or damaged, they become e-waste (URT, 2019; Raudhia & Msolla, 2021).

In Africa, e-waste is a particularly pressing issue, and people working with such waste are the most vulnerable to toxic substances (Bimir, 2020). In 2019, Africa generated 2.9 million metric tons of e-waste, a number that is

expected to triple by 2050 (UNEP, 2020). Tanzania, a country in East Africa, is no exception to the e-waste problem (URT, 2018). About 2.5 kilograms of waste is expected to be generated from electronic devices per day in 2019/22 (URT, 2021), and this number is expected to increase, especially in the large cities of Tanzania (The Citizen, 2021). Mwanza City is one of the councils in Tanzania, facing a large proportional amount of electronic waste production and poor management of collection and disposal (URT, 2018; Sanga, 2021).

Several initiatives have been undertaken to address e-waste problems globally and in Africa. UNEP has launched the Global E-waste Statistics Partnership to gather data on e-waste and promote its proper disposal (UNEP, 2020). The African Circular Economy Alliance was formed in Africa to promote sustainable e-waste management and recycling, as cited by UNEP (2020). In East Africa, the Regional E-Waste Management Strategy was launched to promote e-waste management with a vision of zero negative impacts of e-waste among the East African Community Organization member states by 2030 (The Regional E-Waste Management Steering Committee [REWMSC], 2022).

In Tanzania, there are steps taken by the government and environmental stakeholders to address e-waste problems, such as signing international papers on the East African Communications Organization (EACO) e-waste strategy and issuing trans-boundary forms that provide legal approval for the transportation of e-waste designated to deal with problems (URT, 2019). Also, the government has established the Tanzania Electronic Recyclers Association (TARA) and the Electronic and Postal Communications Act (2020), raising public awareness of e-waste issues to promote e-waste recycling and management in the country (Nyabise et al., 2021; URT, 2019).

Recently, there has been a rapid increase in the use of ICT products in Tanzania (Kaijage & Mtebe, 2017; The Citizen, 2021). Despite all the efforts and measures on e-waste management undertaken by the Government of Tanzania, the knowledge and awareness of e-waste management are still low (Kaijage & Mtebe, 2017; Raudha & Msolla, 2021). Few studies have focused on assessing legislative issues (Mbago, 2018; Raudha & Msolla, 2021) or public awareness of e-waste (Kaijage & Mtebe, 2017; URT, 2019; Raudha & Msolla, 2021; Nyabise et al., 2021). Therefore, e-waste management needs to be assessed among e-repair vendors. The identification of the practices and roles of e-repair vendors in e-waste management is important for the sustainability of e-waste management.

1.1 Statement of the Problem

The extensive use of electronic devices has led to a significant rise in global electronic waste (Hsu et al., 2023). Developing countries like Tanzania face particular challenges in managing this waste stream (Baldé et al., 2017; Parajuly et al., 2019). Despite the enactment of regulations on e-waste management in 2021, Tanzania still encountered challenges in the management of e-waste. Some of the challenges include informal e-waste recycling and disposal practices and a lack of incentives for consumers and enterprises to handle e-waste. In addition, the state is experiencing limited availability of accurate estimates and data on the quantity of e-waste generated (URT, 2021; Ngaponda, 2020; National Bureau of Statistics, 2019).

Previous studies on e-waste in Tanzania focused on policy and regulatory frameworks (Koka, 2017); e-waste generation and quantification (Andeobu et al., 2021); environmental and health impacts (Mdoe, 2017); and public awareness and consumer behavior (Gumbo & Kalegele, 2015). However, there is a lack of understanding regarding the descriptive analysis of e-waste management among electronic repair vendors in urban areas, specifically in Mwanza City, Tanzania. The current literature mainly focuses on e-waste management in national or primary cities (Nyeko et al., 2023; Cardoso et al., 2023), overlooking the unique dynamics in secondary urban centers. Furthermore, the role of electronic repair vendors, who are crucial stakeholders in the e-waste management chain, has not been adequately explored in the Tanzanian context (Raudha & Msolla, 2021).

1.2 Research Objective

The objective of this study was to assess e-waste management among e-repair vendors in Mwanza City, Tanzania. Specifically, the identification of e-waste management practices and the roles of e-repair vendors in e-waste management were done for the sustainability of e-waste management.

II. LITERATURE REVIEW

2.1 Empirical literature review

The burgeoning issue of electronic waste (e-waste) management has garnered significant attention in recent years. Several studies have investigated the complexity of e-waste management in various countries. Nelson et al. (2021) examined the role of dealers in shaping current and future e-waste management trends in Dar es Salaam, Tanzania, highlighting the importance of stakeholder engagement in sustainable e-waste management practices. Similarly, Nuwematsiko et al. (2021) probed the knowledge, perceptions, and practices of e-waste management among

consumers in Kampala, Uganda, revealing significant gaps in awareness and the need for improved e-waste management systems.

Maimba et al. (2019) explored the potential effects of computer e-waste disposal management approaches on human health and the environment in Nairobi City County, Kenya, and underscored the importance of adopting sustainable e-waste management practices. In a related study, Borthakur and Govind (2019) analyzed computer and mobile phone waste in urban India from the perspective of public perception, consumption, and disposal behavior, emphasizing the need to understand consumer attitudes and practices in e-waste management.

While not directly related to e-waste, Joseph (2022) investigated the impacts of traditional extraction of building materials on biodiversity conservation and the livelihoods of communities residing in Mwanza City, Tanzania, highlighting the importance of sustainable resource management and the consideration of environmental and social factors in urban development planning. Marwa et al. (2021) examined the disposal practices of expired and unused medications among households in Mwanza, Tanzania, and underscored the importance of proper waste management strategies and the need for public awareness campaigns to promote safe disposal practices.

These studies collectively emphasize the significance of engaging stakeholders, promoting public awareness, and developing comprehensive waste-management strategies. However, a notable research gap exists in assessing e-waste management practices among e-repair vendors and identifying their role in promoting sustainable e-waste management. This study aims to address this knowledge gap by conducting a descriptive analysis of e-waste management among electronic repair vendors in Mwanza, Tanzania.

2.2 Theoretical Framework

This study employs stakeholder theory as its theoretical framework to investigate e-waste management among electronic repair vendors in Mwanza City, Tanzania. Stakeholder Theory posits that organizations should consider the interests and needs of all stakeholders in their decision-making processes (Freeman, 1984). This approach is particularly relevant for e-waste management, as it involves multiple stakeholders with varying interests and responsibilities.

This study applies stakeholder theory to examine the roles and interactions of electronic repair vendors and other stakeholders within the e-waste ecosystem in Mwanza. We identified electronic repair vendors as key stakeholders in e-waste management systems that significantly impact the repair, refurbishment, and disposal of electronic products (Bhattacharya & Fayezi, 2021). This is crucial because Mwanza faces substantial e-waste generation and inadequate management of its collection and disposal (Ferramosca, 2019; Wiesmeth, 2020).

The analysis involves three key aspects of stakeholder theory. First, we conducted stakeholder identification and recognized relevant stakeholders in the e-waste management system in Mwanza City (Marwa *et al.*, 2021). Second, we explored the interests and expectations of different stakeholders regarding e-waste management, focusing on the priorities and concerns of electronic repair vendors (Ferramosca, 2019; Wiesmeth, 2020). This is essential because studies have highlighted the need to assess e-waste management practices among e-repair vendors and identify their roles in promoting sustainable e-waste management (Joseph, 2022; Marwa et al., 2021). Third, we assessed the current level of engagement and collaboration among stakeholders in the e-waste management system in Mwanza City, identifying opportunities for enhanced cooperation and partnerships to promote sustainable e-waste management practices (Borthakur & Govind, 2019).

The study's findings provide a comprehensive understanding of the roles and responsibilities of electronic repair vendors in relation to other stakeholders in the e-waste management ecosystem. We conclude that stakeholder-oriented strategies and policies that promote sustainable e-waste management practices and support the active participation of electronic repair vendors in transitioning towards a more circular economy are essential (Ferramosca, 2019; Nelson et al., 2021). This study aims to address this research gap by conducting a descriptive analysis of e-waste management among electronic repair vendors in Mwanza City, Tanzania.

III. METHODOLOGY

3.1 Study Area

The study was conducted at Lumumba Street, Nyamagana Ward, in Mwanza City. The study was conducted on Lumumba Street, Nyamagana Ward, in Mwanza City. According to URT (2019), in the big cities of Tanzania, there is a disproportionately high number of people who own electronic equipment such as radios, televisions, computers, phones, earbuds, and household appliances. In addition, there is a concentration of e-device technicians and sellers. Therefore, given that Mwanza City is the second-largest city in Tanzania and the business center of the Mwanza region (URT, 2019), this is one of the reasons for choosing Mwanza City. Lumumba Street in Nyamagana Ward was

chosen because it is one of the streets located in the city center of Mwanza. It serves as a major business zone in which electronic materials are both sold and repaired, as supported by Nyabise et al. (2021).

3.2 Research Design

This study used a cross-sectional design. The reason for using this design is that the cross-sectional design is a research strategy in which one or more groups of subjects are studied at a single point in time (Drew, 2023). Therefore, this design enabled the researcher to gather data quickly despite the limitations of time and resources.

3.3 The Study Population, Sampling Procedure, and Sample Size

This study focused on electronic repair vendors who found and had electronic repair businesses in the study area. Purposive sampling was used to obtain 67 e-repair vendors on selected streets. The sample unit used in this study was an e-repair company. The sample size of 67 e-repair vendors was determined using the formula developed by Cochran (1977) with an unknown population. An approximately 90% confidence level with a 10% marginal error was used to estimate the sample size of e-repair vendors contributing to e-waste management. This formula is expressed as follows:

$$n = \frac{Zscore^2 \times p(1 - p)}{e^2} = \frac{1.64^2 \times 0.5 \times 0.5}{0.1^2} = 66.24 \approx 67$$

Where: n represents the sample size; z is z score from the standard normal distribution reflecting the confidence level, which is 1.64 for 90%; p = population proportion (assumed as 50% or 0.5); $1-p = 0.5$ and; e is the margin of error, which was set at 10%.

3.4 Data Types and Sources

Secondary and primary data were used in this study. Primary data were collected from e-repair vendors using interviews, questionnaires, and observational methods. Secondary data were obtained by reading various research articles and dissertations. A mixed method was applied, and both quantitative and qualitative data were gathered to obtain information. This approach is useful because it provides a comprehensive understanding of the study results (Clark & Ivankova, 2016). Quantitative data were collected using a questionnaire method, while an interview method was used to capture qualitative data, such as awareness of e-repair vendors on e-waste management and factors affecting e-waste management.

3.5 Analysis

Data analysis is the process of collecting, modelling, and analyzing data using various statistical and logical methods and techniques (Calzon, 2023). Descriptive statistics were used to analyze the data. Descriptive analyses were performed using Statistical Package for Social Sciences (SPSS) version 20. The analyzed data are presented in tabular form (table) and figures.

IV. FINDINGS & DISCUSSIONS

4.1 Demographic Characteristics of Electronic Repair Vendors

The study aimed to establish selected demographic characteristics of the respondents. The findings are presented in Table 1.

Table 1

Respondent's Characteristics (n = 67)

Characteristics		Frequency	Percentage (%)
Sex	Male	59	88.1
	Female	8	11.9
Age group	20-35	42	62.7
	36-45	22	32.8
	>46	3	4.5
Education	Primary	11	16.4
	Secondary	34	50.8
	University and others	22	32.8
Experience	Below 1 year	6	9.0
	1- 3 years	13	19.4
	3-6 years	16	23.9
	7 years and above	32	47.8

In a survey of 67 electronic repair vendors as shown in Table 1, it was found that the majority of respondents were male (88.1%) and 11.9% were female. Education was categorized into three groups: primary, secondary, university, and other. Approximately 50.8% had secondary education, 32.8% had university education, and 16.4% had primary education. The age of vendors ranged from 20 to 35 years (62.7%), and 32.8 % %were 36 to 45 years. Approximately half of the vendors had over seven years of experience (47.8%).

4.2 Types of E-Products Repaired

E-products are categorized as mobile phones, computers (desktop and laptops), printers, and kitchen appliances, as shown in (Figure 1). The results showed that 38.9% of e-products repaired were mobile phones; 16.4% were televisions, radios, irons, fans, cameras, air conditioners, fridges, and electronic games; and only 4.4% were kitchen appliances.

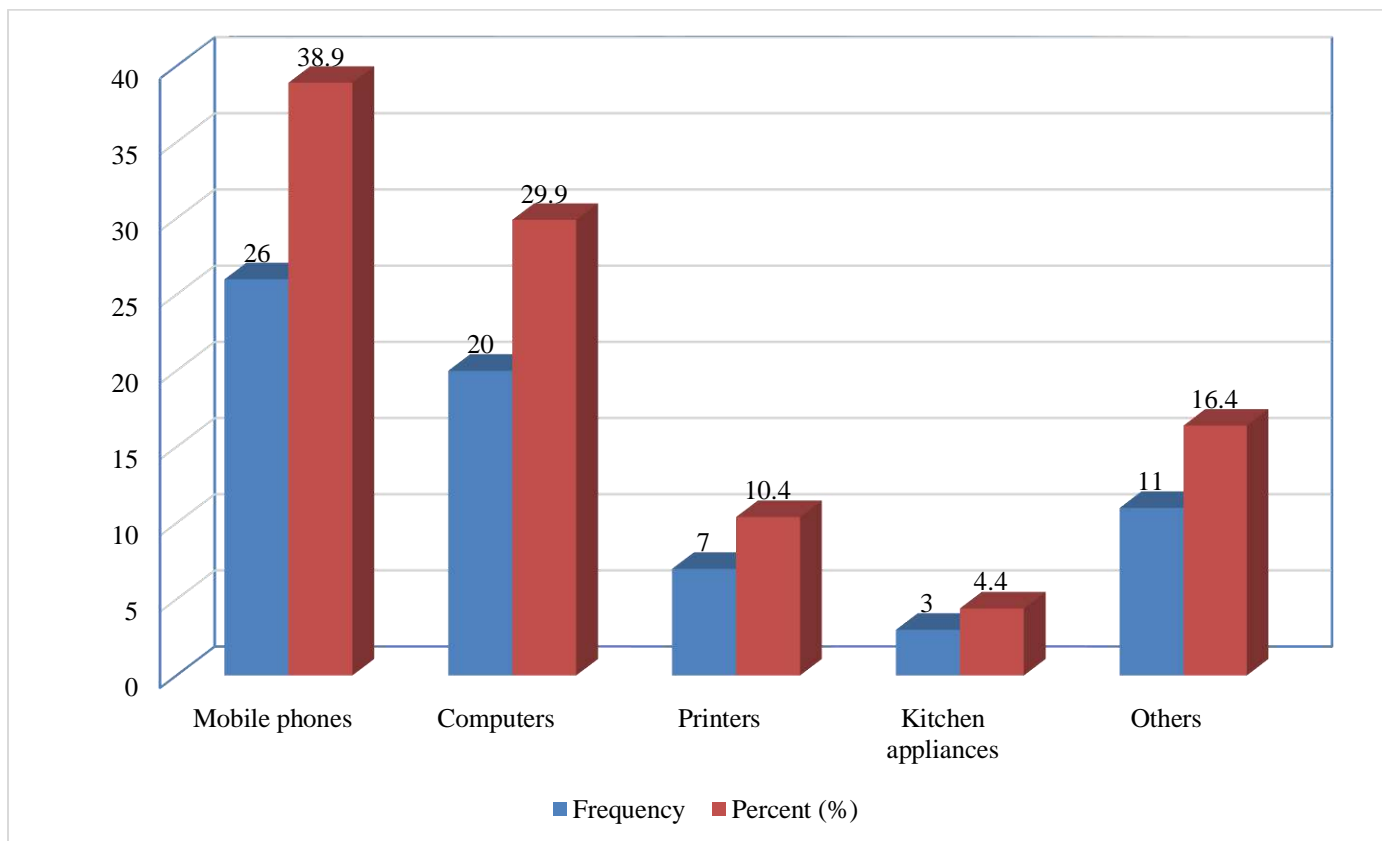


Figure 1
Types of Electronic Products Repaired by E-Repair Vendors

4.3 E-Waste Management Practices by E-Repair Vendors

E-waste management practices applied by electronic repair vendors are an important gauge to determine the current situation in handling non-repairable products, or e-waste, in the study area. The results in Table 2 show that 29.5% of respondents said they manage e-waste by using it as a spare to other e-products, followed by 27.7% who sell it to third parties who are recyclers or makers, and only 2.7% said they used other practices on e-waste management, such as burning and collecting in municipal waste collection vehicles.

Table 2
Multiple Responses on E-Waste Management Practices

Practices	Frequency	Percent (%)
Use as a spare	65	29.5
Resale to third parts	61	27.7
Storage system	36	16.4
Proper disposal through certified Recycling centres	23	10.5
Dumping in landfills	15	6.8
Throw away to improper dumping place	14	6.4
Others	6	2.7



4.4 Contribution of E-Repair Vendors on E-waste Management

Table 3 shows the statements about the contribution of e-repair vendors to e-waste management based on the 67 e-repair vendors who participated. The first statement asked respondents, "Have e-repair vendors contributed to the collection and storage of e-waste for proper recycling?" The results showed that 80.6% of respondents strongly agreed that the collection, storage, and sale of e-waste to recycling centers are contributions of e-repair vendors to e-waste management, while 2.9% were neutral. Second, the statement "educating customers when they come to repair their e-product (e-users)" is a contribution made by e-repair vendors: 23% of respondents strongly agreed and 2.9% disagreed, while 1.5% strongly disagreed and 50.6% were neutral. Third, the statement was "repairing and extending the lifespan of electronic devices". The results showed that 65.7% of respondents strongly agreed that this was a contribution made by them, while 13.4% were neutral. The statement "reduces the need for new electronic devices, and the results show that 38% of respondents strongly agreed, while 16.4% strongly disagreed. The fifth statement was, "Do e-repair vendors promote the reuse of e-components to minimize e-waste?" About 76.2% of respondents strongly agreed, while 1.5% strongly disagreed.

Sixth, the statement was, "Disposing e-waste through selling to recyclers is a contribution made by e-repair vendors to electronic waste management." About 73.1% of the respondents strongly agreed that the disposal of e-waste through selling to recyclers was a contribution made by e-repair vendors, while 1.5% disagreed. Furthermore, in an interview with a key informant (a buyer of electronic waste from an e-recycling center) on the contribution of e-repair vendors, he said the following:

"Electronic repair vendors have an important role for all users of electronic products and recycling centres, and due to that, many e-recycler businesses rely more on getting e-raw materials from such e-technicians. He also continued to say that they collect an average of 15 kg of non-repairable e-products per week from e-repair vendors in Lumumba Street, especially the circuits from different mobile phones, computers, and camera technicians, and they pay Tsh 4,500 per kilogram as the price of purchase" (Buyer of e-waste, 2023).

Table 3

Contribution of E-Repair Vendors on E-Waste Management

Statements	Level of Agreement Based on n = 67				
	SA	A	N	D	SD
Facilitates the collection and storage of e-waste for proper recycling	54(80.6)	11(16.4)	2(2.9)	0(0)	0(0)
Educating (e-users)	16(23.9)	14(20.9)	34(50.6)	2(2.9)	1(1.5)
Repairing and extending the lifespan of electronic devices	44(65.9)	14(20.9)	9(13.4)	0(0)	0(0)
Reduce the need for new electronic product	26(38.8)	13(19.4)	12(17.9)	5(7.5)	11(16.4)
Promote the reuse of e-component to minimize e-waste.	51(76.2)	11(16.4)	3(4.5)	1(1.5)	1(1.5)
Dispose of e-waste through selling to recyclers	49(73.1)	13(19.4)	4(5.9)	1(1.5)	0(0)

Key: Percent (%); Obs (N) 67; Note: A= Agree, SA= Strongly Agree, N= Neutral, D= Disagree, SD= Strongly Disagree

4.5 Economic and Environment Benefits of E-Waste Management

4.5.1 Economic Benefits

The results in Table 4 show that 30% of respondents said that one of the benefits of e-waste management was to increase profits for repair vendors through repair, and 9.1% of the responses were to create new job opportunities, increase the availability of raw materials, save on the cost of raw materials, and boost the local economy.

Table 4

Multiple Responses on Economic Benefits of E-Waste Management

Benefits	Frequency	Percent (%)
Increase profits for repair vendors	66	30
Decreased cost for consumers and businesses	59	26.8
Generating revenue from the selling unrepaired e-devices	48	21.8
Stimulate local economies through repair services.	27	12.3
Others	20	9.1

4.5.2 Environment Benefits

The results in (Table 5) show that 42.4% of responses were about resource conservation, while 5.7% of other responses included reducing pollution, keeping the environment safe and clean, and saving land. This finding indicates that e-waste management significantly influences environmental conditions, particularly resource conservation.

Table 5

Multiple Responses on Environment Benefits of E-Waste Management

Benefits	Frequency	Percent (%)
Resource conservation	67	42.4
Reduce greenhouse gas emissions	51	32.3
Reduce energy consumption through repair	31	19.6
Others	9	5.7

4.6 Discussions

The results of this study show that more males engage in e-repair services than females do. The results were consistent with the study by Seenga et al. (2018) and Nyabise et al. (2021), which indicated males were most engaged in the management of e-waste. The highest age group of respondents ranged between 20 and 35 years, implying that the majority of electronic repair vendors are still young, making it easier for them to deal with issues related to e-waste management. Similarly, the study conducted by Kumari et al. (2021) found that 86% of respondents were aged between 20 and 39 years. In this case, it is alarming that young people in e-waste management programs must be taken into account as part of the programs. Most of them had secondary education, which is in contrast to the findings of Kumari et al. (2019), who found that the majority were not well-educated.

Most products repaired by e-repair vendors were mobile phones (38.8%). This means that the highest amounts of e-waste come from mobile phones compared to others, such as computers and kitchen appliances such as electric ovens, fridges, and hand blenders. This finding is supported by evidence from Nyabise et al. (2021), who found that approximately 87% of the waste generated is from mobile phones and their accessories, followed by computers and their accessories, and home appliances. This finding is supported by Ilankoon et al. (2018), who indicated that 80% of e-waste was from mobile phones. Furthermore, Business Research Company (BRC, 2023) reported that three-quarters of e-waste comes from mobile phones and computers.

E-waste management practices used by electronic repair vendors are an important gauge to determine the current situation in handling e-waste in the study area. Most e-repair vendors manage e-waste by using it as a spare for other e-products. These results imply that e-waste management practices used by e-repair vendors are friendly to the environment and people's health as a whole. These findings are supported by Kandel (2022) and Khamis et al. (2022), who found that e-repair vendors used the old device as a spare part for a newer one. In contrast, De Guimaraes et al. (2020) found that landfills are the most conventional disposal technique for various e-waste streams.

E-repair vendors have various roles in e-waste management. Educating customers on e-waste management was found to play a minor role for e-repair vendors. This finding was supported by Kumari et al. (2019), who found that educating customers is not a major role for electronic repair workers. This implies that educating customers is not a role played by e-repair vendors in the sensitization of e-waste management. The major role of e-repair vendors is to repair and extend the lifespan of electronic devices, which is similar to the results of Ilankoon et al. (2018). In addition, e-repair vendors promote the reuse of e-components and disposal of e-waste by selling it to recyclers to minimize e-waste, as was found by Lepawsk et al. (2023).

The economic benefits of e-waste management include increased profits, decreased production costs, and the creation of new job opportunities. These findings are connected by Fuldauer et al. (2019) and De Guimaraes et al. (2020) and Transparency Market Research (TMR, 2022), who found that saving energy and creating new jobs as a result of e-waste recycling. This implies that despite the majority of respondents earning income from repairing e-products, there are other economic benefits, such as the creation of job opportunities and the reduction of the cost of materials obtained.

Environmental benefits, such as reducing pollution, keeping the environment safe and clean, and saving land, were also the results of e-waste management. Kandel (2022) and Wieland (2021) also found that saving valuable natural resources has environmental benefits associated with managing the e-waste generated. Another study conducted by Fuldauer et al. (2019) found that conserving natural resources was mostly environmentally beneficial. A study conducted in Peru by Lepawsky et al. (2023) found that 10% of the total emissions from global warming could be saved through the repair of e-products. In this case, it is the fact that e-waste management significantly influences environmental conditions, particularly resource conservation.

V. CONCLUSIONS RECOMMENDATIONS

5.1 Conclusions

The findings in this study indicate that using e-waste as a spare part of other products and selling non-repairable e-waste to third parties are current e-waste management practices. Moreover, e-repair vendors have been found to contribute to e-waste management, particularly repair, collection, and storage.

5.2 Recommendations

The study recommends that an e-waste awareness campaign be instituted in the e-repair industry, that e-waste management be undertaken sustainably to combat unnecessary disposal, and that the deposition of e-waste and e-waste collection equipment(s) be provided to e-repair vendors for proper e-waste collection and management. Also, there is a need to conduct further studies to assess strategies used by local authorities to support e-repair vendors in e-waste management.

Conflict of Interest

The authors declare that there is no conflict of interest.

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