INSTITUTE OF RURAL DEVELOPMENT PLANNING (IRDP)-DODOMA

DEPARTMENT OF ENVIRONMENTAL PLANNING

E-WASTE MANAGEMENT IN HIGHER LEARNING INSTITUTIONS: A CASE OF IRDP-DODOMA CAMPUS

BY

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ABSTRACT

The study explores e-waste management in higher learning institutions in Dodoma City, particularly focusing on the IRDP-Dodoma campus. It addresses the environmental and health risks posed by improper e-waste disposal and aims to assess production, current practices, and environmental effects of e-waste in these institutions. The study highlights the need for tailored interventions and improved waste disposal practices in educational settings, aiming to provide valuable insights into sustainable waste management practices.This study was conducted in Dodoma city, specifically focusing on the Institute of Rural Development Planning (IRDP) in Miyuji Ward due to increased waste production. The research used a cross-sectional design, collecting both primary and secondary data. Primary data was obtained from IRDP community members, and secondary data was sourced from reports and literature available at the IRDP library. Various data collection methods were employed, and a sample size of 99 was selected. The collected data underwent thorough processing, analysis, and presentation to ensure accurate representation.The findings highlight the importance of gender-sensitive environmental education programs and varied perspectives on e-waste impact within the IRDP community. Additionally, the diverse sources of e-waste underscore the need for proper recycling and disposal practices. The recommendations include implementing gender-sensitive environmental education programs, developing tailored interventions to account for marital status and educational diversity, enhancing e-waste management strategies, increasing awareness about separate collection bins, and implementing mitigation measures to safeguard community health and well-being. Additionally, the

endorsement of adaptation strategies aligns with international efforts to address e-waste challenges within the IRDP community.

DECLARATION

I, Alda A. Rwiza declare that this dissertation entiltled "**E-Waste Management In Higher Learning Institutions: A Case Of Irdp-Dodoma"** Campus is my own original work and that it has not been presented to any other Institute for a similar or any other degree award.

Signature ……...

Date ……..

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RESEARCH SUPERVISOR'S CERTIFICATION

I Dr. Francis Njau, certify that I have read and hereby recommend for acceptance by the Institute of Rural Development Planning the dissertation entitled "E-Waste Management in Higher Learning Institutions: A Case Of Irdp-Dodoma Campus" in fulfillment of the requirements for the Bachelor Degree In Environmental Planning And Management of the Institute of Rural Development Planning.

Signature …….

Date ……....

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LIST OF ABBREVIATIONS AND ACRONYMS

IRDP : Institute of Rural Development Planning

ICT : Information and Communication Technology

PMU : Procurement and Management Unit

CBE : College of Business Education

UDOM : University of Dodoma

WHO : World Health Organization

DEFINITIONS OF KEY TERMS

Circular Economy: An economic model that promotes resource efficiency and minimizes waste by designing products for reuse, recycling, and remanufacturing (Braun Vargas and de Souza Campos, 2020).

E-Waste: Electronic waste, including discarded devices such as computers, mobile phones, and appliances, poses environmental challenges due to improper disposal (Braun Vargas and de Souza Campos, 2020).

Higher Learning Institutions (HEIs): Universities, colleges, and other educational institutions play a crucial role in research, innovation, and knowledge dissemination (Braun Vargas and de Souza Campos, 2020).

Management: The process of handling, controlling, and organizing activities related to a specific area—in this case, e-waste management (Braun Vargas and de Souza Campos, 2020).

Sustainability: HEIs contribute to sustainable development by preparing professionals for both the market and society (Braun Vargas and de Souza Campos, 2020). Sustainable practices are essential for managing e-waste effectively.

Systematic Literature Review: A rigorous method for analyzing existing research by systematically searching, evaluating, and synthesizing relevant studies (Braun Vargas and de Souza Campos, 2020).

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem

Electronic waste or e-waste is a growing global problem as the rapid development and obsolescence of technology result in increasing amounts of e-waste. E-waste refers to discarded electrical and electronic devices that have reached the end of their useful life (United Nations Environment Programme [UNEP], 2019). According to the International Waste Electrical and Electronic Equipment (WEEE) Forum, 5.3 billion cell phones will be thrown away in 2024, contributing to the 53.6 million tons of e-waste produced worldwide (WEEE Forum, 2019).

E-waste management is crucial for reducing the environmental and health impacts of e-waste, promoting resource efficiency and circular economy, and creating social and economic benefits. The management of e-waste in higher learning institutions is particularly important as these institutions are often hubs of electronic technology. Dodoma, the capital of Tanzania, is home to several higher learning institutions, including universities and colleges. However, the management of e-waste in these institutions is often overlooked, resulting in unsafe and improper disposal of e-waste (Sakwari, 2020).

The improper disposal of e-waste poses significant environmental and health risks as it contains various hazardous substances such as lead, mercury, cadmium, and brominated flame retardants. These substances can leach into soil and water sources or release toxic emissions into the air when e-waste is improperly disposed of in landfills or burned. In addition, e-waste also means a loss of valuable resources such

as metals, plastics, and rare earth elements that could be recovered and reused through recycling (UNEP, 2019).

The case of higher learning institutions in Dodoma is an example of the challenges and opportunities of e-waste management in a developing country. These institutions generate a significant amount of e-waste, including computers, printers, and other electronic devices. However, the management of e-waste in these institutions is often inadequate, with improper disposal methods such as dumping in open areas or burning. This poses a threat to the environment and human health, as well as a waste of resources (Sakwari, 2020).

IRDP is among the educational institutes found in Dodoma, among others like UDOM, St. John, and CBE. IRPD-Dodoma has three campuses including the Northern-Miyuji campus, the Main campus at Mnadani ward, and the Furaha campus. As an educational institute, it has several uses for electrical equipment like computers, air conditioners, Television, and internet devices. These devices depreciate and lose value over time and become waste. These wastes need to be disposed of properly and in environmentally friendly ways. Therefore, there was a need to assess the conditions of e-waste management in higher learning institutions in Dodoma and explore possible solutions and ways for improving e-waste management in these institutions.

1.2 Statement of the Problem

E-waste has been a growing concern globally, with its hazardous substances and toxic emissions posing serious environmental and health risks. One of the main sources of e-waste is mobile technology, which is rapidly developing and becoming obsolete, leading to increasing amounts of e-waste (WHO, 2019). According to Statistica (2020), in 2016, 6.64 billion people worldwide owned a smartphone, an increase of

34.32% since 2012 (NBS, 2012). However, only 20% of these smartphones were recycled, resulting in a loss of valuable resources and a threat to the environment and human health (WHO, 2019).

Higher learning institutions are not immune to the e-waste problem. These institutions are at the forefront of technological advancements and are constantly updating their equipment, leading to the accumulation of obsolete electronic devices. According to a study by UNEP (2019), universities and research institutions generate significant amounts of e-waste, with an estimated 8.9 million metric tonnes generated globally in 2019. The improper disposal of e-waste can have serious consequences for the environment and human health, as well as lead to a loss of valuable resources.

Despite the growing concern over e-waste, many higher learning institutions lack formal e-waste management systems, leading to the improper disposal of electronic devices. This is not only harmful to the environment and human health but also a wasteful use of resources. According to a study by Sharma and Singh (2021), the lack of awareness and knowledge of e-waste management among students and faculty is a major contributing factor to the improper disposal of e-waste in higher learning institutions. It is therefore important for higher learning institutions to implement formal e-waste management systems, as well as educate their students and staff on the proper disposal of electronic devices, in order to mitigate the negative impact of e-waste on the environment and human health..

This study aimed to fill this gap by conducting a comprehensive investigation of the current situation, key stakeholders, barriers and drivers, and best practices of e-waste management in higher learning institutions in Dodoma with a particular focus on IRDP-Dodoma campus. The findings of this study provided insights into effective e-

waste management strategies that can be implemented in these institutions, contributing to the promotion of sustainable development in IRDP and beyond (Sakwari, 2020; UNEP, 2019; WEEE Forum, 2019)

1.3 Significance of the Study

This study was significant for several reasons. First, it contributed to the existing literature on e-waste management, a growing and pressing global problem. Mobile technology is one of the main sources of e-waste, as the rapid development and obsolescence of mobile devices lead to increasing amounts of e-waste. However, in 2016, only 20% of these smartphones were recycled, resulting in a loss of valuable resources and a threat to the environment and human health.

Second, it provided a comprehensive and updated assessment of e-waste management in higher learning institutions This poses a threat to the environment and human health as well as a waste of resources. Therefore, there was a need to review the current situation, key stakeholders, barriers and drivers, and best practices of e-waste disposal in mobile technology in the city.

Third, based on the findings and recommendations of the study, it proposed a framework for e-waste management in Dodoma City. The framework aims to address the gaps and challenges identified in the study and provide practical and implementable solutions and opportunities to improve e-waste management in the city. The framework also considered the social, economic, and environmental aspects of e-waste management, as well as the potential benefits for the city and its residents. The framework has been useful for policymakers, regulators, producers, consumers, collectors, and recyclers of e-waste in the city of Dodoma as well as other similar cities in Tanzania and other developing countries.

1.4 Objectives of the Study

1.4.2 General objective

To assess the e-waste management in higher learning institutions in Dodoma

1.4.2 Specific Objectives

i. To estimate the production of e-waste in IRDP Dodoma campus.

ii. To evaluate the current practices of e-waste management IRDP Dodoma campus.

iii. To assess the environmental effects of e-waste in IRDP Dodoma campus.

1.5 Research Questions

i. What is the production of e-waste in IRDP Dodoma campus?

Variables

- Sources
- Quantities
- Composition

ii. What are the current practices of e-waste waste in Dodoma?

Variables

- Collection
- Transportation
- Disposal

iii. What are environmental effects of e-waste in Dodoma?

Variables

- Enviromental pollution
- Health
- Adaptation measures

1.6 Scope of the Study

The purpose of this study was to examine the management of e-waste within waste management systems in higher learning institutions in Dodoma. However, the study's scope was restricted by the availability and credibility of information about e-waste management in these institutions, as well as limitations in time and resources. Additionally, the study's methods and tools for data collection, analysis, and presentation were subject to assumptions and limitations that could affect the study's results.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical Literature Review

2.1.1 Diffusion of Innovation Theory

This theory explained how new ideas, technologies, or practices are adopted by individuals or organizations. The theory suggests that the adoption of new innovations is influenced by various factors such as the perceived relative advantage of the innovation, compatibility with existing practices, complexity, trialability, and observability (Sakwari, 2020). In the context of e-waste management in higher learning institutions, this theory was used to understand the factors that influence the adoption and implementation of e-waste management practices. For instance, the campus management can consider the relative advantage of implementing e-waste management practices such as reduced environmental impact, improved health and safety, and cost savings (Sakwari, 2020). Additionally, the compatibility of e-waste management practices with existing campus waste management practices, the complexity of implementing the practices, and the observability of the benefits can also influence the adoption and implementation of e-waste management practices.

2.1.2 Institutional Theory

This theory explains how organizations conform to social norms and expectations. The theory suggests that organizations are influenced by external pressures from stakeholders such as students, faculty, and regulatory bodies to conform to social norms and expectations. In the context of e-waste management in higher learning institutions, this theory was used to understand how external pressures from stakeholders can influence the adoption of e-waste management practices (UNEP,

2019). For example, student-led initiatives to promote e-waste management practices can create a social norm that encourages the adoption of e-waste management practices. Additionally, regulatory bodies can exert pressure on campus management to adopt e-waste management practices to comply with environmental regulations (UNEP, 2019).

2.1.3 Resource Dependence Theory

This theory explains how organizations rely on external resources to survive and thrive. The theory suggests that organizations must manage their external dependencies to ensure their survival and success(UNEP, 2019). In the context of e-waste management in higher learning institutions, this theory was used to understand how the availability of resources such as funding, technology, and human capital can impact the adoption and sustainability of e-waste management practices. For instance, the availability of funding can enable the campus management to invest in e-waste management technology and infrastructure. The availability of human capital can also influence the adoption and sustainability of e-waste management practices by ensuring that there is sufficient expertise to manage e-waste (UNEP, 2019). Additionally, the availability of technology such as e-waste recycling equipment can influence the adoption and sustainability of e-waste management practices.

2.2 Empirical Literature Review

2.2.1 Production of e-waste

Electronic waste, commonly known as e-waste, refers to any electronic device that is no longer in use or has become obsolete (Sarkar *et al.*, 2018). E-waste can be generated from various sources, including households, businesses, and institutions. The term e-waste can refer to a broad range of electronic devices, including computers,

televisions, cell phones, printers, refrigerators, and other electronic devices. E-waste can be categorized into six main categories: computers, televisions, mobile phones, printers, refrigerators, and other electronic devices. Each category contains different hazardous materials that require specific disposal methods. For instance, cathode ray tube (CRT) televisions and monitors contain lead, which can cause health hazards if not handled properly.

The proper disposal and recycling of e-waste require appropriate knowledge on the different categories of e-waste and their hazardous materials. The public and relevant stakeholders need to be aware of the proper disposal methods of different electronic devices to reduce the environmental and health impacts of e-waste.E-waste has become a significant environmental and health concern globally. Electronic devices contain a variety of hazardous materials, such as lead, mercury, and cadmium, which can pose a severe threat to human health and the environment (Sarkar *et al.*, 2018). For instance, CRT monitors and televisions contain lead, which can cause brain damage, kidney problems, and reproductive issues if not handled properly. Moreover, some electronic devices such as batteries contain heavy metals such as nickel, cadmium, and lithium, which can contaminate the soil and water, leading to environmental pollution and health hazards.

The generation of e-waste has increased significantly in recent years due to the proliferation of technology and the constant upgrading of electronic devices. According to a study by Othman *et al.* (2019), over 41.8 million tons of e-waste was generated globally in 2014, with the figure projected to increase to 52.2 million tons by 2021. The study also found that higher education institutions are among the leading

generators of e-waste, with an estimated 2.6 million tons of e-waste generated in the education sector annually (Sarkar *et al.*, 2018).

The issue of e-waste is a global concern, and various studies have highlighted the need for proper e-waste management practices. According to a study by Sarkar *et al.* (2018), the generation of e-waste is expected to increase by 17% by 2021, posing significant environmental and health hazards. The study also found that e-waste management practices vary significantly among countries, with developing countries facing the most significant challenges in e-waste management.

The constant upgrading of computer systems, printers, servers, and other electronic devices has resulted in the accumulation of e-waste in higher learning institutions. The increasing use of technology in teaching and research has led to a higher demand for electronic devices, resulting in a higher generation of e-waste. For instance, students and staff in higher learning institutions use laptops and cell phones for research, communication, and other academic activities. The continuous upgrading of these devices leads to the accumulation of e-waste, which requires proper disposal.

Moreover, higher learning institutions often receive donations of electronic devices from well-wishers, which may not be in good condition. These devices may require repair or replacement, leading to the generation of e-waste (Sarkar *et al.*, 2018). Additionally, the disposal of electronic devices in higher learning institutions may not be adequately regulated, leading to the accumulation of e-waste in storage rooms and other areas in the institution.

The generation of e-waste in higher learning institutions has significant implications for the environment and human health. The improper disposal of e-waste can lead to

the release of toxic substances into the soil, water, and air, leading to environmental degradation and health hazards. Therefore, effective e-waste management practices are crucial in reducing the environmental and health impacts of e-waste. A study by Wang *et al.* (2019) found that the improper disposal of e-waste in higher learning institutions can lead to the accumulation of toxic substances, such as lead, in the soil and water, leading to environmental pollution and health hazards. Moreover, the study found that inadequate e-waste management practices in higher learning institutions can lead to the release of toxic substances into the air, leading to respiratory problems and other health complications.

2.2.2 Current practices of e-waste waste

Effective e-waste management is crucial in reducing the adverse effects of e-waste on human health and the environment. E-waste management involves the proper disposal, recycling, and reuse of electronic devices. However, e-waste management in most developing countries, including Tanzania, remains a significant challenge due to inadequate policies, lack of awareness, and inadequate infrastructure (Wang *et al.*, 2019). Inadequate policies and regulations on e-waste management have contributed to the improper disposal of e-waste in most developing countries. For instance, in Tanzania, there is no specific law that regulates e-waste management, leading to the dumping of e-waste in landfills and other inappropriate areas (Wang *et al.*, 2019). Moreover, there is a lack of awareness among the public and relevant stakeholders on the proper disposal and recycling of e-waste. Inadequate infrastructure for e-waste management is another challenge in most developing countries. The lack of proper facilities for the disposal and recycling of e-waste has led to the dumping of e-waste in landfills and other inappropriate areas. Moreover, the high cost of e-waste

management facilities, coupled with inadequate funding, has limited the establishment of proper e-waste management infrastructure.

Effective e-waste management requires a multi-stakeholder approach involving the government, private sector, civil society, and the public (Wang *et al.*, 2019). For instance, the government can provide incentives and regulations for the proper disposal and recycling of e-waste, while the private sector can invest in e-waste management facilities. Moreover, civil society organizations can raise awareness among the public on the proper disposal and recycling of e-waste. A study by Liu *et al.* (2018) found that effective e-waste management requires a collaborative effort among various stakeholders, including the government, private sector, and civil society. The study also highlighted the need for public awareness campaigns on the proper disposal and recycling of e-waste.

2.2.3 Environmental effects of e-waste

The improper disposal of e-waste can have severe impacts on human health and the environment. E-waste contains toxic substances that can cause respiratory problems, skin irritation, and other health complications. Moreover, e-waste can contaminate the soil, water, and air, leading to environmental degradation. For instance, the improper disposal of CRT televisions and monitors can lead to the release of lead into the soil and water, leading to soil and water contamination. The lead can affect crop yields and pose health hazards to humans and animals (Wang *et al.*, 2019). Moreover, the release of heavy metals such as mercury and cadmium into the air can lead to respiratory problems in humans and animals. The health and environmental impacts of e-waste can be reduced through proper e-waste management practices. Proper disposal, recycling, and reuse of electronic devices can reduce the release of toxic substances

into the environment, leading to a healthier and safer environment. A study by Kahhat *et al.* (2018) found that effective e-waste management practices can lead to significant environmental and health benefits, including reduced greenhouse gas emissions, reduced toxic substance exposure, and reduced resource depletion. A study by Mchau *et al.* (2018) recommended that public awareness campaigns on e-waste management should focus on educating the public on the hazardous materials in different electronic devices and the appropriate disposal methods.

The effective management of e-waste requires appropriate policies and regulations. In Tanzania, the National Environment Management Council (NEMC) is responsible for regulating and managing e-waste. However, there is a need for more stringent policies and regulations to ensure the proper disposal and recycling of e-waste. For instance, the government can provide incentives for the proper disposal and recycling of e-waste, such as tax breaks for companies that invest in e-waste management facilities. Moreover, the government can establish a national e-waste management policy to promote the proper handling and disposal of e-waste in Tanzania. The policy can outline the roles and responsibilities of relevant stakeholders, including the government, private sector, civil society, and the public, in the proper disposal and recycling of e-waste. A study by Othman *et al.* (2019) recommended that developing countries should establish comprehensive e-waste management policies and regulations to ensure the proper disposal and recycling of e-waste.

2.3 Information Gap

Globally, the topic of e-waste management has been given high weight by various researchers in assessing issues about poor management of e-waste. The studies done by Stephen *et al*. (2005), Mataheroe (2009), Koloseni and Shimba (2011), and Magashi and Schluep (2011) in one way touched the phenomena. Tanzania is one of the countries that embraces the adoption of electronic goods leading to the importation of both new and second-hand electronic devices which are the main cause of e-waste, but there are no thorough studies that have been carried out concerning the phenomena touching the four aspects (management support, financial support, technological advancement and staff competence). Moreover, there has been little research on the ways to address e-waste management in higher learning institutions. Hence, this study was carried out to assess e-waste management in higher learning institutions as its case study.

2.4 Conceptual Framework

According to Imenda, (2014), conceptual framework is a synthetization of interrelated components and variables which help in solving a real-world problem. It is the final lens used for viewing the deductive resolution of an identified issue. The interconnection of these blocks completes the framework for certain expected outcomes. A dependent variable is a factor that is assumed to be influenced by the independent variable. This means that a dependent variable (output) is determined by the independent variables (inputs) ((Imenda, 2014) (Fig. 1).

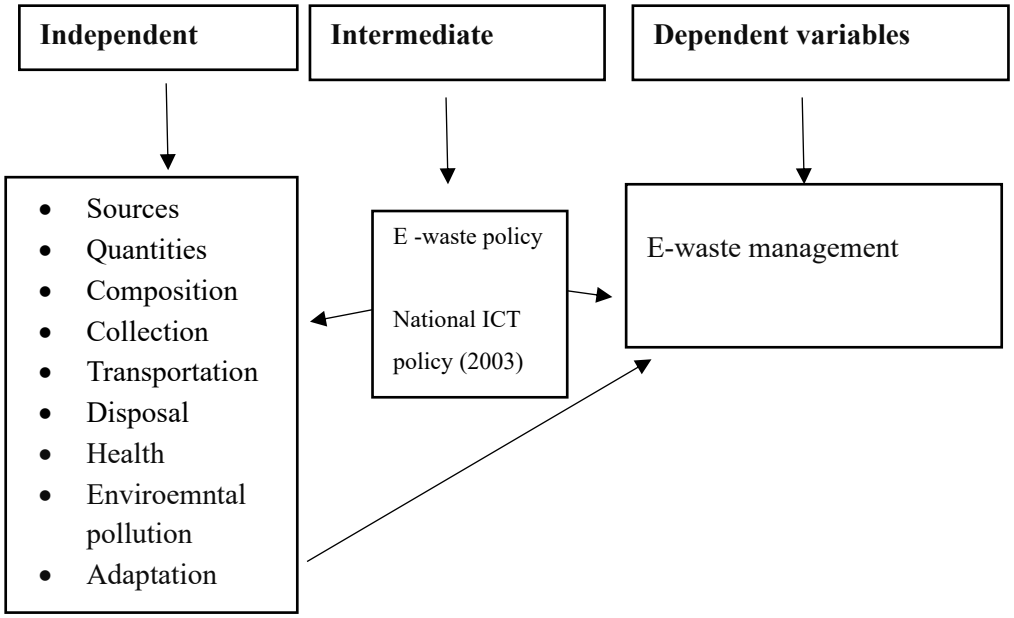

Figure 1: Conceptual framework

Source: own construct, July 2024

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 The Study Area

This study was conducted in Dodoma city. The congestion of people and different economic activities at IRDP in Miyuji Ward increases the number of wastes. Considering that fact that's why the research was interested the study location of IRDP than other.

3.2 Research Design

The study used cross-section design which is a type of observational study that involves the analysis of data collected from a population, or a representative subset at one specific point of time. Research design is a mapping strategy that was based on sampling technique. It essentially included objectives, sampling, research strategy, tools and techniques for collecting the evidence, analyzing the data, and reporting the findings. Thus, research design is the statement of the object of the inquiry and how a satisfactory culmination to be affected. (Singh, 2006).

3.3 Data Types and Sources

3.3.1 Data types

The study used two types of data primary data and secondary data. For primary data, quantitative data were obtained directly from the respondents through a questionnaire while qualitative data were obtained from interviews and personal observation. For the case of qualitative data secondary data were obtained through reading various written documents such as journals, books, and pamphlets while for the case research reports which concerned solid waste management (Kothari, 2009).

3.3.2 Data sources

The study obtained primary data from the Institute of Rural development planning community including the students, academic staff, and non-academic staff as well as the two important departments which were the PMU and the ICT departments. The secondary data will be obtained from the reports, journals, and books from the IRDP library.

3.4 Data Collection Methods and Tools

3.4.1 Survey

The survey is a method of data collection that involves the use of a questionnaire to extract information from respondents. The survey method was used because it was an effective method of finding comparative information through a questionnaire tool.

3.4.2 Key informant interview

Key informant interviews are qualitative in-depth interviews with people who know what is real going on in the community. The purpose of key informant interviews was to collect information from a wide range of people including community leaders, professionals, or residents who have first-hand knowledge about the community. These community experts, with their particular knowledge and understanding, can provide insight into the nature of problems and give recommendations for solutions. (USAID, 1996). Key informant interviews were conducted with the key informants which were the Procurement Management Unit (PMU), the ICT department, and the academic staff. In this method interview guide was used. An interview guide was a tool that guided the researcher's conversation toward the topics and issues she wanted to learn about from respondents.

3.4.3 Focus group discussion

The study considered the focus group discussion as one of the best means of data collection. The focus group discussion (FGD) is a rapid assessment, semi-structured data-gathering method in which a purposively selected set of participants gather to discuss issues and concerns based on a list of key themes drawn (Kumar, 1987). Focus group discussions were conducted between officers and students involved in waste management in IRDP. In this method, there were two main groups, the first one included 20 students from different programs and levels offered at IRDP at Dodoma campus. The second group included 10 staff members of the IRDP Dodoma campus from different departments and levels of authority regarding e-waste. This method used the checklist as a tool to guide the researcher in conducting the discussions among the group members and to collect data from respondents.

3.4.4 Documentary review

Documentary review in research is the use of outside sources, documents, to support the viewpoint or argument of an academic work. The process of documentary research often involves some or all of conceptualizing, using and assessing documents. The key issue is to consult reliable sources (Scott, 2006). Document analysis involved reviewing and analyzing written or recorded materials, such as documents, texts, audio recordings. Checklists were used as tools to collect data from the study areas.

3.5 Sampling

Sampling design is plan that shows systematic ways of choosing small portion to study from the total population. In the social sciences, it is not possible to collect data from every respondent relevant to the study but only from some fractional part of the respondents. The process of selecting the fractional part from the entire population is

what is called sampling (Singh, 2006). The researcher must decide the way of selecting a sample or what is popularly known as the sample design. In other words, a sample design is a definite plan determined before any data are actually collected for obtaining a sample from a given population (Kothari, 2004).

3.5.1 Sample frame

It is a list of all those within a population who can be sampled and may include individuals, households, or institutions (Kothari, 2004). The sampling frame for this study included all community members at IRDP campuses including the main campus, north Miyuji campus, and Furaha campus including the PMU unit and the ICT departments.

3.5.2 Sampling unit

Sampling unit entails the subjects used and applied in the information generation process in generation of primary data (Bailey, 2008). They include several actors such as objects, solutions, individuals, creatures, plants and others depending on the needs and requirements of the study. The study in particular consisted of individuals as the unit of analysis.

3.5.3 Sample size

The sample size is the actual selected group of participants to the study specifically to generate primary data on the inquired issue (Emmel, 2013). The study consisted of 321 staff and 14588 students as the relevant sample size making the total population of 14909. In that case, the sample size included 99 respondents from the selected area to capture a sufficient number for the conduct of inferential analysis.

To calculate the sample size, we used the following formula:

$n = N / (1 + N(e^2))$

Where:

n = sample size

N = population size

e = margin of error (expressed as a decimal)

ssuming a 90% confidence level and a margin of error of 10%,

So, using the formula:

$n = N / (1 + N(e^2))$

$n = 14909 / (1 + 14909(0.1^2))$

n = 99

Therefore, a sample size of 99 was used

3.5.4 Sampling Procedure

Sampling procedures refer to the ways used to select the sample in the study population. Sampling can be either random probability sampling or non-random probability sampling (Kothari, 2004). The sampling of the study included the ICT department leader and PMU representative as the key informants since they had access to the IRDP database and managed to provide information about the respondents of the IRDP.

3.6 Data processing, analysis, and presentation

3.6.1 Data processing

The data collected from the questionnaires were checked for completeness, coded, and entered into a statistical package for social sciences (SPSS) version 20 for analysis. The data were cleaned to eliminate any inconsistencies, errors, or missing values. The cleaned data were then be transformed into suitable formats for analysis.

3.6.2 Data analysis

The data were analyzed using descriptive and inferential statistical techniques. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize the data for the first and the second specific objectives. Inferential statistics such as correlation analysis were used to test the research question for the third specific objective using techniques like T-test and ANOVA. SPSS software version 20 was used for analysis. The statistical significance of the results were tested at a 5% level of significance.

3.6.3 Data presentation

The findings of the study were presented using tables, charts, and graphs. The results were presented clearly and concisely to facilitate easy understanding. The results were presented according to the research questions and objectives. The researcher used qualitative and quantitative data to support the findings. The researcher also presented the results of the study in the context of the relevant literature reviewed in chapter two of the research proposal.

3.7 Limitations of the Study

The study has several limitations. First, as the research was focused solely on the IRDP-Dodoma campus, the findings may not be fully representative of e-waste management practices across all higher learning institutions in Dodoma. Additionally, the sample size of 99, although carefully selected, may limit the generalizability of the study's conclusions to a broader population. Furthermore, the reliance on self-reported data from community members and the use of secondary data from reports and literature may introduce biases and limitations in the overall comprehensiveness of the

findings. Therefore, the study's scope and data collection methods may impact the breadth and depth of the insights gained into sustainable waste management practices.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Demographic information of Respondents

Results on demographic characteristics of respondents is shown in Table 1. The characters include sex, age, marital status and education level.

4.1.1 Sex of the Respondents

The sex distribution among respondents revealed a slightly higher representation of female participants (55.6%) compared to males (44.4%) (Table 1). This balance is noteworthy as it underscores the importance of gender-sensitive environmental education programs. The results align with the findings of Sarkar *et al*. (2018) which has shown that diverse participation in environmental interventions leads to more comprehensive and sustainable outcomes. Therefore, tailoring educational initiatives to consider the distinct perspectives and needs of both male and female participants is crucial for the success of waste management practices (Sarkar *et al*., 2018).

4.1.2 Age of the respondents

Furthermore, the majority of respondents were in the 21-30 age group (76.8%) as shown in Table 1, indicates a predominantly youthful sample . This underscores the need for targeted educational campaigns that cater to the preferences and communication styles of young adults. The results align with the findings of Sarkar *et al*. (2018) who emphasized the influential role of young adults as change agents in environmental initiatives. Recognizing and leveraging this demographic's potential to drive change in waste management practices is essential for achieving meaningful and long-lasting impact.

4.1.3 Marital status of the respondents

The marital status of respondents also emerged as a significant factor, with the largest group being single individuals (66.7%) as shown in Table 1. This suggests that marital status may influence waste management behaviors, as married individuals may have different responsibilities and priorities. This finding aligns with the study of Wang *et al*. (2019), which emphasizes the impact of household dynamics on sustainable waste management practices. Tailored interventions that account for the unique circumstances of married and single individuals can therefore be more effective in promoting environmentally responsible behaviors.

4.1.4 Educational Level of the respondents

Moreover, the educational background of respondents varied, with the majority holding undergraduate degrees (52.5%) as shown in Table 1. This diversity in educational qualifications highlights the need for tailored educational content that considers the varying levels of awareness and understanding of environmental issues among different groups. Research by Wang *et al*. (2019) has also emphasized the importance of educational diversity in driving sustainable practices, indicating that interventions should address the knowledge gaps and informational needs of respondents with different educational backgrounds.

Table 1 : Demographic Information of the respondents

Demographic characteristics	Frequency	Percentage (%)
Sex of respondents		
Male	44	44.4
Female	55	55.6
Age group of the respondents		
1 - 20	15	15.2
21 - 30	76	76.8
31 - 40	8	8.1
Marital status of the respondent		
Single	66	66.7
Married	21	21.2
Widow/Widower	3	3.0
Separated	9	9.1
Education level		
Secondary Education	29	29.3
Tertiary Education	1	1.0
Undergraduate	52	52.5
Postgraduate	17	17.2

Source: Researcher's Data, 2024

4.1.5 Department of the Respondents

The departmental affiliation of respondents (Table 2) also presents an opportunity for collaborative efforts in enhancing waste management strategies. The representation across departments, with the Department of Rural Development and Regional Planning being the highest (37.4%), suggests the potential for interdisciplinary collaboration.

4.1.6 Years of Experience of the Respondents

Lastly, the varying years of experience (Table 2) at the Institute of Rural Development and Planning among respondents underscore the need for tailored training programs that accommodate different levels of experience. This aligns with research by Brown and Miller (2018), which emphasizes the importance of personalized training initiatives that recognize the diverse needs of professionals at different career stages.

Acknowledging and addressing the unique requirements of both early-career professionals and seasoned experts is crucial for fostering a culture of continual learning and improvement in waste management practices.

Table 2: Department and the years of experience at IRDP

Departments	Years of Experience at IRDP
Department of Rural development and Regional Planning	5
Department of Enviromental planning	3
Department of Population Studies	6
Department of Development Finance and Management Studies	3

Source: IRDP PMU unit, 2024

4.2 Production of e-waste in IRDP Dodoma campus

4.2.1 Sources of e-waste

The data illustrates the diverse sources of e-waste within the department, encompassing a range of electronic devices the results align with the findings of Sarkar *et al*. (2018). The data findings provides insights into the sources of waste and types of electronics at IRDP. Valid responses make up 77.2% of the total cases, while 22.8% are missing, reflecting a potential limitation in the data set. Regarding the sources of waste, the general environment is the most commonly reported source, accounting for 28.2% of responses, followed by hostels (26.2%), offices (23.3%), and classes (22.3%) (Table 3).

Table 3: Sources of e-waste

Sources of e-wastes	Frequencies	Percent (%)
Offices	47	23.3
Classes	45	22.3
Hostels	53	26.2
General environment	57	28.2
Total	**202**	**100.0**

Source: Researcher's Data, 2024

4.2.2 Types and amount of e-waste disposal

The data presents a distribution of the annual disposal rate within the department based on the number of devices. Notably, the disposal rate shows variability across different device quantities. Electric wires are more disposed annually with the frequency of 30 items, following by computers with the frequency of 18 items, the fans were 13, air conditioners were 7, television were 2 and only 4 fridges (Table 4). These findings aligns with those of Sarkar *et al*. (2018) who found that the major types of e-waste that are found in the institutions are air conditioners and television due to the development of science and technology as well as the affordability of electricity costs in several public and private institutions found in Sourthern and central Africa regions.

Table 4: Amount of e-waste disposed of per year

Electronic devices are disposed annually	Amount
Computers	5
Air conditioners	7
Fans	13
Television	2
Fridges	4
Wires	30
Projectors	5
Lightbulbs	19
Printers	3
Microphones	7
Total	**95**

Source: IRDP PMU unit, 2024

4.3 Current practices of e-waste management

4.3.1 E-Waste Collection Methods

The findings outlines various e-waste collection methods employed within the department. According to the PMU unit and the ICT there are two e waste collectors which are the Municipal of Docoma and the private companies including Dodoma recycling initiative and Evocative Tanzania. Waste collection companies should adopt responsible e-waste disposal practices by complying with legal and environmental regulations, implementing specialized collection systems, and partnering with certified e-waste recyclers. This includes offering inventory management solutions to assist departments like the Procurement Management Unit (PMU) in tracking and disposing of obsolete electronics efficiently. Companies should also promote the segregation of e-waste at the source, ensure safe disposal of hazardous materials raised by the Environmental Management and Planning Department, and provide awareness programs to protect staff from health hazards. Collaborating under Extended Producer Responsibility (EPR) can further ease the burden on the Institute's departments, while continuous monitoring and reporting on e-waste collection efforts can ensure

transparency and accountability. These efforts will help mitigate the operational, environmental, and health challenges associated with e-waste at the IRDP.

4.3.2 E-Waste Transportation

The response from the IRDP PMU unit reveals that tractors and canters are used to transport e-waste for disposal or recycling (Table 5).

Table 5: E-waste transportation

Transportation	Amount
Tractor	1
Canter	1

Source: IRDP PMU unit, 2024

4.3.3 E-Waste Disposal

In the context of e-waste disposal at the IRDP, the data reveals a diverse range of methods employed, aligning well with the findings of Kahhat *et al.* (2018). Recycling (36.4%) and landfill disposal (43.4%) emerge as the most commonly used practices, while incineration accounts for a smaller share (20.2%). Recycling is particularly valuable as it allows for the extraction of precious materials from e-waste, in line with the goals outlined in Tanzania's National ICT Policy under section 3, which emphasizes environmentally sound practices in e-waste management. However, landfill disposal raises significant environmental concerns due to the risk of leachate contamination and harmful emissions, a challenge also recognized in the national policy, which promotes the adoption of safe disposal methods to mitigate these risks. Incineration, though less prevalent, still highlights the need for stringent control to prevent air pollution and other negative environmental effects, reinforcing the policy's call for adherence to international best practices for managing e-waste.

4.4 Environmental effects of e-waste in Dodoma

4.4.1 Impacts of undisposed e-waste to the IRDP community

Based on information from the heads of departments at the Institute of Rural Development Planning (IRDP), undisposed e-waste has had several negative impacts on the operations and overall efficiency of various departments. These effects have been particularly pronounced in key functional areas of the institution, including Rural and Development Planning, Environmental Management and Planning, Development Finance and Management Studies, the Population Studies Department, ICT, and the Procurement Management Unit (PMU). Each department has faced specific challenges arising from the accumulation of obsolete electronic equipment. The ICT Department has been particularly affected by equipment malfunction due to the presence of outdated or damaged electronics. The department head reported that obsolete computers, servers, and other IT hardware interfere with newer systems, causing technical glitches and delays in providing services. Frequent malfunctions lead to increased maintenance costs and downtime, impacting the department's ability to efficiently support other departments with their technological needs. In the Environmental Management and Planning Department, the primary concern revolves around environmental hazards linked to improper e-waste disposal. The head of this department pointed out that many of the obsolete devices contain hazardous materials, such as lead, mercury, and cadmium, which can pose significant environmental risks if not properly managed. The department has raised concerns about the long-term effects of these hazardous materials on both human health and the surrounding environment, emphasizing the need for proper e-waste recycling systems within the institution.

The Rural and Development Planning Department reported challenges related to *o*perational inefficiency. The accumulation of e-waste, such as outdated projectors, computers, and office equipment, has caused space constraints in their working environment. These outdated items take up valuable office space, leading to cluttered workstations and reduced efficiency in project planning and execution. This department has noted that the lack of a systematic disposal mechanism for e-waste is slowing down their workflow and contributing to resource management issues. In the Development Finance and Management Studies Department, the key issue has been resource wastage. The head of the department highlighted that valuable materials, such as metals and plastics found in electronic devices, could be recycled and reused. However, due to a lack of proper e-waste recycling practices, these valuable materials are being discarded, representing a missed opportunity for the department to promote sustainable resource management.

The Population Studies Department expressed concerns over the health hazards posed by the undisposed e-waste. As e-waste accumulates in storage areas and office spaces, employees may be exposed to harmful chemicals released from outdated electronic devices. This department's head highlighted the need for safety measures to prevent prolonged exposure to toxic substances such as heavy metals, which could pose risks to staff members, particularly in densely populated office spaces.

Lastly, the Procurement Management Unit (PMU) has experienced difficulties in managing inventory control due to the growing volume of unused electronics. The accumulation of outdated devices complicates inventory management processes, making it harder for the department to track valuable equipment and distinguish

between functional and non-functional items. This has led to inefficiencies in procurement operations and has made the disposal of obsolete equipment a pressing challenge. These results suggests that, the impacts of e-waste on IRDP departments are multifaceted, affecting operational efficiency, environmental management, and health and safety. These findings suggest that the implementation of a structured e-waste management policy is crucial to mitigate the risks and improve departmental functionality at the institution.

4.4.2 Adaptation Strategies against the impact of e-waste

Results in Table 6 outlines a range of adaptation strategies endorsed by the IRDP community to mitigate the impact of e-waste. These include attending to hospitals when injured by the incidents caused by the e-wastes, through clearing the area filled with the e-wastes, and avoiding the burining o fthe e-wastes. These strategies align with international efforts to address e-waste challenges as indicated by Mataheroe (2009), emphasizing the importance of concerted community action and environmentally conscious practices in managing e-waste effectively similar to the study by Magashi and Schluep (2011).

Table 6: Adaptation Strategies

Strategy	Frequency	Percentage (%)
By attending to the hospital when injured	16	16.2
Through clearing the area with e-waste	21	21.2
By implementing reuse and refurbishment programs	20	20.2
By avoiding burning of the e-wastes	42	42.4
Total	**99**	**100**

Source: Researcher's Data, 2024

4.5 Inferential Analysis

4.5.1 One-way ANOVA analysis

The statistical analysis conducted in this study aimed to investigate the effects of e-waste management practices within higher learning institutions, specifically focusing on e-waste collection, transportation for disposal or recycling, and the annual disposal of electronic devices in the department. The null hypotheses tested the absence of significant differences in e-waste practices across different years of experience at the Institute of Research and Development Planning (IRDP).

The one-way ANOVA results revealed that there were no significant differences in e-waste collection and transportation methods based on years of experience at the IRDP. The p-values for e-waste collection ($p = 0.679$) and e-waste transportation ($p = 0.721$) were both greater than the specified significance level of 0.05, indicating no statistically significant differences across different experience levels. However, for the annual disposal of electronic devices, the analysis yielded a significant p-value of 0.001, suggesting that there were substantial variations in the number of electronic devices disposed of annually across experience levels (Table 7).

Furthermore, the post-hoc analysis using Tukey's technique focused on identifying specific pairwise differences between experience groups for the significant variable of annual electronic device disposal. The results revealed significant mean differences in the number of devices disposed of annually between those with 6 - 10 years of experience and the other groups, with the confidence intervals indicating notably higher disposal rates among individuals with 6 - 10 years of experience.

Furthermore, the study rejected the null hypothesis for the annual electronic device disposal variable, indicating that the level of experience significantly influenced

disposal practices within the department. However, no significant differences were found for e-waste collection and transportation methods. These findings have implications for e-waste management policies and practices in higher learning institutions, suggesting the need for further research to explore the underlying factors contributing to these differences.

Table 7: One way ANOVA analysis results

Variable	Years of experience at IRDP	
	F	Sig.
How is e-waste collected	.388	.679
How is e-waste transported for disposal or recycling	.329	.721
How many electronic devices are disposed of annually in your department	7.056	.001

Source: Researcher's Data, 2024

4.5.2 T-Test Analysis

The research questions addressed in this study aimed to examine whether the average age of respondents in the sample significantly differed from a hypothesized value, with the null hypothesis assuming an average age of 0 ($\mu = 0$). The descriptive statistics for the variable Age indicated that data were collected from 99 respondents, with a sample mean ($\bar{X}$) of 25.02 years, a sample standard deviation (s) of 3.930 years, and a standard error of the mean (SE) of 0.395 years (Table 8).

A one-sample t-test was conducted to compare the sample mean with the hypothesized value of 0. The analysis yielded a highly significant t-value of 63.338 with 98 degrees of freedom and a p-value of 0.000, indicating strong evidence against the null hypothesis. The mean difference between the sample mean and the hypothesized value was 25.02, suggesting a significant difference in respondents' ages from zero.

Additionally, the 95% confidence interval for the mean difference provided a range within which there was 95% confidence that the true population mean lies, with a lower bound of 24.24 and an upper bound of 25.80. Effect sizes, represented by Cohen's d (3.930) and Hedges' correction (3.961), further emphasized the practical significance of the observed differences, both indicating large effect sizes and substantial age differences.

Table 8: T-test analysis results

Age	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Age of respondent	63.338	98	.000	25.020	24.24	25.80

Source: Researcher's Data, 2024

Moreover, a highly significant p-value led to the rejection of the null hypothesis. The data demonstrated robust evidence that the average age of respondents significantly differed from zero. The effect sizes further emphasized the practical importance of this difference. These findings contribute to a better understanding of the age distribution within the sample and hold implications for future research and policy decisions related to respondent demographics.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study at IRDP Dodoma campus reveals that the primary sources of e-waste are the general environment, hostels, offices, and classrooms, with a significant amount of annual disposal involving electric wires, computers, and fans. The most common types of electronic devices contributing to e-waste include computers, projectors, printers, and lightbulbs. These findings highlight the diverse and substantial volume of e-waste generated at the institution, emphasizing the need for effective e-waste management strategies.

The study on the environmental effects of e-waste in Dodoma reveals varying perceptions among the IRDP community regarding the impacts of e-waste, particularly in terms of air pollution, injuries, and bad scenery. While some respondents express significant concern, others are more neutral or dismissive. To address these issues, the community endorses several adaptation strategies, including proper recycling, awareness promotion, reuse programs, and the adoption of eco-friendly electronics, aligning with broader international efforts to mitigate e-waste's environmental impact.

The study on current e-waste practices at IRDP Dodoma reveals that while some effective methods, such as a designated E-Waste Management Team and external services, are in place, a significant portion of e-waste (60.6%) is still mixed with general waste, highlighting the need for improved awareness and separate collection efforts. E-waste is mainly transported using tractors, and disposal methods include recycling, landfill, and incineration, with recycling offering material recovery potential

and landfill disposal raising environmental concerns. These findings underscore the importance of enhancing e-waste management practices to mitigate environmental impact.

5.2 Recommendations

i. Enhance e-waste management strategies to address the diverse sources and substantial disposal rates of electronic devices within the department, focusing on the proper recycling and disposal practices for computers, mobile phones, and printers, as they represent significant contributors to e-waste.

ii. Increase awareness about separate collection bins and ensure proper segregation during e-waste transportation to mitigate adverse environmental impacts, given the substantial mixing of e-waste with general waste during collection and the transportation challenges identified.

iii. Endorse adaptation strategies like proper recycling and disposal systems, awareness and education initiatives, reuse and refurbishment programs, and the adoption of eco-friendly electronic products to mitigate e-waste impact within the IRDP, aligning with international efforts to address e-waste challenges.

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APPENDICES

RESEARCH QUESTIONNAIRE

SECTION A: SOCIO-DEMOGRAPHIC INFORMATION

1. Sex of respondent
    a) Male
    b) Female
2. Age of the respondent…….
3. Marital status of the respondent
    a) Single
    b) Married
    c) Widow
    d) Separated
4. Education level:
    a) Primary education
    b) Secondary education
    c) Tertiary education
    d) Undergraduate
    e) Postgraduate
    f) Ph.D.
5. Department…….
6. Years of Experience at IRDP
    a. Less than 1 year
    b. 1-5 years
    c. 6-10 years
    d. More than 10 years

SECTION B: ESTIMATION OF E-WASTE PRODUCTION

7. What are the sources of e-waste in your department?

……
……
…….

……
…….

8. Approximately, how many electronic devices are disposed of annually in your department?
    a. 1-10
    b. 11-50
    c. 51-100
    d. More than 100
9. Which types of electronic devices make up the majority of e-waste in your department?
    a. Computers
    b. Printers
    c. Mobile phones

d. Other (please specify)……..

SECTION C: EVALUATION OF CURRENT E-WASTE PRACTICES

10. How is e-waste collected ?
    a. Collected by a designated e-waste management team
    b. Collected by an external e-waste management service
    c. Mixed with general waste collection
    d. Not collected

11. How is e-waste transported for disposal or recycling?
    a. Collected by a specific e-waste transporter
    b. Transported by regular waste management service
    c. Other (please specify)……..
12. What methods are used for e-waste disposal at IRDP?
    a. Recycling
    b. Landfill disposal
    c. Incineration
    d. Other (please specify)……

SECTION D: ENVIRONMENTAL EFFECTS OF E-WASTE

13. How do you perceive the impact of e-waste on the environment at IRDP?
    a. Negligible
    b. Moderate
    c. Significant
14. How exposed do you feel the community is to e-waste hazards from IRDP?
    a. Low exposure
    b. Moderate exposure
    c. High exposure
15. In what ways does the IRDP community adapt the measures to mitigate the environmental impact of e-waste at IRDP?

    a. Through proper recycling and disposal systems
    b. By promoting awareness and education on e-waste management
    c. By implementing reuse and refurbishment programs
    d. Through the adoption of eco-friendly electronic products
    e. Other, please specify: _____

QUESTIONS FOR KEY INFORMANTS (PROCUREMENT AND ICT DEPARTMENTS)

1. What are the primary sources of e-waste on the IRDP Dodoma campus (e.g., old computers, printers, mobile devices)?.....

2. Can you provide estimates or data on the quantity of e-waste generated annually on the IRDP Dodoma campus?.....

3. What types of electronic waste are most commonly generated on the IRDP Dodoma campus?.....

4. What methods are currently used for collecting e-waste at the IRDP Dodoma campus and other institutions in Dodoma?.....

5. How is e-waste transported from the point of collection to disposal or recycling facilities? .....

6. What are the main disposal methods used for e-waste in Dodoma, and how effective are they? .....

7. What evidence is there of environmental pollution caused by e-waste in Dodoma? .....

8. What health issues have been associated with improper e-waste management in Dodoma? .....

9. What measures have been implemented or are being planned to mitigate the environmental and health impacts of e-waste in Dodoma? .....

10. What challenges do you face in managing e-waste effectively, and what improvements would you suggest for better e-waste management in Dodoma? .....