

**THE SOCIO-ECONOMIC IMPACTS OF REFUR-  
BISHED COMPUTERS ON SMALL AND MEDIUM EN-  
TERPRISES (SME) IN MOMBASA KENYA, AND THE  
ROLE OF THE FORMAL SECTOR IN PROMOTING  
CIRCULAR ECONOMY.**

**Jyväskylä University  
School of Business and Economics**

**Master's Thesis**

**2022**

**Author: Yussuf Sugow  
Subject: Corporate Environmental Management  
Supervisor: Stefan Baumeister**



**JYVÄSKYLÄN YLIOPISTO  
UNIVERSITY OF JYVÄSKYLÄ**

## ABSTRACT

Author: Yussuf Sugow	
Title: The socio-economic impacts of refurbished computers on small and medium enterprises (SMEs) in Mombasa- Kenya, and the formal sector's role in promoting a Circular Economy (CE) business model.	
Subject: Corporate Environmental Management	Type of work: Master's thesis
Date: 08.09.2022	Number of pages: 62
<p>The dependence and use of information and communication technology (ICT) tools remain part of modern society's daily life. The increased use of electronic devices such as computers and mobile phones have significantly impacted global e-waste generation in recent years. However, effective e-waste management could be a strategy to divert e-waste streams into socio-economic potentials to protect the environment and improve society's wellbeing. In the global north, effective e-waste policy, such as the EU directive, and active extended producer responsibility (EPR) help in tackling e-waste streams, while lack of e-waste policy and frameworks in the global south catalyse the generation of e-waste streams. However, social enterprises help societies in the global south deal with the mess of e-waste challenges and convert it to economic potentials. One of the social enterprises working to improve e-waste management in Kenya is Close the Gap (CTG), which plays a crucial role in effective e-waste management by providing training to small and medium businesses (SMEs), creates awareness, and prolong devices' lifetime by refurbishing them. The company recently established a circular economy hub (CE-Hub) to accelerate the promotion of a circular economy (CE) business models. To understand the potential impacts of e-waste, this thesis investigates the socio-economic impacts of refurbished computers on SMEs and how the CTG promotes effective e-waste management in transitioning to CE business models in Mombasa, Kenya. The study applied qualitative interviews to understand interviewees' life experiences on e-waste management and how the operation of the CE-Hub impacts their social and economic wellbeing. The study results showed that the operation of CTG together with her new CE-Hub facility brought employment opportunities for unemployed youth, promote effective e-waste management, and improved livelihoods. The findings clearly indicate that providing support, training, and awareness creation on e-waste management to SMEs and local community could accelerate the CE transition in Kenya.</p>	
Key words e-waste management, refurbished computers, formal sector, SMEs	
Place of storage Jyväskylä University Library	

## CONTENTS

CONTENTS.....	5
ACRONYMS.....	7
FIGURES, PHOTOS AND TABLES DESCRIPTIONS.....	8
1 INTRODUCTION .....	9
1.1 Problem statement.....	12
2 THEORETICAL FRAMEWORK.....	14
2.1 Introduction.....	14
2.2 Overview of global e-waste management.....	16
2.2.1 The global north.....	16
2.2.2 The global south.....	17
2.3 Overview of e-waste management in Kenya.....	20
2.3.1 The formal sector and CE in Kenya. ....	22
2.3.2 E-waste management challenges.....	24
2.4 Socio-economic potentials of e-waste .....	25
2.4.1 Employment opportunities .....	25
2.4.2 Source of income.....	26
2.4.3 Economic growth.....	26
3 RESEARCH METHODOLOGY .....	28
3.1 Introduction.....	28
3.2 The study area .....	28
3.3 The case study company.....	30
3.4 Data collection.....	31
3.5 Data analysis.....	32
3.6 Validity and reliability of the study .....	32
4 RESULTS .....	33
4.1 Socio-Economic Impacts .....	33
4.1.1 New start-ups.....	33
4.1.2 Employment opportunity and source of income.....	33
4.1.3 The e-waste management.....	34
4.1.4 The circular economy perspective.....	36
4.2 The Case Company.....	36
4.3 The Circular Economy Hub (CE-Hub) .....	39
5 DISCUSSION .....	41
5.1 E-waste management .....	42
5.1.1 Training and Awareness.....	42
5.1.2 Resource recovery.....	43
5.2 Socio-economic impact.....	44
5.2.1 Employment opportunities .....	44
5.2.2 New entrepreneurs.....	45

5.2.3	Promote business digitization and online marketing .....	45
5.3	The CE-Hub and circular economy business models.....	47
5.4	Challenges in transitioning to CE business models in Kenya.....	48
6	CONCLUSION .....	49
	REFERENCES.....	51
	APPENDIX 1 .....	57

## ACRONYMS

<b>CE</b>	Circular Economy
<b>CE-Hub</b>	Circular Economy Hub
<b>CTG</b>	Close the Gap
<b>EEE</b>	Electric and Electronic Equipment
<b>EoL</b>	End of Life
<b>EPR</b>	Extended Producer Responsibility
<b>EU</b>	European Union
<b>E-waste</b>	Electronic waste
<b>FIG</b>	Figure
<b>GDP</b>	Gross Domestic product
<b>ICT</b>	Information and Communication Technology
<b>JUA KALI</b>	Kenya informal sector
<b>KEBS</b>	Kenya Bureau of Standards
<b>KPA</b>	Kenya Port Authority
<b>MSW</b>	Municipal Solid Waste
<b>NCMS</b>	Northern Corridor Member States
<b>NGO</b>	Non-Governmental Organization
<b>SME</b>	Small Medium Enterprise
<b>WEEE</b>	Waste Electrical and Electronic Equipment

## FIGURES, PHOTOS AND TABLES DESCRIPTIONS

### 1. A:

**Table 1:** This table summarises study key findings, impacts and challenges that affects the process of e-waste management.

**Table 2:** Quotes from study participants on CE, e-waste management, and social-economic impacts of refurbished computers.

**Table 3:** The list of study participants, business represented, and interview duration.

### B:

**Photo 1:** Refurbished computers ready for sell at the CE-hub

**Photo 2:** CTG technicians checking arrived computers for errors and defaults

**Photo 3:** CTG partners from SMEs attending a CE and e-waste management at CTG centre in Mombasa.

### C:

**Interview questions:** Semi-structured interview meant for SMEs and CTG employees.

### 2. Figures:

**Figure 1:** Map showing the trade-route from Mombasa port to NCMS such as Uganda, Rwanda, Burundi, DRC, and South Sudan.

**Figure 2:** This figure shows the flow of second-hand computers in and out of Kenya through involved stakeholders such as the CTG, SMEs, foreign corporations, and the informal sector.

**Figure 3:** This figure describes the practicality of the CE-Hub operation in Mombasa.

# 1 INTRODUCTION

With rise of global digitalisation, Information and Communication Technology (ICT) has remained the backbone of modern businesses and education in recent years (Muhammad, 2018). ICT comprises diverse technologies, tools, and infrastructure as Amutha (2020) define ICT as *“an umbrella that includes any communication device or application, encompassing, radio, television, cellular phones, computer, and network hardware and software, satellite system and so on, as well as the various services and applications associated with them, such as video conferencing and distance learning”*.

Nevertheless, studies identified links between ICT and economic growth, poverty reduction, and improved social activities (Aghaei et al., 2017; Avgerou, 2003; Niebel, 2018). For instance, ICT equipment such as computers play a vital role in the efficiency and smooth running of business activities such as innovation, product designing, customer satisfaction, decision-making, and production. Similarly, ICT infrastructure, such as computers, in schools significantly improves the quality of education (Peeraer et al., 2011), and reduces inequality between schools in rural and urban areas (Amutha, 2020).

In this regard, the accessibility of ICT infrastructure, such as computers, in schools in developing countries has shown a positive effect on the teacher-student learning process (Peeraer et al., 2011). But Chao (2015) reveals that despite the availability of computers in schools, lack of ICT training to teachers in Mombasa high schools affects teachers' ability to integrate ICT into their work such as planning and execution of teaching activities. However, many developing countries rely on external sources as most of these computers might be donated by well-wishers and organisations as refurbished or upgraded devices.

Meanwhile, Tonetti (2000) pointed out that refurbished computers are energy-intensive devices compared to new ones and might have an adverse effect on the environment. Still, their benefits to society outweigh their environmental concerns; for instance, video conferencing reduces business trips, paperless office work, online exams, and cloud-based data storage. However, a sustainable collection and refurbishment of ICT equipment for business and educational use depend on managing the broader field of municipal solid waste (MSW).

A significant portion of MSW is waste electric and electronic equipment (WEEE), commonly known as e-waste, which poses an adverse effect on the environment and risks lives of societies (Bushehri, 2010). According to Brownlee (2018) only 13% of the 40 million metric tons of e-waste produced annually are recycled. The author further claims that most of this e-waste is dismantled and burned informally in developing countries, causing adverse environmental effects and health risks. A recent report shows that 53.6 million metric tons (mt) of e-waste products with a battery or plugs, such as computers and mobiles, were

discarded in 2019, of which only 17.4% were officially recycled. As a result of higher electric and electronic consumption rates coupled with shorter lifecycles and limited repair options, the report predicts a significant growth of global e-waste as it will reach 74 mt by 2030 (Forti et al., 2020).

Consequently, the disposal of ICT equipment such as computers and mobile devices remains the highest amount of e-waste streams and is one of the biggest global environmental challenges in recent decades (Bushehri, 2010; Muhammad, 2018)). Bushehri (2010) added that many valuable devices, such as computers and mobiles, are landfilled annually without being refurbished or recycled. Nonetheless, E-waste is a double-edged sword, meaning that it could be an opportunity for prosperity and sustainable development or a catalyst for poverty, environmental degradation, and human health catastrophe.

Lack of policy frameworks and laws governing e-waste management, coupled with a lack of funds and investment in financing infrastructure, worsens the global South's situation (Herat and Agamuthu, 2012). However, the formal sector is involved in managing and refurbishing ICT equipment such as computers in extending usage and practice responsible disposal of obsolete devices. This process remains a vital ingredient for promoting environmental protection strategies, economic growth, improved students' learning process, and income generation for the involved community (Anyango et al., 2018).

Meanwhile, one fundamental principle of CE is avoiding waste generation by reusing ICT devices such as computers to avoid landfilling and incineration after the end-of-life (MacArthur foundation, n.d). The extension of ICT devices' lifespan by refurbishing and reusing them brings the circular economy (CE) concept on board. However, in the global south, the formal sector, such as social enterprises, promotes a CE business model by applying the CE principles in collecting, refurbishing, and prolonging computers' lifetime.

Nevertheless, quite a significant amount of ICT devices is either kept in homes or disposed of in landfills due to a lack of knowledge, infrastructure investment, public awareness, and policy formulations (Otieno and Elijah, 2016). Similarly, Rizos et al. (2016) emphasised the significance of awareness creation in improving the CE business model due to its economic and employment potential. The fact remains that ICT devices such as refurbished computers have many advantages to society, but the management of obsolete devices and the disposal process is still a concern.

In Kenya, like in many other developing countries, ICT is an essential tool for economic growth (Desmond et al., 2021). Still, insufficient investment in ICT, lack of laws, and infrastructure remain a setback and directly affect the digital divide and industrialization goals. Similarly, Mwangi et al. (2013) identify lack of awareness and information to SMEs as key challenges affecting the promotion of SMEs in Mombasa. However, the formal sector fills the gap by importing second-hand and cheap devices to bridge the digital divide and provide training



and awareness on e-waste management to SMEs and communities (Close the gap, n.d). Despite the adverse effects of these devices at the end of their life, they positively impact SMEs and the community, and process of reuse shows signs of CE principles. For example, Close the Gap (CTG), the case study in this thesis, established a Circular Economy Hub (CE-Hub) in Mombasa where computers are refurbished. The (CTG) is a social enterprise company in Kenya on a mission to promote effective e-waste management and bridge the digital divide. The close the gap (n.d) mission statement reads, *“Close the Gap collects decommissioned computers from companies and arranges for other organisations to clean the hard disks and then check and configure the hardware according to the requirements of its end-users. The computers are then shipped to the destination country by sea or air transport to support educational, medical, entrepreneurial, and social projects. All the projects are demand-driven and impact-oriented initiatives”*

In addition, the company refurbishes computers and supports projects and start-ups in e-waste management to promote sustainable management of e-waste. Interestingly, the company recently launched a circular economy hub (CE-Hub) in Mombasa- Kenya, where collected computers are refurbished before being sold to small and medium enterprises (SMEs) and other interested customers. The CE-Hub initiative is a promising start that could improve Kenya’s ailing e-waste management and pave the way to the CE transition. Close the gap (n.d) describes the Circular economy Hub as *“The state of art IT asset disposition facility in Jomvu (location). IT asset disposition, or ITAD is the process of how and where to dispose or re-manufacture IT-hardware. The Circular Economy HUB is the first fully automated ICT Assembly and manufacturing plant at the Kenyan coast. Here we assemble computer components, mobile devices, spare parts, and other tech devices into affordable ‘made in Kenya’ nearly new computer devices. These devices will be used in educational, medical, and social projects”*.

The study has specific aims to help the researcher answer the research questions, for example, 1) Identify the role of the formal sector in promoting a circular economy by providing training and awareness to SMEs 2) Study the potential impacts of refurbished computers on SMEs in the study area 3) Identify possible factors that may hinder the transition of CE business models in Kenya 4) Study and observe the operation of SMEs and the CE-Hub.

The following research questions will guide this thesis throughout the process.

1. What are the socio-economic impacts of refurbished computers on SMEs in Kenya?
2. How does the formal sector promote a circular economy business model?

The thesis applied data collection strategies and methodologies to review relevant secondary data to understand the topic and how literature discussed it. For the primary data collection in understanding the impact of refurbished

computers, the thesis applied qualitative data collection where the researcher prepared semi-structured interviews to find answers to the research questions.

## 1.1 Problem statement

Studies found that the generation of end-of-life (EoL) ICT devices such as computers remains one of the world's environmental challenges (Herat and Agamuthu, 2012). The take-use-dispose method of consumption is one of the most significant setbacks to the sustainable development goals in developing countries that may hinder efforts to transition to circular economy business models. Consumers landfill EoL devices due to lack of sufficient knowledge causing adverse effects on the environment and risking human lives (Otieno and Elijah, 2016).

However, studies such as Desmond et al. (2019) show that developed countries have better e-waste management infrastructure and operational policies than developing countries. For that reason, developing countries are economically lagging due to the lack of e-waste infrastructure and procedures to generate revenue from the valuable resources of e-waste, such as gold, metal, and copper.

A recent study identified a lack of e-waste policy, poor governance, lack of public knowledge on EoL management, lack of infrastructure, lack of technology among others as key factors contributing to the poor e-waste management in the developing countries (Anyango et al., 2018). Consequently, ICT devices such as computers from western countries as donations and trade in bridging the digital divide flooded the developing countries' secondary markets, thus, affects generation of unmanaged e-waste streams.

Kenya is a good example where e-waste generated is abandoned and ends up in open landfills. However, Proper e-waste management in this country could change the lives of millions of unemployed youths and positively impact the living conditions of millions of others who depend on them as their breadwinners. Unfortunately, in Kenya, e-waste is considered trash rather than a resource, and its management remains the most significant solid waste challenge facing the government of Kenya.

Nonetheless, researchers have generalised ICT sector, which is a broad term, to understand e-waste management in developing countries. For example, studies such as Anyango et al, (2018); Danson Ngethe, (2020) focused on human attitudes and government institutions to understand the generation and management of e-waste streams in Kenya. Additionally, Waema et al. (2008) focused on the flow of e-waste in Kenya with a specific consideration on desktop computers, printers, notebooks and related accessories.

Most importantly, most of the studies conducted in Mombasa focus on tourism and health issues, except few studies such as (Chao, 2015; Wekisa and

Majale, 2020), which focus on the impact of ICT training to teachers in high schools and effect of waste generation on quality of life in Mombasa respectively. However, specific studies on SMEs in Mombasa were conducted by Ondier, (2013) and Mwangi et al, (2020), but the focus of these studies differ from this thesis as they were investigating issues related to strategic management and factors affecting the growth of SMEs in Mombasa County.

As a result, there seems to be a literature gap on the potential impact of ICT devices such as refurbished computers on SMEs and how the formal sector promotes a circular economy through the collection and management of these computers. For that reason, little is known about the potential socio-economic impact of refurbished computers on SMEs and how the formal sector manages EoL devices to promote a circular economy in Mombasa.

Therefore, this thesis investigates the potential impact of refurbished computers on SMEs and the role of the formal sector in promoting a circular economy business model by refurbishing computers and training stakeholders on e-waste management.

## 2 THEORETICAL FRAMEWORK

### 2.1 Introduction

The generation of WEEE, which is also known as e-waste, is one of the fastest growing solid waste streams and has become one of the most significant environmental and social challenge in recent years Bushehri, (2010). The e-waste stream generation is accelerated by the digitalization of businesses and education, where the use of computers and mobile phones has become part of daily life (Muhammad, 2018). According to Williams et al. (2008), computers play an essential role in education and business development in the developing world. However, due to the implementation of e-waste laws and Extended Producer Responsibility (EPR) in developed countries Herat and Agamuthu, (2015), e-waste is managed responsibly, and resources recovered in the waste management process leading to the reduction of raw materials used in production. While in developing countries, a lack of policies and regulations leads to poor e-waste management, causing widespread environmental havoc and risks to human health. However, effective e-waste management may lead to economic growth, environmental protection, and social benefits, and ineffective e-waste management would be vice versa.

According to the Environmental Protection Agency (2017), as cited by Shittu et al. (2021), E-waste refers to any equipment, piece, or gadget whose functionality depends on electrical currents or electromagnetics in performing its designed purpose. However, a detailed explanation of e-waste is given by the European Union (Directive 2012/19/EU) as; *“equipment which is dependent on electrical currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1000 Volts for alternating current (AC) and 1500 Volts for the direct current”* (European Union, 2012) as cited by Shittu et al. (2021). However, the StEP initiative (2014), as quoted by Kumar et al. (2017) specifically defines e-waste as *“a term to cover items of all types of electrical and electronic equipment (EEE) and it is part that the owner has discarded as a waste without intention of re-use”*. The earlier definition provides technical specifications of e-waste, while the latter explains what is classified as e-waste from the consumers' perspective.

In developing countries, it is estimated that 1-3% of municipal solid waste is hazardous waste such as e-waste (Herat et al., 2015). A significant portion of these devices is disposed of after the EoL and landfilled, causing adverse effects on the environment and human lives. Forti et al. (2020) predict that global e-waste will reach 74mt in 2030 as the demand and consumption of electrical and electronic devices grow steadily, coupled with the short-life cycles and limited repair options. According to the authors predictions, with current trends of the mass

demand and consumption of electronic devices, the e-waste stream is expected to increase tremendously. However, the generation of global e-waste has been affected by many factors, such as policies, demand, accessibility, price, and technological development (Shittu et al., 2021; Mihai et al., 2016).

However, the CE is considered a twin approach to reduce waste generation and facilitate resource recovery. The CE encourages reusing, remanufacturing, and refurbishing of used materials such as electronic devices that have completed their first lifecycle (Angouria-Tsorochidou et al., 2018). The CE adoption would promote economic growth, create employment opportunities for locals, and mitigate adverse impacts on environmental and human health risks (Riso et al., 2016). This process reduces the generation of waste streams, as MacArthur Foundation (n.d) defines the CE as an approach to prevent waste generation in the first place. This definition gives the impression that CE is a business concept that promotes resource recovery and prevents waste generation by applying e-waste management techniques to maximize resource recovery. Even though CE is still evolving, Kirchherr et al. (2017) define CE as *“an economic system that is based on business models which replace end-of-life with reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes”*. This definition of CE gives the impression that CE is a solution to the disposal of whole or parts of hazardous ICT devices such as wires, screens, and batteries, among others, and prevents landfilling of EoL devices in reducing the adverse effect on the environment and human lives.

Nevertheless, resource recovery and product circularity are the most significant challenge leading to the continuous extraction of raw materials that are already depleting. Despite the economic potential of e-waste due to precious elements, Salmenperä et al. (2021) estimate that only 10% of the global economy is circular. Furthermore, an earlier study Kumar et al. (2017) argues that only 15% of global e-waste is fully recycled. These authors' argument gives the impression that global production still relies on virgin materials extraction with limited resource recovery, leading to environmental challenges and risks human lives. However, waste management is believed to play a crucial role in transitioning to a CE (Salmenperä et al., 2021). The resource recovery strategy, such as reusing and refurbishing, is the foundation for the transition to a CE (MacArthur Foundation, n.d). Fofou et al. (2021) mentions that remanufacturing and refurbishing electronic devices has been considered an option to promote a CE business approach in recent years. Even though the transition to a CE is affected by diverse factors such as policy, geography, and human attitudes, informal and formal businesses in the developing world still rely on informal resource recovery for recycling and refurbishing products. However, resource recovery is the backbone of many local communities and businesses as the recovery of reusable machine parts and metals from obsolete machines remains their source of income (Williams et al., 2008). Therefore, e-waste streams could either be an environmental

and human health disaster or socio-economic benefits for businesses and communities, depending on the strategies used to recover resources and reduce waste generation.

## **2.2 Overview of global e-waste management**

### **2.2.1 The global north**

E-waste management remains one vital strategy industrialised countries use to recover valuable resources such as gold and copper while avoiding extracting virgin materials to protect the environment. Similarly, the availability of policies and laws governing e-waste management in developed countries allows shared responsibilities among stakeholders such as producers and consumers on e-waste management. For example, in the EU WEEE directives (2002), member states are obliged to encourage manufacturers to take full responsibility for the electronic devices under their brands through a take-back scheme after the EoL. This process has been facilitated and favoured by the availability of good infrastructure, knowledge and skills, and public readiness to participate. According to Shittu et al. (2021), the European community remains at the forefront of e-waste management as EU member states meet the high sets of collection and recycling in line with the WEEE directives (Directive 2012/19/EU).

Nevertheless, the WEEE reverse supply chain has existed in EU member states for over a decade following the enacting of EU WEEE directives in 2002. The EU WEEE directive has not specified modalities but defines the general collection and recycling objectives of e-waste. Consequently, member states chose their modalities to manage the e-waste collection and recycling process (Ylä-Mella et al., 2014). In Finland, for example, the implementation of WEEE directives was successful following the incorporation of EU WEEE directives into national legislation coupled with functional e-waste management infrastructure Ylä-Mella et al. (2014).

Similarly, Herat and Agamuthu (2015) argue that EU member states are far ahead of other countries in e-waste management because EU directives cover a wide range of products, such as small and large household appliances and electrical and electronic devices. Furthermore, the authors' arguments show that implementing Extended Producer Responsibility (EPR) is strong and effective in the developed world due to the strict policies and laws governing e-waste management. Thus, manufacturers and sellers are responsible for the market's reverse supply chain of products.

The Basel convention, EU WEEE directives and the 3Rs (reduce, reuse, recycle) initiatives have impacted e-waste management in the developed world,

where resource recovery and recycling were fundamental concepts of these initiatives (Sthiannopkao et al., 2013). The authors claim that these initiatives led to effective resource recovery and recycling coupled with the UN's StEP (Solve the E-waste Problem), which coordinates global efforts in combating e-waste problems and potentially harvesting elements in e-waste through resource recovery and recycling. However, Kumar et al. (2017) argues that harvesting potential elements for economic benefits from e-waste is ineffective as global e-waste recycling rate stands at 15%. This gives the impression that despite the global initiatives of e-waste management for economic benefits and environmental protection, recycling rates still need to be accelerated to maximise resource recovery.

Furthermore, Desmond et al. (2019) argue that redesigning products, systems and business models is the critical focus for the EU and the global north in transitioning to a CE. In addition to the policies and willingness of consumers to be part of the e-waste management coupled with effective EPR and product redesign facilitate the proper disposal channel and pave the way to CE transition. As a result of good e-waste management, developed countries utilise the economic potential of e-waste and, at the same time, protect the environment by applying CE business models. The application of CE business models promotes reusing and refurbishing devices after the end of their first life cycle to prevent e-waste generation. Angouria-Tsorochidou et al. (2018) mention that circular economy models prioritise the reuse and refurbishment of devices over the first use-cycle recycling. Meaning that CE models promote the reuse of machines to avoid waste generation and reduce virgin resource extraction.

However, as e-waste streams have already been generated in masses and are still expected to continue, Risoiz et al. (2016) argue that improving CE business models would be an employment engine and could create around 50,000 jobs in the electronic industry alone. However, Mihai et al. (2016) claim that developed countries are reluctant to recycle e-waste but dump it in landfills or export it to developing countries because of high labour costs and strict environmental regulations. Consequently, a significant portion of e-waste is exported to developing countries as second-hand usable devices. Despite e-waste challenges in the destination countries, policy and regulations significantly affect e-waste management in developed countries. As a result, CE business models are quickly adopted and play a vital role in the sustainable development initiatives of the global north.

### **2.2.2 The global south**

On the contrary, in developing countries, population growth, lack of public awareness, political incompetence, lack of national policy, absence of rules and regulations, financial mismanagement, illegal imports, lack of proper recycling

technology, and lack of corporate responsibility impact the rate of e-waste generation and management (Diaz, 2017; Anyango and Mwololo, 2013). In the meantime, many developing countries allow free entry of second-hand devices to bridge the digital divide as Bisschop (2012) reveal that technology-driven demand for electronic devices to bridge the digital divide in global south led to the influx of second-hand machines into the secondary market. This means that the consignment of used electronic and electric devices from developed countries is sent to developing countries, leading to stockpiles of e-waste at homes, offices and dumpsites. Unfortunately, there are no strategies to check and confirm the usability of these devices upon arrival in the destination countries, which led to the illegal disposal of e-waste (Rautela et al., 2021).

Anyango et al. (2018) found that the lack of disposal channels available to end-users remains challenging as many EoL devices are stored at homes and offices. The author further claims that only 10% of e-waste goes to recycling facilities due to a lack of a functional take-back scheme for consumers; thus, e-waste is disposed of together with other solid waste. Consequently, a significant portion of these devices end up as e-waste streams. Therefore, dumping e-waste together with solid waste is a common disposal channel for consumers in developing countries. This type of informal disposal not only creates environmental challenges and health risks but also complicates the resources recovery for recycling and sabotages economic growth.

The situation of e-waste trade in developing countries has been deteriorating recently as most of the corporations in developing countries are profit oriented. Bisschop (2012) claims that actors such as foreigners, locals and local port officials benefit from importing used machines to developing countries, the author terms the action of these actors as "*committing environmental crime*". These companies take advantage of the weak institutions and lack of policies to maximize their profits at the expense of human health and environmental pollution. As a result, there might be a link between importing electrical and electronic devices as a form of donations or trade by multinational companies and e-waste generation in developing countries.

Studies such as Shittu et al. (2021) and Mihai et al. (2016) argue that most of these devices are nearing their end of life and may have a short lifespan in the hands of consumers, thus adding more burden to the ailing e-waste streams in developing countries. However, importers argue such claims as donations, the digital divide, technological development, and recyclable materials to promote their businesses. Due to lack of proper disposal channels, consumers may have no option other than to dispose of them with other solid waste. The importation of these devices has been facilitated by lack of policies and laws governing e-waste management and weak and corrupt institutions in destination countries (Mihai et al., 2016). This means that due to ineffective policies and guidelines on e-waste management in the global south, corporations take advantage of the weakness and import devices nearing EoL.



As a result, corporations in the global north see potential in exporting tons of used electronics such as computers as donations or trade to developing countries such as Kenya. Recent research from Shittu et al. (2021) claims that an estimated 2.9mt of e-waste was produced in Africa in 2019. As African nations have no industrial capacity in manufacturing electrical and electronic devices, most of these were imported as used devices from Europe, Asia and other western countries, with as little as two years of lifespan remaining. This shows that the notion of the digital divide is misused, and corporations took advantage of the free entry regulations imposed by many African countries to promote digitalization. Thus, leaving the e-waste in the hands of the unskilled informal recyclers to recover saleable parts and landfilling the useless parts. The process of resource recovery by the informal sector is causing environmental challenges and risks human lives. Williams et al. (2008) argues that informal recycling of e-waste in developing countries such as India, China and Nigeria have been a long-time challenge resulting from dismantling electronic devices, which involves pulling wires from computers and burning them in open piles to recover elements.

However, a recent study by Shittu et al. (2021) claim that 57-billion dollars worth of secondary materials is present in the generated WEEE in 2019. The author's argument is an indication that effective e-waste management prevents adverse environmental effects, reduces health risks, and promotes economic growth. Nevertheless, ineffective e-waste management in developing countries remains a challenge in transitioning to a CE business model because billions of dollars worth of elements are lost annually in e-waste. However, developing countries cannot utilize the economic potential of e-waste due to lack of e-waste management infrastructure, policies, and technological development. However, instead, e-waste is dumped along with solid waste causing economic sabotage, environmental challenges, and risks human health (Anyango and Mwololo, 2013). A similar study shows that e-waste is dismantled and buried informally in the developing world, causing adverse environmental effects and risks human health (Brownlee, 2018). The studies reveal that the e-waste management situation in the developing world, where the informal sector steers the process, remains an economic and environmental challenge. Therefore, dumping e-waste with solid waste is an obstacle not only for the informal sector in benefiting resource recovery but also for the international companies trying to improve the situation of e-waste management.

However, there might be traces of CE strategies in developing countries as Andersen et al. (2021) claim that CE is partly implemented in developing countries. This indicates that consumers practice traditional product circularity despite the many challenges associated with e-waste management in Africa. This traditional circularity of products does not involve dismantling devices but prolonging the device life and reusing it by giving them to friends or donating them to schools. In this regard, Schlupe et al. (2009) found that over 50% of Kenyans gave their computers to friends or donated them to schools after possessing them

for more than five years. This coincides with the MacArthur Foundation's, (n.d) claim that the aim of CE is avoiding waste generation in the first place by reusing machines to extend their lifespan. However, these claims may not be validated due to a lack of documentation as Andersen et al. (2021) state that there is a lack of documentation to prove the circularity of products in developing countries. However, the scope and documentation of these activities matter, which causes indifference. Even though there is a lack of documentation, consumers in the developing world practice product circularity that coincides with CE principles as they avoid waste generation by reusing and donating products. However, the challenge here is a lack of a disposal channel where consumers can safely dispose of their old devices when they purchase a new machine. Therefore, there are CE strategies in place in developing countries but remain unsustainable due to a lack of policies guiding e-waste management, disposal channels and reverse logistics

### **2.3 Overview of e-waste management in Kenya**

Like many other developing countries, Kenya is a destination for used electrical and electronic devices from developed countries to bridge the digital divide and promote the growth of the ICT sector. Most of these devices have one-to-two years of lifespan remaining when the consignment arrives in Kenya. Brokers and businesses are involved in importing refurbished machines, making the ICT sector one of the fastest growing in Kenya (Waema et al., 2008). Danson Ngethe (2021) suggests that the availability of happy consumers in developing countries to buy second-hand computers led to the influx of these devices from North to South through brokers and businesses. The authors argue that digitalization of businesses and education in recent years accelerated the demand for refurbished computers.

Similarly, Anyango et al. (2018) claim that the retailers and end users of second-hand computers play a significant role in prolonging device lifespan and recycling as they remain the central consumers in the secondary market. The author claims that most end users are reluctant to hand over their old devices due to a lack of awareness and keep them (old devices) at home for long periods. However, the above authors have a common concern about the disposal mechanisms available to consumers when they need to get rid of these devices. Due to lack of disposal mechanisms available to consumers, these devices are thrown together with other solid waste after 2-3 years, causing more challenges to e-waste management.

A study by Muranga (2014) shows that organizations and government institutions work together to find a sustainable SWM in Nairobi. However, the study found that there is a lack of trust between government waste management officers and the community after the community's requests were not responded to, affecting external stakeholders', such as NGOs, involvement in waste management. Furthermore, lack of corporation among stakeholders led to the irresponsible behaviour of small businesses and communities in waste disposal as

they claim that they pay taxes and license fees and delegate the waste collection responsibility to government institutions. According to the study, the lack of corporations, community awareness, and disposal infrastructure, coupled with the absence of policies, remain the biggest challenge in Nairobi's municipal waste management. Therefore, the study identified indiscriminate disposal of solid waste in streets, backyards, and dumpsites leading to the high accumulation of hazardous waste disposal in residential and business areas sabotaging economic growth and posing health risks to residents.

Anyango et al. (2018) identified similar challenges in e-waste management at government institutions in Kenya as the study result shows that lack of disposal infrastructure in the country led to the informal dumping of e-waste. For instance, the Kenya Bureau of Standards (KEBS), which is the government body responsible for testing and ensuring locally manufactured and imported goods meet required standards as stipulated in the laws and regulations, faces challenges in the safe disposal of rejected hazardous e-waste. However, the law specifies that the importer meets the disposal cost. Nevertheless, discussing the factors affecting KEBS in executing their duties as stipulated in the law is not in the scope of this study. Another interesting finding of the study was that Kenya Port Authorities (KPA) auctioning EoL computers to employees as a disposal strategy of e-waste on a first-come, first-serve basis. This indicates that e-waste is generated within the same government institutions responsible for preventing the challenge, on top of the influx from abroad.

Consequently, a study by Anyango and Mwololo (2013) found that more than 80% of Kenyans had computers that reached EoL in their possession, and 52% of these consumers keep obsolete machines at home due to lack of awareness and directions on what to do with them. The study further identified that 90% of the survey respondents have no e-waste disposal policy. But only 10% said that they use a framework that is based on the public procurement and disposal Act of 2005, but the framework failed due to a lack of enforcement from government. Stakeholder collaboration is a significant factor in effective waste management as (Rautela et al., 2021; Muranga, 2014). This shows governments' lack of intention to enact policies on effective e-waste management through awareness campaigns and capacity buildings for consumers may have a negative impact on e-waste management.

However, specific studies such as Mwangi et al. (2013); Chao 2015; and Mahmoud mohammad (2018) conducted in Mombasa reveal the importance of ICT in education and SMEs. For example, Chao (2015) who is a teacher by profession identified the importance of ICT integration in teaching at high schools. The focus of the study was to investigate the impact of ICT training to high school teachers in Mombasa and how the already trained teachers apply ICT skills in planning and executing daily teaching activities using computers at school facilities. The study found that despite the availability of ICT equipment at schools, lack of sufficient ICT training to teachers affects teachers' ability to integrate ICT

into their work to make more efficient and innovative. The author identified insufficient finance, lack of infrastructure, and lack of ICT training as key challenges of integrating ICT into education in Mombasa high schools. This clearly indicates the importance of ICT in teaching to produce ICT skilled students who could innovate business ideas in promoting economic growth.

Similarly, Mwangi et al. (2013) studied the level of development of SMEs through the eyes of financial institutions in Mombasa. The study covered diverse categories of SMEs, such as public, formal, informal, and privately owned, all based in Mombasa. The author notes that most SMEs' growth and development decline in the third year. The common challenge faced by these SMEs as identified by the study was lack of relevant financial information. The study also found that SMEs need sufficient information on bank loans, and all relevant financial schemes relevant to their operation. This is an indication that despite the size and capacity, all SMEs need information on their line of operation to survive.

### **2.3.1 The formal sector and CE in Kenya.**

Even though studies did not specifically investigate the impact of international companies working in the ICT sector in promoting CE in Kenya, a recent study by Andersen et al. (2021) examined the operation of firms working in the Ruaraka in the Nairobi industrial area. The study applied evolutionary economic theory to understand the processes of economic change and the role of innovations in economic greening at the firm level using environmental parameters as a basis. Even though the study's focus was to investigate production industries such as the manufacturing, the result showed that SMEs practices more product circularity compared to the big corporations. Despite the availability of resources and incentives to big and international companies, the study discovered that 36% of SMEs claimed to have eco-design targets compared to the 8% of big companies. The fact remains that SMEs play a significant role in economic growth as a report by ITC (2019) notes that 98% of Kenya's all businesses is SMEs and contribute 37% of the country's Gross Domestic Product (GDP). The report added that SMEs are employment creation engines in Kenya and remain untapped. This is interesting and could be interpreted as a massive potential in investing in SMEs to maximize social and economic benefits for all through practicing CE business models.

However, the informal sector that lacks capacity and skills handles more e-waste than the formal companies (Anyango et al., 2018). But Kumar et al. (2017) argue that recycling industries rely on precious metals recovered from e-waste streams as an economic benefit. Furthermore, Widmer et al. (2005) note that e-waste recycling is an attractive and potential business opportunity for companies due to the monetary value of precious elements in e-waste. This indicates that many for-profit companies play an essential role in transitioning to a CE business model through collecting, designing, recycling, and producing eco-friendly

products. However, many factors, such as material quality, policies, and disposal, affect these companies' production as they rely on the informal sector for their production. This shows that formal companies depend on the informal recycling sector to recover valuable elements from e-waste.

However, the efforts and commitments by the formal sector in using recovered materials are hindered by concerns about the quality of the recyclable material recovered by the informal recycling sector due to contamination in the disposal process. Parts of e-waste are disposed of together with solid waste due to lack of disposal channels coupled with lack of policies and regulations governing e-waste management in the country (Anyango et al., 2018). This implies that valuable elements in e-waste are not reaped sufficiently as unskilled people handle the process. However, Williams et al. (2008) claim that despite the unsafe dismantling and handling process, the e-waste resource recovery remains a source of income for informal recyclers. Therefore, formalizing the informal recycling sector plays a significant role in effective e-waste management (Rautela et al., 2021). Thus, promotes quality materials recovery.

Another important sector in Kenya is the informal sector, which remains the heart of e-waste management as they recycle valuable resources recovered from landfills and dumpsites and feed manufacturing sectors (Otieno and Elijah, 2016). For instance, the Jua Kali is a famous informal recycling sector in Kenya that manages a large amount of solid waste in Kenya, where most of Kenya's working population relies on it for their livelihoods. The sector practices informal urban mining, where local people collect precious metals in discarded devices and sell them to local repairing and recycling industries to produce new products (Otieno and Elijah, 2016). The informal sector manages large amounts of e-waste through the informal collection, recovery, and recycling of discarded devices to maintain resource circularity (Anyango et al., 2018). However, despite the potentiality of the sector in transitioning to CE, if provided support, the informal recycling sector faces challenges in executing its activities due to lack of factors such as financial support, infrastructure, and government support.

Despite the environmental challenges associated with e-waste dismantling in developing countries, the informal sector plays a crucial role in e-waste management and recovery of discarded resources for repairing and recycling (Shittu et al., 2021). The informal sector remains a vital stakeholder in the supply chain of resource recovery as the number of precious metals recovered from secondary minerals surpassed conventional mining. Xavier et al. (2021) finds that 250-350g of gold per ton could be recovered from e-waste compared to the traditional mining of 1-5g per ton of Ore. The author further argues that urban mining is essential in implementing CE practices where resources are recovered for reuse, repairing and reproduction purposes with fewer investments than conventional mining. Though urban mining is a different topic and not within the scope of this thesis, there is a potential in investing the informal sector in diverting the focus from natural mining to urban mining. This process would reduce pressure

on natural resources and promote CE transition in countries like Kenya, where secondary minerals are abundant in e-waste streams.

### **2.3.2 E-waste management challenges**

To begin with, Kenya is a signatory to international and regional conventions in controlling the transboundary movement of hazardous wastes and their disposal. However, these policies are ineffective due to lack of national e-waste management policies. To help the government and other actors involved in the management of e-waste effectively and promote environmental protection, the National Environmental Management Authority (NEMA, 2010) formulated a national e-waste management guideline (Otieno and Elijah, 2016). The authors note that NEMA guidelines promote various environmental protection and awareness creation, describe e-waste categories and target groups, technologies for treatment and procedures for disposal. However, an earlier study Anyango and Mwololo (2013) show that lack of capacity in collection, processing, and mechanisms in separating e-waste from solid waste led to the failure of government institutions responsible for licensing to implement a universal licensing framework. The authors further note that the guidelines of NEMA were drawn from international policies to which Kenya is a signatory. As Kenya still depends on international conventions on her e-waste management, the CE potential in managing solid waste remains unrealized, which affects the pursuit of sustainability (Shamim et al., 2019). This gives the impression that applying international policies and conventions alone may not lead to sustainable e-waste management without national legal abiding guidelines on e-waste management.

Secondly, lack of awareness of obsolete device disposal is another challenge Kenyans encounter for effective e-waste management. Rautela et al. (2021) note that the informal recycling sector handles more than 80% of global e-waste in developing countries, including Kenya, which have no plans to manage imported e-waste; thus, landfilling and storing them in warehouses remain the only available options. As the government of Kenya has no strategies to manage the influx of e-waste from abroad, most of this e-waste is handled by the informal recycling sector leading to economic loss, environmental pollution, and risks human lives. Moreso, Anyango et al. (2018) argue that low awareness on imported secondary e-waste and lack of waste segregation affects Kenya's e-waste management. The authors arguments show that global e-waste management directly affects the Kenyan population as they remain a significant receiver of second-hand electronic devices such as computers and mobile phones.

Furthermore, Anyango and Mwololo (2013) study show that 52% of Kenyans store computers at home due to a lack of awareness and directions on what to do with the obsolete machines. Therefore, information sharing with consumers on what to do with old devices could improve the disposal process and later leads to the recovery of quality materials that could be reused for other purposes.

Awareness among all stakeholders would be a gateway to effective e-waste management, where consumers could properly dispose of their old devices. As a result, the informal recycling sector recovers poor-quality materials and sells them to companies for reuse and recycling, leading to the production of poor-quality products that could end up in waste streams due to their short lifetime.

Thirdly, lack of e-waste management infrastructure in Kenya has led to the inconveniences of waste collection, separation, segregation, and recovery of resources in e-waste. Widmer et al. (2005) argue that the absence of WEEE recycling infrastructure leads to reliance on informal sector in processing e-waste, posing environmental challenges and risks lives of those dismantling obsolete devices to recover precious elements. The informal sector dismantles and sells recovered materials in backyards to scrap metal dealers and other individuals interested in buying these recovered resources. In contrast, the formal sector faces challenges in receiving quality materials to feed recycling industries to promote resource circularity. However, big corporations such as Safaricom and Nokia failed to implement a takeback scheme for e-waste due to a lack of collection points for consumers to drop their obsolete device (Omwenga and Otieno, 2013). Another study find that the scheme failed also due to competition among producing companies of Safaricom and Nokia, which made the corporations ineffective in applying EPR (Tacho and Waema, 2013).

Finally, lack of reliable data hinders policymakers in planning e-waste management strategies. The lack of data slows down industries wishing to make investment decisions (Widmer et al., 2005), and overshadows the practicality of CE activities in Kenya (Andersen et al., 2021). However, the flow of second-hand computers to Kenya has increased significantly after the government removed tax levies on electronic devices to promote the growth of e-learning and the launch of the e-government strategy in 2004 (Otieno and Elijah, 2016). As a result, the ownership of computers has increased rapidly. Desmond et al. (2021) claim that the ICT growth in Kenya in recent years has led to growing ownership and accessibility of computers in homes, offices, and internet cafes. Therefore, lack of data coupled with absence of green computing, a new approach to managing e-waste sustainably (Rautela et al., 2021), complicates e-waste management in Kenya.

## **2.4 Socio-economic potentials of e-waste**

### **2.4.1 Employment opportunities**

E-waste management involves various activities ranging from dismantling to resource recovery from dumpsites through scavenging inform of urban mining (Xavier et al., 2021). Formal and informal companies need human resources to supply raw materials to produce new products. For that reason, many young and unemployed Kenyans benefit from e-waste management through resource recovery from dumpsites. One fundamental principle of CE is job creation,

where those involved in e-waste management have access to decent jobs in one way or the other as McArthur foundation, (n.d) and Xavier et al. (2021) link urban mining to CE principles. This means that urban mining protects the environment and creates employment opportunities for those involved in the resource recovery process.

Although Kenya has 55% of its labour force as youth aged 18-35 years, 85% remain unemployed and the youth unemployment in Kenya could increase crimes and radicalization activities (Chitembwe et al., 2021). However, SMEs in Kenya remain an employment creation engine as ITC (2019) notes that SMEs create 80% of new employment opportunities annually in Kenya, and 80% of Kenya's working population relies on SMEs for income generation. Similarly, informal recycling creates job opportunities and a source of income for those involved in the computer recycling process (Williams et al., 2008). This means that SMEs and informal computer recycling create job opportunities and improve the living conditions of those involved in the process of informal e-waste management.

#### **2.4.2 Source of income**

The informal sector in Kenya deals with dismantling of obsolete devices to make a living. Despite the health and environmental challenges associated with the dependence on e-waste as a source of income, communities living around the dumpsites collect e-waste materials and sell them to scrap metal dealers to earn a living. The waste pickers sell collected scrap e-waste to interested buyers in the backyards to make a living (Rautela et al., 2021). Furthermore, Williams et al. (2008) claim that recovering reusable machine parts and metals from e-waste is a source of income for communities. However, the authors note the challenges associated with this informal e-waste management as those buyers landfill post-recovery residues and effluents, leading to soil, water, and air pollution. However, the collection and recovery of resources through informal activities not only remain a source of income but also promotes economic development as many local recycling companies use these recovered resources as raw materials to feed their industries. Xavier et al. (2021) notes that mining secondary resources from dumpsites could be reused in the production industries to avoid waste generation. One example is the famous local informal sector in Kenya called JUA KALI, which produces various locally made products using the recovered resource from dumpsites. The resource recovery activities create job opportunities and promote economic growth in Kenya.

#### **2.4.3 Economic growth**

Despite the challenges of informal collection and recovery of e-waste, the emergence of new entrepreneurs and small businesses dealing with e-waste management has led to the informal economic growth that feeds formal companies in maintaining the supply chain of resource recovery. Even though a study by ITC (2019) shows that SMEs' potentials for economic growth remain unexploited



in Kenya, studies such as by Widmer et al. (2005) and Kumar et al. (2017) identify the importance of e-waste management on economic growth in developing countries, and Waema et al. (2008) and Desmond et al. (2021) further claim that ICT promotes economic development. The government of Kenya has initiated several projects to ensure its people have access to ICT to promote business growth. As a result, the authors claim that the emergence of cyber cafes in Nairobi, with five to hundred second-hand computers, has increased, where Kenyans benefited by accessing computers to run their businesses. However, despite the lack of e-waste management infrastructure, SMEs in Kenya play a significant role in promoting economic growth through their innovation and handwork, where entrepreneurs innovate and develop business strategies with little support from formal companies and the government. Therefore, effective e-waste management not only protects the environment but also could be a potential for economic development that could supplement the government's efforts to alleviate poverty.

## 3 RESEARCH METHODOLOGY

### 3.1 Introduction

This study investigates the potential impacts of refurbished computers on SMEs in the Mombasa region. The reason behind the selection of the study area is to identify how the recently established CE-Hub in Mombasa by CTG impacts SMEs economically and socially and CTG's role in promoting CE in the study area. The focus of the study is limited to the impact of the CTG intervention in the Mombasa region.

In this section, the researcher presents the process of data collection, sampling size, case company, and study area of the thesis. According to Kothari, (2004) the research design is the systematic, comprehensive and theoretical analysis in a particular field of study. The research methodology is a significant section of the project as it leads the researcher to obtain sufficient answers for the research questions. The section will also include data collection and analysis processes. In this section of the thesis, steps followed to achieve the objectives of the study are presented.

The methodology of the thesis guides the researcher to obtain sufficient data in answering the research questions and meet the objectives of the study. The sampling size used in the thesis are confined to SMEs and CTG representing formal sector in Mombasa city. The target respondents of the study were managers, supervisors, and owners of small businesses considered as stakeholders in the case company. The researcher selected the respondents to ensure that data obtained are reliable as these respondents are involved in the business on daily basis and might provide sufficient data for the thesis.

### 3.2 The study area

Mombasa is a coastal city in the south-eastern part of Kenya along the Indian ocean. The city is the oldest and second-largest city in Kenya. The town is well known for its strategic location on the Indian Ocean and has been a trade centre for centuries (Salim, 2018). In the last decades, the city welcomed diverse foreign corporations operating in Kenya and the neighbouring countries. Because many companies find Mombasa a strategic place for their businesses as the port serves countries in East and central Africa (Logistics-hub, n.d.).

Mombasa is a home for international ICT firms such as Google, Oracle and IBM due to the accessibility of optic fiber cable, which provides internet service to the region, that comes through Indian Ocean to Mombasa (Mahmoud mohammad, 2018). However, Gekara and Chhetri, (2013) find that these firms are based close to the port to reduce long waiting time of cargo clearance due to the congestion in the port. Therefore, many ICT firms such as the CTG also find

Mombasa as a strategic point to access NCMS, as shown in Figure 1, and minimise cargo clearance time at the port.

Mombasa port is a global trade gateway to the northern corridor member states (NCMS) of Kenya, Uganda, Burundi, Rwanda DR Congo, and South Sudan (Gekara and Chhetri, 2013). The authors added that the port is the only trade gateway to the landlocked countries in East Africa and is ranked fifth in Africa. Consignments of goods are received through Mombasa port and transported to NCMS through the routes shown on figure 1. These goods are second-hand electronics such as used computers whose consumer demands increase every day due to the cheap prices coupled with the demand for technology in developing countries Anyango et al. (2018).

However, there is a concern that some of these consignments may illegally sneak to Kenya markets through the black market causing operational challenges to international companies willing to invest in e-waste management in Kenya. Many of these second-hand electronic devices increase the e-waste streams in Mombasa as a recent study by wekisa and Majale (2020) identified that 2200 tons of waste is generated daily in Mombasa with 65% collected for disposal and management.

NO.	Interviewee	Position of participant	Duration of interview	Business represented
1.	A	Managerial	40	CTG
2.	B	Operational	40	CTG
3.	C	Owner	36	SME
4.	D	Owner	40	SME
5.	E	Supervisory	32	SME
6.	F	Owner	38	SME
7.	G	Owner	-	SME
8.	H	Owner	-	SME

Table 3: list of Interview participants

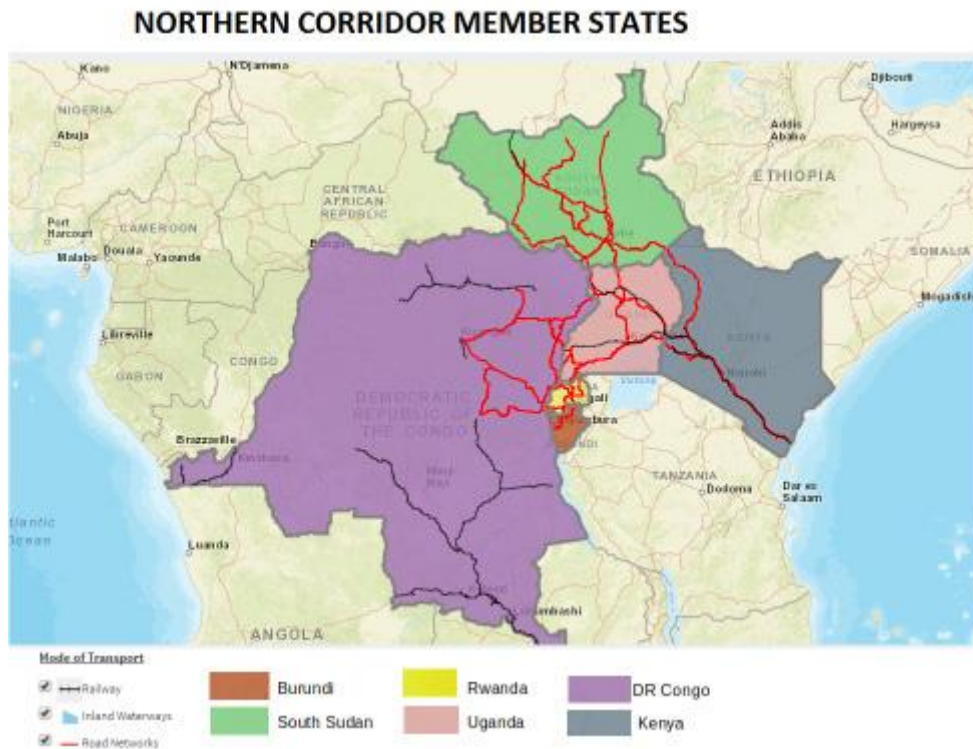


Figure 1: Routes from Mombasa port to NCMS,

### 3.3 The case study company

The Close the Gap (CTG) Kenya is a social enterprise operating in many developing countries such as Kenya (Close the Gap, n.d). The CTG is the case study of this thesis to investigate the impact of the company's impacts of operation on SMEs in e-waste management and transition to CE business model. The company collects used computers from international companies in Europe, import them to Kenya, and refurbish for the purpose of selling to SMEs and individual consumers. The objective of CTG Kenya is to bridge the digital divide by providing high quality refurbished computers for educational, medical, and social projects (Close the Gap, n.d). To improve the digital skills and knowledge of many Kenyans, CTG educates, accommodates them as interns at the CE-Hub in Mombasa.

As shown in Close the Gap, (n.d) website, the CTG Hub is a one stop shop at Ratna square in Mombasa with necessary facilities such as meeting rooms, cafe and co-working spaces for co-workers, entrepreneurs, and start-ups. Additionally, the CE-Hub is located a few hundred meters away from the port. The CE-Hub is the first of its kind in Kenya where collected computers from abroad are received and refurbished before selling to customers.

With its new CE-Hub established in Mombasa, the company is targeting to achieve the following objectives, as stated in the company's 2020 progress report. i) Refurbish 105,000 assets, ii) Improve accessibility of computers/ICT assets to 1.2 million students in Kenya. iii) Create e-waste creation to 10,000 people in Mombasa area. Additionally, local youth impact through 12-week internship program is projected.

### 3.4 Data collection

Brinkmann (2014) defines a qualitative research interview as “an *interview with the purpose of obtaining descriptions of life world of the interviewee in order to interpret the meaning of described phenomena*”. Similarly, Creswell (1998) states that the phenomenological research approach of qualitative research helps the researcher to understand the life experiences of target interviewees on a particular concept or phenomena. Based on this definition, a semi-structured interview was used as a guide to facilitate the interview process of this thesis. The SMEs and the CTG's representatives were the key participants in providing their experiences regarding the impact of refurbished computers on their businesses and social life.

The interview questions were structured for CTG managers and SMEs owners to understand the entire operation of these businesses. The first part of the interview was personal introduction and the researcher introduced himself and informed the participants about the aim of the study and purpose of using their data to generate this report. In the second part, interview participants were asked to describe the process and flow of refurbished computers from abroad to Kenya and how EoL devices are managed. In the final part of the interview was to understand participants knowledge about CE concept and how to apply in their businesses. The researcher provided definition of CE and its application to those participants who had never heard about it.

As shown in table 3, out of the eight planned study participants, four represented SMEs and two CTG employees, while two withdrew their consents to participate due to undisclosed reasons. The interview took 30-40 minutes, depending on the respondent's ability to understand the concept and prolong the discussion. All interviews were recorded with participants' full consent and remained anonymous throughout the process, except one business owner who did not consent the interview to be recorded. Signed privacy notice and research notification were provided to the interviewees, explaining that the data obtained would only be used for this thesis.

Additionally, small businesses and the CE-Hub operation process were observed to understand the processes of dismantling and refurbishing computers. This observation helped the researcher to understand the practical operation of the CE-Hub and observe skills of technicians in handling machines.

### **3.5 Data analysis**

The data analysis was crucial part of the study to identify themes in finding answers to the research questions. First, recorded interviews were listened to understand how interviewees addressed the questions. Secondly, a table was created to put relevant quotes and phrases that would help answer research questions and identify the similarities of interviewees' responses. Finally, the recorded interviews were listened to one by one, and at the same time, notes were taken with the research questions in mind. In the appendix of this thesis are few copies of the analysis tables.

### **3.6 Validity and reliability of the study**

According to Lakshmi and Mohideen, (2013) Validity and reliability are common in quantitative studies but recently considered vital in qualitative studies as well. The authors divided validity as internal and external validity, where the first one helps in ensuring that study were free from systematic errors during designing, data collection and analysis, while the latter one explains whether study results can be generalised to other groups with similar interests. However, Pannucci and Wilkins, (2010) note that systematic errors can occur at any phase of the study such as the research design, data collection, analysis and conclusion. To avoid these errors, the researcher was in constant contact with his supervisor and asked for guidance throughout the process. However, despite the prior knowledge and experience of the researcher on the topic, which can be interpreted as a positive bias, this report represents outcome and results of the study to the best knowledge of the researcher.

## 4 RESULTS

This study aimed to identify the potential impact of refurbished computers on SMEs and how the CTG promotes the transition to a circular economy in Mombasa, Kenya. The results presented below were categorized into themes to group similar findings.

### 4.1 Socio-Economic Impacts

#### 4.1.1 New start-ups

The study found that collection and refurbishment of computers in Kenya accelerate the economic growth among small businesses. As a result of first-hand experience gained by employees of CTG and SMEs in the ICT sector, employees were innovative and established their own start-ups. The demand for ICT in Kenya motivated many young Kenyans to join the ICT business as an employee or entrepreneur. Due to the easy accessibility and affordability of refurbished computers in the locality encouraged many young Kenyans to run their start-ups, such as computer selling shops, cyber cafes, and online businesses.

The study found that availability of cheap and accessible refurbished computers, which do not require a significant investment to start a business, led to increased start-ups in the Mombasa region. Though e-waste management remains a challenge in managing second-hand devices, the study found that refurbished computers have impacted SMEs, consumers, and the wider community. Even though many new entrepreneurs have no access to full training and support, they decided to start businesses using their experiences and skills gained as SMEs' employees. One SME manager said:

*“This business is an eye-opener for our employees because they can work independently and start their own business using the skills and knowledge they learned here”*

However, most of these entrepreneurs are in the informal market, creating concerns about the disposal of obsolete devices. Despite the disposal challenges associated with e-waste management, many entrepreneurs are committed and self-motivated to reach their business development goals and establish a sustainable source of income for their dependents.

#### 4.1.2 Employment opportunity and source of income

The study revealed that SMEs employed local unemployed Kenyans and played a vital role in the country's efforts to reduce unemployment. The employees in these businesses have access to practical training throughout their employment periods and gain first-hand experience in the ICT sector. Many employees were promoted, and others joined big companies leaving space for new employees to follow their path. It was found that these SMEs play a crucial role in the government's efforts to reduce poverty and promote economic growth. These

businesses employ diverse groups such as ICT graduates whose primary responsibilities are the technical operation and uneducated Kenyans whose main duties are soft parts such as cleaning, arranging devices and delivering services. One SME owner summed it up:

*“Some of my employees have gone to open their own business, some have gone to government and companies. I have been having some of my employees who have been taken by Kenya revenue Authority, some have been employed by companies because of the experience they have gotten here because we are having real experience not like in companies as we tackle one on one with people”*

The livelihoods of the employed Kenyans have improved due to the employment opportunities provided by the SMEs dealing with refurbished computers. The study found that these SMEs accommodate many unemployed citizens and provide a sustainable source of income for them and their families. However, some employees have other jobs besides working in these businesses due to insufficient income. For instance, those working as employees in these businesses gain experiences that would lead to new start-ups and sustain their income to support their families. One SME supervisor is quoted as saying:

*“If there would be no this computer business, I won’t be here talking to you, but I would be somewhere in the village ...selling these machines is a source of income, we appreciate our government who allowed us to sell these machines”*

Another interesting finding of the study was that refurbished computers also played a vital role in the digital divide as they impacted students learning process, especially during the Covid-19 pandemic when schools, colleges and universities went into online study mode. In addition to the desire to own a computer by many students in Africa to catch up with the digital world, the availability of cheap devices in the local shops gave a chance for young people to own a machine and increased their motivation and learning process. However, many young people keep devices for a few years before donating to a friend or throwing them away with other solid waste due to lack of functional disposal channels in the area. Another SME manager said:

*“You know in Africa, people are not able to buy new machines, most of them buy cheap and affordable ones.....you know the IT world is coming to Africa, so its better that we sell refurbished computers, which are affordable to students and other community members who wants to own a used machine”*

#### **4.1.3 The e-waste management**

The study found that SMEs managers and owners have been mobilised and trained on e-waste management and device maintenance. In addition, CTG accommodates students and graduates for internships that allow them to acquire experiences in their field of study, while also receiving training packages on e-waste management and circular economy. Many of these young students have studied ICT-related courses in universities or colleges and were eager to acquire



practical experiences in the sector either as employees or entrepreneurs. Some of these interns later became entrepreneurs whose skills and knowledge about CE and e-waste management were improved. For instance, the study found that SMEs understand the CE business model and its potential on their businesses. Additionally, SMEs showed good knowledge of responsible disposal of e-waste and follow-up. However, the lack of policies and formal disposal channels in Kenya led to selling computer parts to scrap metal dealers to dispose of e-waste. One SME manager mentioned how they dispose of excess e-waste:

*“There are people (scrap metal dealers) who come here looking for computer parts, they buy in kilos or in CPU form for Kshs 300. We sell to them because the machine is beyond repair and that’s how we normally destroy them”*

The result showed that e-waste management remains the biggest challenge for small businesses in Kenya to transition to a circular economy business model. Despite the efforts by CTG to train business owners to dispose of their end-of-use devices responsibly, many sell obsolete devices to scrap metal dealers with small fees. The scrap dealers are a significant player in the market due to the absence of an operational take-back system, e-waste management policy, and lack of consumers’ awareness to manage e-waste.

SMEs owners and managers raised concerns that they do not know how scrap metal dealers dispose of obsolete devices after the valuable elements are extracted from the machines. The study found that many of these scrap metal dealers are foreigners and buy devices with small fees to extract expensive components such as copper and gold and landfill the remaining parts. The disposed parts pollute the environment and put the lives of communities at risk. However, scrap metal dealers dismantle e-waste informally by dismantling parts in an open environment and dumping hazardous elements into water sources such as rivers, causing water pollution and risk lives of communities using such rivers as a source of water. SMEs expressed that they sell obsolete devices to scrap metal dealers due to a lack of proper disposal channels in Kenya, as this remains the only option available to SMEs and the informal recycling sector in Kenya. The quoted statement of a business manager says:

*“Some people know how to extract elements from non-working machines using some kind of chemicals which I don’t know, but the negative part is the disposal part where scrap metal dealers buy the trash (obsolete devices), dismantle them to extract elements and dump the rest like metals, plastics from CPUs into the river”*

However, the SMEs expressed concerns about the quality of these machines imported from Europe and Asia because many come with unrepairable technical and physical defects. As a result, the SMEs either dismantle these machines to use as repair parts for other devices or dispose of the whole device by selling it to scrap metal dealers. SME manager said:

*“ Most machines have common problems like over 20% of the machines in a consignment of 1000 machines have problems may be that model had may be graphics or*

*keeping data well or may be the hard disk of that lot had problems may be due to weather or how the machines were used"*

#### **4.1.4 The circular economy perspective**

The CE business model plays a vital role in e-waste management, and the CTG applies it to combat the adverse effects of e-waste and reap economic potential of e-waste. The study identified that SMEs managers and owners were trained on CE principles and how to apply them to their businesses. It was clear from their responses that they have better knowledge about the CE principles and understand the potential benefits of effective e-waste management. Despite the SMEs knowledge and understanding of CE business models, the study found that CE in Kenya is still weak as policy enforcement and disposal channels are not available. However, the respondents are concerned about disposal channels of EoL devices. One participant said:

*"Disposing of these machines would also have an advantage to us, if they are properly disposed of in the right way"*

As a resource circularity remain a crucial pillar in effective e-waste management, the study found that SMEs apply resource circularity techniques to avoid e-waste generation. For example, the results showed that despite lack of policies and training on e-waste management, SMEs buy obsolete devices from local people, dismantle them, and use parts, such as screens and keyboards, to repair other devices and resell them. This process is common in the informal sector to circulate resources and prolong device lifetime. The result showed potential in e-waste management as the process of informal dismantling and fixing devices remain a source of income for many entrepreneurs in Kenya.

*"Somebody who has an issue with his/her machine come to us, we repair it for him/her, there is another way where someone come to us to sell his/her device to us after it stops working, we buy it and use most of that machine as spare parts like we remove the screen and use it to fix another machine and resell it back"*

## **4.2 The Case Company**

The CTG is a foreign-owned social enterprise working in Kenya to bridge the digital divide and, at the same time, promote circular economy principles through e-waste management. The CTG has been working in the collection and refurbishment of computers for twenty years. Apart from the collection and refurbishment of computers, the CTG was a co-founder of the WEEE centre in Nairobi. The involvement of the private sector in e-waste management is crucial in developing countries because of the capacity and knowledge possessed by foreign companies such as CTG. One CTG employee said:

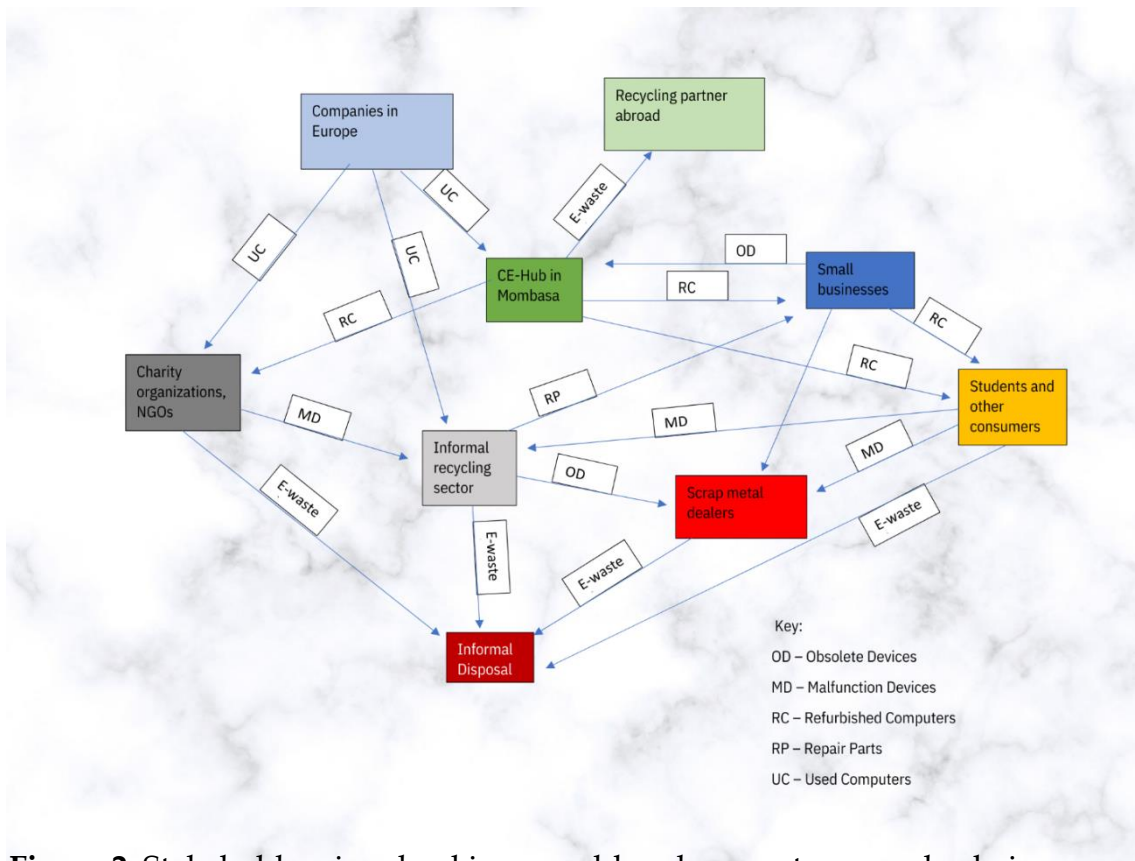
*"In 2013 I think it was 8 years ago, we were co-founder of WEEE center in Nairobi and we dispose of our end of second time used computers in a proper way"*

The company collects used computers from big corporations in Europe and other developed countries, refurbish them and sends them to Kenya for social and educational use. The CTG is one of the influential formal companies working in the ICT sector to reduce the digital divide and promote CE business models in Kenya. The company uses two models to collect used computers from big corporations in Europe. The first model is buying used and ready-for-disposal computers from corporations at a fair price, importing them to Kenya for refurbishment, and selling them to customers and stakeholders as cheap and high-quality machines. The second model is quite like the earlier one, but the difference is that some corporations donate around 20% of their used computers and sell the rest to the CTG.

Due to the lack of effective EPR, policies and laws governing e-waste management in Kenya, the company faces challenges in collecting used computers within Kenya for refurbishment. As the informal economy is dominant in Kenya and many depend on the informal recycling sector as a source of livelihood, formal corporations face challenges in promoting resource recovery. Local scrap metal dealers and a lack of e-waste law enforcement facilitated the illegal disposal of EoL machines. Devices are dismantled informally to extract expensive elements such as copper and gold and dump the remaining parts such as metal, copper, and gold.

In Figure 2, the study result showed that diverse stakeholders are involved in the supply chain of used machines from Europe and Asia to Kenya. In Kenya, these stakeholders include the informal recycling sector, consumers, scrap metal dealers, charity and civic organizations and SMEs. In addition, the big corporations in Europe and second-hand computer dealers in Asia play a vital role in importing used machines into Kenya. However, the focus of this study was to investigate the process and flow of used computers from Europe to Kenya through CTG and her partner SMEs.

The study found that the CTG buys used machines from European companies and refurbishes them before they are sold to SMEs or donated to charity and civic organizations. As explained earlier, the CTG applies two models in procuring these machines. Firstly, one model buys used machines in good condition from big corporations in Europe at a fair price. Secondly, in addition to the first model, some corporations donate about 20% of their used machines. Big European corporations also donate used machines to charity organizations in Kenya to promote the digital divide. The SMEs are also direct receivers of used machines from Asia and Europe for profit-making in the secondary market.



**Figure 2.** Stakeholders involved in second-hand computers supply chain.

Nevertheless, the CTG is one of the formal stakeholders in the ICT sector that returns e-waste to European companies for recycling. In contrast, due to a lack of return infrastructure and capacity, selling old machines to local scrap metal dealers is a significant part of the SMEs' disposal process. The informal disposal of obsolete devices is common and complex in Kenya as there are no policies and regulations governing the disposal channels. However, CTG partner SMEs practice a formal disposal process because of exposure to training and effective e-waste management procedures, and return unrepairable parts, such as motherboards, to Europe for recycling using CTG facilities.

Despite the challenges associated with the informal disposal process of EoL machines, the informal and formal businesses practice resource circularity where old devices are repaired and resold locally as a second-hand machine to prolong device lifetime. For example, the informal recycling sector is crucial in resource circularity. Because the informal recycling sector collects malfunction devices (MD) from consumers, charity organizations, and used computers (UC) from European companies to dismantle and recover functional parts and sell them to computer repair shops such as SMEs.

As illustrated in Figure 2, the result showed that all the stakeholders involved in the supply chain of second-hand computer business take part in the informal disposal of old machines or parts either directly or indirectly. For example, consumers, scrap metal dealers and charity organizations directly send old devices or components to landfills together with other solid waste. Meanwhile, the CE-hub, partner SMEs and companies in Europe indirectly promote informal disposal due to a lack of return channels. Due to the absence of a return channel in the supply chain, consumers and the informal recycling sector have no option

but to dispose of old machines to spare space for the next consignments and devices arriving from aboard.

### 4.3 The Circular Economy Hub (CE-Hub)

The CE-Hub is a facility initiated by CTG in 2020, where imported computers are refurbished, and e-waste managed. The CE-Hub is one of its kind in Kenya, where computers are refurbished and made ready for sale as quality second-hand devices. The CE-Hub in Mombasa was a milestone toward sustainable e-waste management in Kenya that could facilitate the circularity of resources for economic and social benefits. Before the CE-Hub by CTG in Mombasa, the company imported refurbished computers ready for sale to Kenya as the collection and refurbishment took place outside Kenya.

Nevertheless, in recent years, the company only imports parts and used computers to Kenya and does the refurbishment at the CE-Hub. This process brought many benefits to Kenya, such as employment, training, and a roadmap for future e-waste management to reap full economic potential through resource recovery and effective e-waste management. One CTG employee explains the process:

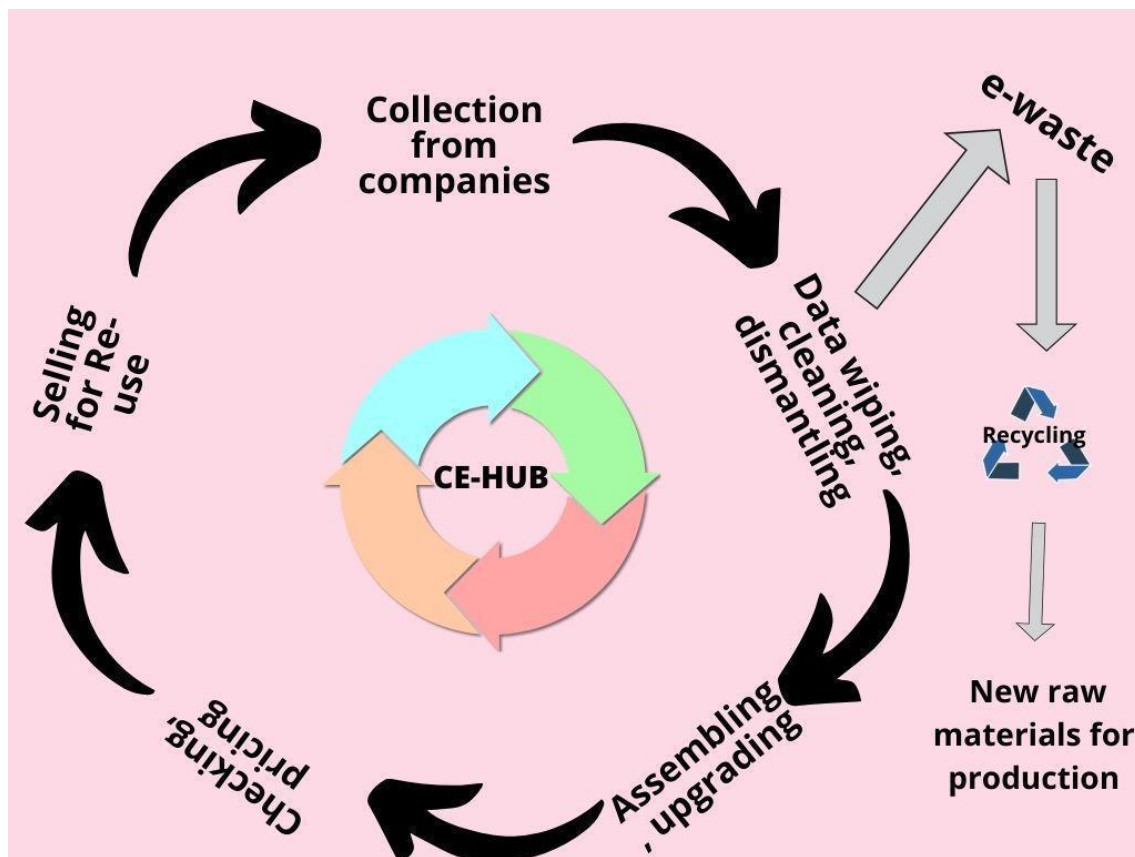
*“After the devices arrive in the harbor, we take them to the CE-Hub. The process starts by unpacking the container. We “check in” all the devices. By checking in we check the state of the devices, the specifications and register them in our stock system. After this they go through different kind of processes. We call the processes: teardown, monitor, mobility, and data wipe. At the teardown all broken devices, are processed. These are devices that cannot be re-manufactured. We take them a-part and we dispose the e-waste safely. At monitor, we process and test all screens”*

As shown in Figure 3, the CE-Hub operates in a closed loop process where the company avoid e-waste generation as much as possible. The collection stage has taken place in Europe, where CTG Buys good condition used computers from European corporations and imports them to Kenya for refurbishment.

Since CTG is a for-profit company, the machines are bought from corporations at a fair price and sold to partner SMEs and customers in developing countries to extend their lifespan for a couple of years before being discarded or disposed of as e-waste. Figure 3 summarizes the process of computer refurbishment at the CE-Hub before selling these computers to stakeholders and other customers.

First, the computers are checked by technicians in the CE-Hub when arriving in Kenya to identify defects. The process covers a range of activities such as data wiping, cleaning, shredding of glass and plastics and dismantling some parts of the computers to recover functional parts. Secondly, the shredded pieces are sent to local industries to produce new products such as plastic chairs, et

cetera and the non-shredded components such as the motherboard are sent for recycling back to Europe.



**Figure 3.** Resource circulation at the CE-HUB

At the second stage is where the study found that e-waste is produced because of the shredding and dismantling of machines to remove malfunction parts. However, the e-waste produced in this stage goes to sister companies in Europe, recycled and used as raw materials to produce new products.

Thirdly, after data wiping and cleaning, the functional machines are assembled and upgraded and sent for a final check-up before it is priced according to their generations and models. The study identified that most of the machines refurbished are the latest generations as consumers need to upgrade their old machines. The final stage is selling the machines to partner SMEs or directly to customers, where the device is reused, and its life extended for a couple of years. But due to a lack of return channels available to consumers, the study found that old machines are kept in homes and offices.

However, the CE-Hub manages the e-waste generated within the process of refurbishment in the hub. The study found that few machines are returned by partner SMEs due to the presence of scrap metal dealers and other local informal recyclers, which are faster than big corporations in negotiating with owners.

## 5 DISCUSSION

The study primarily investigated the impact of refurbished computers on SMEs in Mombasa, Kenya and how the CTG as a formal sector in the field, promotes a circular economy in the collection and refurbishment of used computers. The study's research questions were 1) What are the potential impacts of refurbished computers on small-scale businesses in Kenya? and 2) How does the CTG operation promote a circular economy business model in Mombasa?

The results showed economic and social potentials in the effective management of electronic and related accessories in the study area. But the scope of this study is limited to refurbished computers imported by CTG and sold to SMEs as partners. The CTG company recently established a CE-Hub in Mombasa where collected computers from international corporates in Europe are refurbished and tested before selling to stakeholders and other interested customers within Kenya and beyond. SMEs and other customers benefit from these cheap, accessible, ready-for-use computers coupled with software training and awareness on proper e-waste disposal mechanisms.

The analysis identified that CTG partner SMEs have a better understanding of the process of resource circularity. Because these SMEs have been trained about the importance of e-waste management and its economic potential. Therefore, they maintain the circularity of resources by repairing and maintaining devices and dispose of e-waste responsibly. Additionally, the CE-Hub establishment in Mombasa provides employment opportunities for many young Kenyans and paves the way to a better understanding of e-waste management within the local communities.

Despite the challenges, such as lack of policies and guidelines on e-waste management, CTG follows international guidelines such as ISO standards to dispose of e-waste responsibly. For instance, Computers are screened and checked when they arrive in Kenya, and the e-waste is exported to a sister company in Europe for recycling. The CE-Hub has mechanisms and processes to ensure that these computers are fit for use as refurbished machines before being dispatched to partner SMEs or private customers. Furthermore, the CE-Hub retains and dismantles those machines with defects and follows a safe and responsible disposal channel to ensure that e-waste is returned and recycled in partner companies' facilities in Europe. However, some entrepreneurs have no proper disposal channels and, for that reason, sell obsolete devices to scrap metal dealers for a small fee. These scrap metal dealers intend to extract precious elements from EoL devices and landfill the rest causing environmental and risk human health.

The study identified that the process followed by CTG before the establishment of CE-HUB in Mombasa was different from the current one as the company used to collect and refurbish computers outside Kenya and imported ready-

for-sell computers. On the contrary, the company currently collects and imports computers and conducts the refurbishment process in Kenya. This process brought to Kenya economic and social benefits such as economic growth and employment opportunities. The following sub-sectors interpret the study's findings and how the results answer the research questions.

## **5.1 E-waste management**

The e-waste management remain a central discussion point in this paper because reaping socio-economic benefits of CE business models depend on the effectiveness of e-waste management. Therefore, in the next sub-sections will present discussion about key findings and factors that facilitate effective e-waste management without necessarily going out of study scope.

### **5.1.1 Training and Awareness**

The CTG is a social enterprise that collects and imports second-hand computers from Europe to Kenya. In addition, the company provides technical training to stakeholders such as software installation, device repair and maintenance. A recent study shows that awareness creation is one option to implement green computing for sustainable e-waste management (Rautela et al., 2021). Thus, CTG's awareness creation could lead to sustainable e-waste management in the future. In addition, the company accommodates students as interns and exposes them to practical jobs that give them courage and experience in bridging the digital divide.

The result revealed that business owners and their employees had gained technical skills and knowledge since the refurbished computer business started booming in Kenya. Furthermore, the CTG partner SMEs have received software installations, repair, and computer maintenance training packages. This training has increased their skills and knowledge on e-waste management, thus CE business models to minimize environmental pollution, and increased earnings.

For example, before training, the business owners disposed of a whole device together with other solid waste. However, now, they can extract and recover functional elements safely before sending the remaining for recycling to reduce economic loss. Moreover, they understand how that device would harm human health and the environment if disposed of unsafely. Additionally, the knowledge and understanding of e-waste management and responsible disposal of obsolete devices showed that CTG partner SMEs' attitudes and perceptions of waste management have changed. This is indication that SMEs have the capacity to adapt and change business strategies in short period and reap potentials of effective e-waste management. The CTG training and awareness packages exposed SMEs to the monetary value of e-waste and are aiming to utilise and consider e-waste as a resource than a trash.



In this regard, Widmer et al. (2003) believe that e-waste recycling is an attractive and potential business opportunity for companies due to the monetary value of precocious elements in e-waste. The author estimated that 1 ton of e-waste contains 0.2 tons of copper, which has a monetary value of 500 euros. This indicates that awareness and capacity building to local business owners would lead a better understanding of e-waste management, thus leading to economic growth and resource circularity.

However, as the informal economy plays a vital role in economic growth and accounts for 37% of the country's GDP (ITC, 2019, p14-17), economic value resource is lost in the waste due to a lack of proper recovery strategies and conditions. Widmer et al. (2005) suggest that many developing countries lose economic value resources in the waste due to a lack of infrastructure, knowledge, skills, and law enforcement. Therefore, the result indicated that capacity building to SMEs would be a game changer for Kenya's 2030 vision to join the middle-income countries.

Additionally, the findings showed that the CE-Hub acts as a training ground for graduates who are accommodated as interns to acquire practical training and experience. The CE-Hub action is a step taken to combat the adverse effects of e-waste and tap its potential economic values to promote a sustainable source of income. As a result of digitalisation and the introduction of social media, students and young people remain the largest end-users of electronic devices such as computers and mobile phones, and they play a significant role in the disposal rate of e-waste. Hence, educating young people on e-waste management and CE business models would improve e-waste management, reduce its adverse impact on human health and the environment, and increase its economic benefits.

### **5.1.2 Resource recovery**

Due to the lack of proper return channels and e-waste awareness in developing countries, many young people keep obsolete devices at home or throw them away with other households' solid waste (Anyango et al, 2018). Therefore, CTG capacitated and trained stakeholders to combat e-waste challenges to minimize economic loss and environmental challenges. Even though the CTG partner SMEs represent a small percentage of the market, their resource recovery skills and understanding of CE business and e-waste management showed that capacitating local entrepreneurs would be a good start for transitioning to CE business models in Kenya.

However, the efforts could be discouraged by a lack of policies and government support since the laws and policies governing e-waste management have not been enforced in Kenya. As a result, many local businesses dispose of computers with other solid waste as they empty spaces for new functional machines to arrive. This process put resource recovery in a poor state and remains

the heart of the problem in Kenya. Because local scavengers, who lack basic training, skills, and knowledge on safe disposal of e-waste, are crucial actors in dismantling computers in dumpsites to extract expensive elements such as copper and gold to earn a living.

Additionally, scrap metal dealers play a crucial role in the illegal disposal of e-waste due to the lack of policies and rules governing e-waste disposal in Kenya. A news article published by the daily nation Kalua (2022) claims that the Government of Kenya has realized the economic sabotage of scrap metal businesses in the country. Following the vandalization of vital infrastructures such as power transformers and rail guards, the President of Kenya ordered a total shut-down of these businesses in January 2022. This clearly shows how destructive and retrogressive such businesses could be without clear policies and laws governing their operations. However, it seems that the government of Kenya neglects e-waste challenges and allows illegal dumping of e-waste, thus undermines economic development.

## **5.2 Socio-economic impact**

This section will present impacts of effective e-waste management with a close consideration to the studied company and partner SMEs. The sub-sections below will discuss findings concerning the impacts of refurbished computers to SMEs and the wide community, and how these impacts could be linked to CE transition process.

### **5.2.1 Employment opportunities**

The results revealed that refurbished computers impacted the employees' and business owners' livelihoods. To begin with, the employees' living conditions are improved due to the employment opportunity resulting from refurbished computer business. The findings revealed that businesses have positively impacted employees as they secured wage-earning employment that many of their colleagues do not have. This study coincided with earlier studies such as Rizos et al. (2016), which found that practicing CE principles on SMEs would create employment opportunities and catalyze the transition to CE business models.

However, due to lack of employment opportunities in Kenya, youth remain unemployed for long period of time, and this may compromise their proactiveness in the future (Chitembwe et al., 2021). Having this issue in mind, employees become proactive and work outside their normal working hours to earn more income. For example, one respondent mentioned that he works on weekends in a different part-time job to maximize his monthly earnings. This shows that employees have a better living experience and are motivated to find new jobs as they feel confident performing extra work outside their regular hours. Consequently, this kind of psychological motivations would motivate youth to remain employed without necessarily staying into one business or company.

In this regard, a recent study Chitembwe et al. (2021) found that youth unemployment is a vital factor facilitating youth radicalization in the region. The study found that 77% and 10% of respondents agreed and strongly agreed respectively that youth unemployment is a significant factor in the radicalization process. This indicates that providing youth employment opportunities could be essential in reducing poverty and crime. However, lack of youth employment led to many young Kenyans committing local and international crimes. Therefore, providing job opportunities to young people would play a central role in the transition to a CE business in Kenya.

### **5.2.2 New entrepreneurs**

The study found an increase in the emergence of entrepreneurs joining the ICT sector. Most of these entrepreneurs studied ICT in universities but remained jobless for a long time due to a lack of job opportunities in the country. However, some of these unemployed youth got internship opportunities at CTG, and some were employed in the company. As a result of the training provided, most of them decided to start their businesses and provide employment opportunities to other jobless youth who did not get the opportunity for internships. The SMEs supported by CTG also employed another group of youth and, after a few years, decided to start their businesses.

However, despite the training provided and their innovation, some could not start businesses due to a lack of investment and financial support. Rizos et al. (2016) identified SMEs' lack of investment and support as crucial factors affecting CE business models at grassroots levels. Despite the challenges identified by earlier studies, this study found that youths were innovative to have started online businesses and avoided the expenses incurred in renting premises. Therefore, the internships and training provided to these young people impacted the growth of small businesses; leveraging such activities could improve the entire country's unemployment challenges and lead to economic growth.

### **5.2.3 Promote business digitization and online marketing**

With refurbished computers, the findings showed that business owners had saved precious time recording business activities, leading to efficiency and increased productivity. Similarly, refurbished computers application in their businesses improved internal transparency and obtained quality data. Apart from selling refurbished computers to customers, business owners and employees use these refurbished machines to operate their businesses. For example, the same devices are used for marketing and advertising products online by uploading photos and share with customers. Therefore, customers could access all products on one website, and it would be easy for them to choose the product they are interested in before visiting the shop.

Kenya's online shopping activities stand at only 1% of the country's GDP compared to the global rate of 59% (Orare et al., 2019). This indicates lack of motivation and innovation to run online businesses in Kenya, despite availability of skilled and knowledgeable manpower. However, SMEs advertise refurbished machines ready for sale by uploaded to the internet where the interested customer can easily access them. The customer visits the business website and checks various refurbished computers to choose the right one that fits customer's requirements and budget. Then, the customer either visits the business premise or calls the business and asks for clarifications and price negotiations. The business provides more clarifications on the machine specification as requested by customer. Finally, the customer buys and owns the machine with a one to two years warranty depending on the computer's generation. This shows that business is digitalized, and customers can access and choose machines while staying at homes. The digitization of businesses benefits the business and saves time and money for the customers.

Similarly, the finding showed that businesses saved money and time by buying cheap and quality refurbished computers from a nearby CE-Hub and use them to run business. In addition, business owners are trained in safe disposal of e-waste and CE business models, where they are motivated to recover resources from obsolete devices. The CTG has a working space for partner SMEs where they can conduct meetings, test innovations and share experiences. The partner SMEs can, in advance, book a room in the CTG website on a specific date and time to conduct their business. This process also shows that SMEs are encouraged to be professionals and communicate in a digitized way to engage their business with big corporations.

The results showed that Partner SMEs use refurbished computers to improve their business visibility and convince customers that their business is the right choice. In addition, the partner SMEs create surveys to understand customer satisfaction by following customers' feedback and improvement suggestions. This process improves business-customer relations and leads to product improvements, thus potential new customers and retaining the existing ones.

Many young entrepreneurs with the expertise to innovate or start a new business lack the finance. However, with the availability of cheap refurbished computers, many started online businesses without necessarily having physical structures. The identification of customers is one vital factor to the business, and many entrepreneurs identify their consumers before the business is started by checking online and doing small research. In this process, entrepreneurs engage their customers in an online business and sell their services and products.

Another interesting finding showed that the availability of refurbished computers introduced online businesses as few partner SMEs run their businesses online and do not have a physical office or premise to run the business.

The online business interacts with customers through the internet and sells services without practically incurring costs for setting up business structures such as shops. This type of business is cost-effective and can easily be set up if the owner has viable business ideas and customers. This shows that refurbished computers benefited physical businesses such as computer selling shops and promoted online business and service selling. Clearly, these machines' importance to businesses is underestimated as they play a vital role in marketing, especially online marketing, which has become popular in recent years due to the availability of internet services.

### **5.3 The CE-Hub and circular economy business models**

The CE-Hub in Mombasa is the first of its kind in Kenya and acts as a bridge to transition to CE business models. Due to the extensive process involved in e-waste management, local companies cannot run e-waste management facilities. However, one company, the WEEE centre in Nairobi, is the biggest and most active facility in Kenya that manages e-waste, following international standards to process e-waste. Before the establishment of the CE-Hub, the CTG was one of the co-founders of the WEEE centre and supported them technically and materially. Unlike informal dismantling, formal recycling facilities apply extensive processes in recovering reusable materials from e-waste. The significant steps in this process include collection, pre-processing, post-processing, and disposal (Rautela et al., 2021).

In addition to the extensive processing of e-waste, the CE-Hub applies a green computing approach where partner SMEs are trained on e-waste disposal techniques and promote reuse of second-hand computers and responsible disposal of e-waste. According to Rautela et al. (2021), green computing is a new approach to manage e-waste sustainably by applying the 4Rs (reduce, reuse, recycle, and recover) to avoid waste generation using eco-friendly technologies. Applying eco-friendly technologies in e-waste management shows a promising step toward CE business models that could promote the reuse and recovery of resources. However, the work of CTG in promoting CE business models in Kenya is a drop in the ocean as the country lacks an e-waste management policy and a significant portion of e-waste is handled by the informal sector and remains undocumented.

Similarly, the study found that many new entrepreneurs have viable business ideas but lack support and a place to test them, leading to fewer innovations. However, the partner SMEs can use the CE-Hub for testing their business ideas before implementation. As a result, the analysis shows that providing a working space for new entrepreneurs could boost their morale and innovations in starting new businesses, thus contributing to the country's economic growth. This indicates that providing youth training on e-waste management could increase the rate of innovations and start-ups in the country, leading to effective resource re-

covery and improving socio-economic activities. However, the scope of these activities remains tiny compared to the informal economic activities on e-waste management in the country. Therefore, the CTG activities could be a gateway to leveraging formal e-waste management in preventing the loss of valuable resources to improve the socio-economic well-being of Kenyans.

## **5.4 Challenges in transitioning to CE business models in Kenya**

The study found diverse challenges that hinder the transition of CE business models in Kenya. The following section summarizes the challenges identified for effective e-waste management.

First, Kenya is a signatory to international conventions on the prevention of the movement of hazardous materials, and the influx of used electric and electronic equipment (EEE) has increased in recent decades. The lack of a specific e-waste policy and framework and the removal of tax levies on electronics accelerate the importation of second-hand computers. It was evident in the findings that due to a lack of return channels; these computers remain in the hands of consumers for a long time and finally may be disposed of together with other solid waste making the resource recovery more complicated for the formal production industries.

Secondly, the absence of e-waste management infrastructure for collecting, segregating, and processing WEEE is another challenge affecting e-waste management. As a result, the e-waste is dismantled informally by unskilled people, causing damage to themselves, the environment and the entire society. Big corporations such as Safaricom and Nokia initiated a take-back scheme for e-waste. However, a lack of infrastructure, such as collection points, led to the failure of the programs (Omwenga and Otieno, 2013). The study respondents mentioned that the biggest challenge for e-waste management in Kenya is the lack of collection points which directly impacts the effective collection of e-waste for segregation and processing.

Lastly, lack of community awareness and mobilization on e-waste disposal and management are significant issues affecting effective e-waste management in Kenya. The study found that a lack of awareness and training for SMEs and the informal recycling sector remains a challenge to e-waste management. However, the partner SMEs in this study represent a small fraction of the entrepreneurs in Kenya, which shows that awareness creation and training provision to local people could improve the e-waste situation in Kenya.

## 6 CONCLUSION

To summarize, this thesis aims to investigate the socio-economic impact of refurbished computers on SMEs in Mombasa and the role played by the CTG, as a formal company operating in Mombasa, to promote CE business models. The study deployed qualitative data collection, such as semi-structured interviews, to gather data from interviewees. The literature in the study notes that the global north manages e-waste effectively in tapping resources to feed various sectors for reuse compared to the ailing global south's e-waste management. The availability of e-waste management infrastructure and effective policy in the global north led to resource recovery and circularity.

On the contrary, the literature and the study findings show that lack of policy, awareness and e-waste infrastructure are key factors affecting effective e-waste management in the global south. However, the study notes that effective e-waste management in the global south could have economic and social potentials for economic growth and societal wellbeing. For example, the study identified that job creation, source of income and promotion of business innovation were few potential impacts of refurbished computers in the Mombasa region.

Similarly, the CTG and the CE-Hub facility, the case study company, play a vital role in improving the e-waste management situation in Kenya. The CTG provided stakeholders capacity building and technical training and supports start-ups willing to improve e-waste management. The skills and knowledge of partner SMEs on e-waste management show that providing training to SMEs could be a game changer for the ailing e-waste management in Kenya. Despite the efforts of CTG in improving e-waste management, the importation of tons of used computers under various nametags, such as donations, and the digital divide dominate the market. In addition, individuals and private companies take advantage of the government of Kenya's efforts to promote digitalisation through tax levies on electronic imports, making e-waste management more challenging. However, the lack of law enforcement leading to informal dismantling of computers in the secondary market dominated by the informal recycling sector and scrap metal dealers remains a setback in promoting CE business models in Kenya.

### 6.5 Limitations of the study

The study limitation was the scope of the study area as it was confined to Mombasa town, where the interviewees were based at. Another limitation was the number of interviewees. For example, a few interviewees consisting of CTG partner SMEs and CTG employees, were involved in the study. However, widening the study area and increasing the number of participants to bring other vital sectors on board, such as government institutions, the informal sector, and other formal companies working on the same issue, could add more value to the

study findings. Therefore, a potential future study could investigate the collaboration gap between various sectors in promoting CE business models in Kenya.

Note: The researcher used “small businesses” in figure 3, which he meant SMEs.



## REFERENCES

- Aghaei, M., & Rezagholizadeh, M. (2017). The Impact of Information and Communication Technology (ICT) on Economic Growth in the OIC Countries. *Economic and Environmental Studies*, 17(42), 257-278. <https://doi.org/10.25167/ees.2017.42.7>
- Amutha, D. (2020). The Role and Impact of ICT in Improving the Quality of Education. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3585228>
- Andersen, M. M., Ogallo, E., & Galvão Diniz Faria, L. (2021). Green economic change in Africa - green and circular innovation trends, conditions and dynamics in Kenyan companies. *Innovation and Development*, 1-27. <https://doi.org/10.1080/2157930x.2021.1876586>
- Angouria-Tsorochidou, E., Cimpan, C., & Parajuly, K. (2018). Optimized Collection of EoL Electronic Products for Circular Economy: A Techno-economic Assessment. *Procedia CIRP*, 69, 986-991. <https://doi.org/10.1016/j.procir.2017.11.020>
- Anyango Tocho, J., & Mwololo Waema, T. (2013). Towards an e-waste management framework in Kenya. *Info*, 15(5), 99-113. <https://doi.org/10.1108/info-05-2013-0028>
- Anyango, S. O., & Munyugi, L. K. (2018). E-Waste Management Practices: Policies Strategies and Regulations, In Selected National Institutions, Nairobi, Kenya. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 12(3), 81-92. <https://doi.org/10.9790/2402-1203018192>
- Avgerou, C. (2003). The link between ICT and economic growth in the discourse of development. In *Organisational information systems in the context of globalisation* (pp. 373-386). Springer, Boston, MA.
- Bisschop, L. (2012). Is it all going to waste? Illegal transports of e-waste in a European trade hub. *Crime, Law and Social Change*, 58(3), 221-249. <https://doi.org/10.1007/s10611-012-9383-0>
- Brinkmann, S. (2014, July 1). Unstructured and Semi-Structured Interviewing. *The Oxford Handbook of Qualitative Research*, 276-299. <https://doi.org/10.1093/oxfordhb/9780199811755.013.030>
- Brownlee, C. (2018). In Nano, Volume 12, Issue 12. *ACS Nano*, 12(12), 11721-11724. <https://doi.org/10.1021/acsnano.8b09384>
- Bushehri, F. I. (2010, November). UNEP's role in promoting environmentally sound management of e-waste. In fifth ITU Symposium on "ICTs, the Environment and Climate Change" Cairo, Egypt.

- Chitembwe, S. J., Okoth, P. G., & Matanga, F. K. (2021). The Nature, Extent and Impact of Youth Radicalization in Mombasa and Kwale Counties, Kenya. *OALib*, 08(06), 1-21. <https://doi.org/10.4236/oalib.1107386>
- Close The Gap. (n.d.). Who we are - Close The Gap. <https://www.close-the-gap.org/who-we-are>
- Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Sage Publications, Inc.
- Desmond, P., & Asamba, M. (2019). Accelerating the transition to a circular economy in Africa. *The Circular Economy and the Global South*, 152-172. <https://doi.org/10.4324/9780429434006-9>
- Diaz, L. F. (2017). Waste management in developing countries and the circular economy. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, 35(1), 1-2. <https://doi.org/10.1177/0734242x16681406>
- Fofou, R. F., Jiang, Z., & Wang, Y. (2021). A Review on the Lifecycle Strategies Enhancing Remanufacturing. *Applied Sciences*, 11(13), 5937. <https://doi.org/10.3390/app11135937>
- Forti, V., Balde, C. P., Kuehr, R., & Bel, G. (2020). The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential.
- Gekara, V. O., & Chhetri, P. (2013, November). Upstream transport corridor inefficiencies and the implications for port performance: a case analysis of Mombasa Port and the Northern Corridor. *Maritime Policy & Management*, 40(6), 559-573. <https://doi.org/10.1080/03088839.2013.776716>
- Gertrude Mariam Chao, Impact of Teacher Training on Information Communication Technology Integration in Public Secondary Schools in Mombasa County, *Human Resource Management Research*, Vol. 5 No. 4, 2015, pp. 77-94. doi: 10.5923/j.hrmmr.20150504.01
- Herat, S., & Agamuthu, P. (2012). *E-waste: A problem or an opportunity? review of issues, challenges and solutions in asian countries*. London, England: SAGE Publications. doi:10.1177/0734242X12453378
- International Trade Centre (ITC). (2019). Promoting SME Competitiveness in Kenya. <https://intracen.org/resources/publications/shetrades-promoting-sme-competitiveness-in-kenya>
- Kalua, I. (2022, May 14). We can manage scrap metal trade better and avert sabotage. *The Standard*. <https://www.standardmedia.co.ke/opinion/article/2001445441/we-can-manage-scrap-metal-trade-better-and-avert-sabotage>

- Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, 221–232. <https://doi.org/10.1016/j.resconrec.2017.09.005>
- Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.
- Kumar, A., Holuszko, M., & Espinosa, D. C. R. (2017). E-waste: An overview on generation, collection, legislation and recycling practices. *Resources, Conservation and Recycling*, 122, 32–42. <https://doi.org/10.1016/j.resconrec.2017.01.018>
- Kumar, A., Holuszko, M., & Espinosa, D. C. R. (2017). E-waste: An overview on generation, collection, legislation and recycling practices. *Resources, Conservation and Recycling*, 122, 32–42. <https://doi.org/10.1016/j.resconrec.2017.01.018>
- Lakshmi, S., & Mohideen, M. A. (2013). ISSUES IN RELIABILITY AND VALIDITY OF RESEARCH. *International Journal of Management Research and Reviews*, 3(4), 2752–2758. <https://www.proquest.com/scholarly-journals/issues-reliabilityand-validity-research/docview/1415612380/se-2>
- logistics-hub. (n.d.). Mombasa County. Retrieved October 10, 2022, from <https://invest.mombasa.go.ke/page/logistics-hub>
- MacArthur, E. (n.d.). Circular economy principles. Ellen MacArthur Foundation. Retrieved April 12, 2022, from <https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>
- Mahmoud mohammad, M. (2018). Innovation strategies and sustainable competitive advantage of information and communication technology firms in Mombasa Kenya [MA thesis]. University of Nairobi.
- Mihai, F. C., & Gnoni, M. G. (2016). E-waste Management as a Global Challenge (Introductory Chapter). *E-Waste in Transition - From Pollution to Resource*. <https://doi.org/10.5772/64596>
- Muhammad Tariq Majeed. (2018). Information and communication technology (ICT) and environmental sustainability in developed and developing countries. *Pakistan Journal of Commerce and Social Sciences*, 12(3), 758–783. Retrieved from <https://doaj.org/article/a5ac60cde60e41ad88437be27b96826e>
- Muranga, M. P. (2014). Stakeholder's involvement in municipal solid waste management. University of Jyväskylä. <https://jyx.jyu.fi/bitstream/handle/123456789/44288/URN%3aNBN%3afi%3ajyu-201409192825.pdf?sequence=1&isAllowed=y>
- Mwangi, M., George, G. E., Mindila, R., Nyakwara, S., Onger, J., & Okeyo, H. N. (2013). An evaluation of Financing and Development of Small and

Medium Enterprises in Mombasa County Kenya. International Institute for Science Technology and Education.

- Ngethe, D. (2021). Influence of electronic waste management systems in Kenya. A critical literature review. *Journal of Environment*, 1(1), 45–60. <https://doi.org/10.47941/je.618>
- Niebel, T. (2018). ICT and economic growth – Comparing developing, emerging and developed countries. *World Development*, 104, 197–211. <https://doi.org/10.1016/j.worlddev.2017.11.024>
- Northern Corridor Transit and Transport Coordination Authority: Background. (2013). Northern Corridor Transit and Transport Coordination Authority. <http://www.ttcanc.org/page.php?id=11>
- Ondier, M. O. (2013). Strategic issue management practices by small and medium enterprises in Mombasa County, Kenya (Doctoral dissertation, University of Nairobi). <http://erepository.uonbi.ac.ke:8080/xmlui/handle/123456789/60503>
- Orare, G., & Nkirina, S. (2019). INFLUENCE OF INTERNET MARKETING STRATEGIES ON THE MARKET SHARE OF ONLINE SHOPS IN NAIROBI COUNTY IN KENYA. *Journal of Marketing Studies*, 3(1), 1–26. Retrieved from <https://carijournals.org/journals/index.php/JMS/article/view/848>
- Otieno, I., & Elijah, O. (2016). E-Waste Management in Kenya: Challenges and Opportunities. *Journal of Emerging Trends in Computing Information Sciences*, 6(12), 661. [https://www.researchgate.net/publication/290947613\\_E-Waste\\_Management\\_in\\_Kenya\\_Challenges\\_and\\_Opportunities](https://www.researchgate.net/publication/290947613_E-Waste_Management_in_Kenya_Challenges_and_Opportunities)
- Pannucci, C. J., & Wilkins, E. G. (2010, August). Identifying and Avoiding Bias in Research. *Plastic and Reconstructive Surgery*, 126(2), 619–625. <https://doi.org/10.1097/prs.0b013e3181de24bc>
- Peeraer, J., & Van Petegem, P. (2011). ICT in teacher education in an emerging developing country: Vietnam’s baseline situation at the start of ‘The year of ICT’. *Computers & Education*, 56(4), 974–982. doi:<https://doi.org.ezproxy.jyu.fi/10.1016/j.compedu.2010.11.015>
- Rautela, R., Arya, S., Vishwakarma, S., Lee, J., Kim, K. H., & Kumar, S. (2021). E-waste management and its effects on the environment and human health. *Science of The Total Environment*, 773, 145623. <https://doi.org/10.1016/j.scitotenv.2021.145623>
- Rizos, V., Behrens, A., van der Gaast, W., Hofman, E., Ioannou, A., Kafyeke, T., Famos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., & Topi, C. (2016). Implementation of Circular Economy Business Models by Small

- and Medium-Sized Enterprises (SMEs): Barriers and Enablers. *Sustainability*, 8(11), 1212. <https://doi.org/10.3390/su8111212>
- Salim, S. (2018, June 28). History of Mombasa. Mombasa County. Retrieved October 10, 2022, from <https://www.mombasa.go.ke/history-of-mombasa/>
- Salmenperä, H., Pitkänen, K., Kautto, P., & Saikku, L. (2021). Critical factors for enhancing the circular economy in waste management. *Journal of Cleaner Production*, 280, 124339. <https://doi.org/10.1016/j.jclepro.2020.124339>
- Schluep, M., Rochat, D., Munyua, A. W., Laissaoui, S. E., Wone, S., Kane, C., ... & Network, K. I. A. (2008, September). Assessing the e-waste situation in Africa. In *Electronics Goes Green 2008+ and 1st World ReUse Forum*. Germany: Berlin.
- Shittu, O. S., Williams, I. D., & Shaw, P. J. (2021). Global E-waste management: Can WEEE make a difference? A review of e-waste trends, legislation, contemporary issues and future challenges. *Waste Management*, 120, 549–563. <https://doi.org/10.1016/j.wasman.2020.10.016>
- Sthiannopkao, S., & Wong, M. H. (2013). Handling e-waste in developed and developing countries: Initiatives, practices, and consequences. *Science of The Total Environment*, 463–464, 1147–1153. <https://doi.org/10.1016/j.scitotenv.2012.06.088>
- Tonetti, R. (2000, September). Environmentally sound management of used and scrap personal computers (pcs). In US EPA, Office of Solid Waste Second OECD Workshop on Environmentally Sound Management of Wastes Destined for Recovery Operations (pp. 28-29).
- Waema, T., & Mureithi, M. (2008). E-waste management in Kenya. [https://www.rds.org.co/apc-aa-files/ba03645a7c069b5ed406f13122a61c07/e\\_waste\\_kennia.pdf](https://www.rds.org.co/apc-aa-files/ba03645a7c069b5ed406f13122a61c07/e_waste_kennia.pdf)
- Wekisa, E., & Majale, C. (2020, June). Spatial distribution of waste collection points and their implications on quality of life in Mombasa County, Kenya. *Journal of Urban Management*, 9(2), 250–260. <https://doi.org/10.1016/j.jum.2020.02.003>
- Widmer, R., Oswald-Krapf, H., Sinha-Khetriwal, D., Schnellmann, M., & Böni, H. (2005). Global perspectives on e-waste. *Environmental Impact Assessment Review*, 25(5), 436–458. <https://doi.org/10.1016/j.eiar.2005.04.001>
- Williams, E., Kahhat, R., Allenby, B., Kavazanjian, E., Kim, J., & Xu, M. (2008). Environmental, Social, and Economic Implications of Global Reuse and Recycling of Personal Computers. *Environmental Science & Technology*, 42(17), 6446–6454. <https://doi.org/10.1021/es702255z>

Xavier, L. H., Giese, E. C., Ribeiro-Duthie, A. C., & Lins, F. A. F. (2021). Sustainability and the circular economy: A theoretical approach focused on e-waste urban mining. *Resources Policy*, 74, 101467.  
<https://doi.org/10.1016/j.resourpol.2019.101467>

Ylä-Mella, J., Keiski, R. L., & Pongrácz, E. (2015). Electronic waste recovery in Finland: Consumers' perceptions towards recycling and re-use of mobile phones. *Waste Management*, 45, 374–384.  
<https://doi.org/10.1016/j.wasman.2015.02.031>

## APPENDIX 1

### A: Tables

Key findings	Specific impact	Factors affecting the impacts	Challenges
Economic growth	New entrepreneurs Employment opportunity Digital business	Availability of cheap computers Willingness and ready customers Training packages on innovation and business idea testing	The uncontrolled flow of used computers to the market The quality of imported machines
Social issues	Digital divide Improved student learning Source of income	Online studies Desire to own a machine Source of income for business owners and employees	Lack of return channels Disposal along with other solid waste Lack of business diversity
E-waste management	Responsible disposal Resource circularity Improved skills and knowledge of e-waste management	Training packages Long time experience with business owners in the field Availability of internship opportunities for students and graduates	Informal disposal Landfilling Presence of scrap metal dealers Lack of sufficient awareness of society lack of e-waste policies
Circular Economy	Collection and refurbishment Repairing, reusing, and reselling	E-waste management training packages Owners' capacity to buy new machines Donating machines to friends, schools, and charity organisations	Lack of incentives and collection centres Lack of government initiative to manage e-waste

Table 1: Key findings and challenges

<b>Theme</b>	<b>Respondent C</b>	<b>Respondent D</b>	<b>Respondent A</b>	<b>Respondent B</b>	<b>Respondent F</b>
<b>Economic and social impacts</b>	<i>"This business is an eye-opener for our employees because they can work independently and start their own business using the the knowledge and skills they learnt from here".</i>	<i>"By running this business, we are able to employ people, improve their technical skills and knowledge to understand different types of machines and sell them according to their specifications".</i>	<i>"Some of my employees have gone to open their own business, some have gone to government and companies. I have been having some of my employees who have been taken by Kenya revenue Authority, some have been employed by companies because of the experience they have gotten here because we are having real experience not like in companies as tackle one on one with people".</i>	<i>"As I run an online business and I don't have a physical shop where customers can meet me, these refurbished computers are my shop where I meet my clients and sell my service".</i>	<i>"The way CTG informed us in a meeting, disposing of these machines would also have an advantage to us if they are disposed of properly".</i>
<b>e-waste management and awareness</b>	<i>"If these machines are not properly disposed of as we heard from CTG and other companies, they could start emitting gases, if am not wrong, that</i>		<i>"In 2013 I think it was 8 years ago, we were co-founder of WEEE centre in Nairobi and We dispose of our end of second time used computers in a proper way".</i>	<i>"so, the e-waste part is really important part for us.... every computer that we implement in a project or goes out of our factory and leaves.... we guarantee that device is</i>	<i>" all the materials here are treated like they should be, we have machines here which is like shredding the glass and plastic for reuse and then the parts like motherboard which can't be treated here they go to Europe".</i>



	<i>could be harmful to our health and our day today lif</i> ".			<i>dismantled in a proper way</i> ".	
<b>Circular economy perspective</b>	<i>"All our refurbished devices in an average lifespan are re-used for five more years.... I think prolonging the lifetime of the device is always a good thing, so reusing them (devices) means that the impact on the environment is reduced.... That's a significant impact"</i> .	<i>"We use most of the machines we buy as spare parts, we remove the screen and fix it with another machine and sell it back"</i> .	<i>"We had a discussion in CTG meeting about CE business models, for example, CTG sells machines to us, we sell to customers and when the machine has a technical problem, it is taken back for repairing and reused again to extend its life, but the machine reaches end of life, it is disposed of properly by an expert or a recycling company"</i> .		<i>"Somebody who has an issue with his/her machine come to us, we repair it for him/her, there is another way where someone come to us to sell his/her device to us after it stops working, we buy it and use most of that machine as spare parts like we remove the screen and use it to fix another machine and resell it back"</i> .

Table 2: Few quotes on socio-economic impacts, e-waste management and CE perspective

## B: Photos



Photo 1: ready to dispatch refurbished computers at the CE-Hub



Photo 2: Checking and data wiping process at CE-HUB



Photo 3: CTG partner SMEs participating CE economy training

### C: Interview questions

1. What is your role in the company/organisation?
2. How long have you been working in this company/organisation?
3. Do you have other work experiences? If yes, What?
4. Could you describe in short your major roles/duties in the company/organisation?
5. Could you explain the importance of computer collection and refurbishment in regards to e-waste management in the Kenya context? (B and C)
6. In your view, what could be the adverse effects of refurbished computers?
7. How do small businesses benefit from the donation of refurbished computers?
8. Does your company/organisation use refurbished computers? If yes, what do you do with them? If not, why? (B)
9. What challenges do you face in using refurbished computers? (B)
10. What do you do with the End-of-Life (EoL) computers? (B)
11. Who do you think has the responsibility of managing EoL devices? (both C and B)
12. Could you give a brief description of the computer refurbishment process from collection to donation? (C)

13. What are the potential challenges in the collection process of used computers in Kenya? (C)
14. Is there a take-back scheme for refurbished computers donated or sold to end-users? If yes, describe the process? If not, Why? (B and C)
15. Do you think the collection and refurbishment of computers would transition to a circular economy in Kenya? If yes, how? If not, why? (B and C)
16. What could be the role played by the informal recycling sector (IRS) in the process of collection and refurbishment? (C)
17. What are your recommendations on the road to a circular economy in Kenya? (B and C)