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MECS Study on The Repair and End of Life of Electrical Appliances in Kenya

Context Study Report April 6, 2023

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Modern Energy Cooking Services (MECS) is a seven-year programme funded by UK aid (FCDO) which aims to accelerate the transition in cooking away from biomass to modern energy. By integrating modern energy cooking services into energy planning, MECS hopes to leverage investment in clean electricity access, both grid and off-grid, to address the clean cooking challenge. Modern energy cooking is tier 5 clean cooking, and therefore MECS also supports new innovations in other relevant cooking fuels such as biogas, LPG (bio) and ethanol, though the evidence points to the viability, cost effectiveness, and user satisfaction that energy efficient electric cooking devices provide. The intended outcome is a market-ready range of innovations (technology and business models) which lead to improved choices of affordable, reliable and sustainable modern energy cooking services for consumers. We seek to have the MECS principles adopted in the SDG 7 global tracking framework, including integrating access (7.1) , renewables (7.2) and energy efficiency (7.3) and promote an informed integrated approach.

For more information, visit www.mecs.org.uk

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Acronyms

ATM	Automated Teller Machine
CSR	Corporate Social Responsibility
EEE	Electrical and electronic equipment
EIA	Environmental Impact Assessment
EoL	End-of-life
ERP	Extended producer responsibility
ESM	Environmentally Sound Management
e-waste	Electronic waste
EWIK	E-Waste Initiative Kenya
GHG	Greenhouse gases
GOGLA	Global off-grid Lighting Alliance
ICT	Information & Communications Technology
KCB	Kenya Commercial Bank
KES	Kenya Shillings
Kgs	kilograms
LCD	Liquid crystal display
LEDs	Light emitting diodes
LMICs	Low and middle-income countries
LPG	Liquid petroleum gas
MECS	Modern Energy Cooking Services Programme
MNOs	Mobile Network Operators
MRFs	Material recovery facilities
NEMA	National Environmental Management Authority
NMS	Nairobi Metropolitan Services
OGS	Off-grid solar
PAYGo	Pay-as-you-go
PCB	printed circuit board
PROs	Producer Responsibility Organizations
PSPs	Pico solar products
PV	Photovoltaic
PVC	Polyvinyl chlorides
S&L	Standards and labeling
SHSs	Solar home system kits
SSCS&S	Sure Success Computer Sales & Services
t	Metric tonne
TV	Television
UK	The United Kingdom
USA	United States of America
USD	United States Dollar
WEEE	Waste electrical and electronic equipment

Executive Summary

This report aims to determine the state of e-waste management in Kenya by critically reviewing the corpus on electronic waste (e-waste) management in the country. Even though many studies have been conducted on e-waste management, very few are conducted on developing countries in Sub–Saharan Africa including Kenya who face a significant e-waste management issue. The rapid expansion of ICT in Kenya and the growth of the off-grid solar sector over the past decade has seen the proliferation of e-waste in the country. This e-waste poses a great threat to the environment and to the health of its inhabitants and there is a sense of urgency to act on this problem.

In 2022, Loughborough University, through the Modern Energy Cooking Services (MECS) Programme engaged CLASP to conduct a research study on repair and end-of-life practices relating to cooking appliances in Kenya. As the market for electrical cooking products is only just taking off in many Sub-Saharan countries including Kenya, the study explored the end of life of televisions which has a relatively mature market as a proxy. The research study was carried out in two stages. The first stage of the research involved a contextual study and customer behavior survey to understand the drivers behind current behaviors and practices relating to appliance failure and end-of-life practices as well as existing barriers to sustainable behavior. Here, inclusive elements such as gender, income levels, and disability were included to ensure that nuanced data was collated. The second stage involved an end-of-life ecosystem mapping to identify a comprehensive range of stakeholders engaged in handling materials at all stages of end-of-life pathways, to assess the capability and capacity of each, to estimate materials flow volumes handled by each, to identify barriers constraining the operations of each, and to assess the awareness and influence of prevailing policies.

For the policy review, CLASP applied a systematic literature review process on academic, grey literature, media, local and national policy, and social media. The review of the selected articles revealed that lack of policy, lack of consumer awareness, lack of technical expertise, and limited recycling infrastructure were the main barriers to effective e-waste management in the country.

While the country has adopted a few regulations and standards to regulate the appliances and -waste sectors, as well as being a signatory to regional and international conventions, policy enforcement is still weak and inadequate to meet current market conditions. Awareness of these policy guidelines amongst both households and stakeholders is very low with many being totally unaware of the existence of regulations, and the few who do have only vague knowledge of the specifications of the policies. The research also revealed that Kenya mainly practices informal recycling.

This was followed by household and stakeholder surveys across sample regions in the country. A summary of key findings is provided below and expounded in the body of the report.

- Majority of the respondents (71%) across all the selected geographical regions use main grid electricity to power their households.
- The most common appliances owned by households were mobile phones (90.6%), lighting appliances such as torches (80%), radios (85%), and TVs (77%). Few households mentioned owning electrical cooking appliances with 19% owning electric kettles, 11% owning microwaves and 4% owning electric pressure cookers.
- Majority of the households (76%) were unwilling to purchase used appliances. This was attributed to being unsure of their quality by many of the respondents.
- When an appliance fails, most of the respondents (72%) mentioned that they take it for repair. The most common repair option used by households (90%) was local repair shops. Cost effectiveness is the most important factor when determining actions to take upon appliance failure (77%)
- Decision making was largely male led. This included decision making on appliance purchase, failure, and disposal. 69% of households mentioned that the male head of household had the most influence on appliance failure behavior. Failure behaviour refers to the choices made to determine what should be done to an appliance that has stopped working for any reason. Decisions on disposal refer to the options taken to get rid of an appliance that is irreparable. 48% of households rely on burning as the primary disposal method for general household waste with the female head of the household in charge of these disposal related decisions (50%).
- Majority of the respondents (66%) mentioned that they believed that their current behavior was not environmentally friendly. Of those that acknowledged this, a majority (83.7%) expressed a willingness to use more sustainable means of disposal. A desire for lower environmental pollution and awareness of proper e-waste disposal methods would be the primary drivers of this change.
- The stakeholder survey revealed that 78% of respondents were in the private and informal sector, confirming initial findings from literature that the e-waste sector is predominantly informal in Kenya. 86% of respondents confirmed collaborated with other stakeholders in the sector.
- 94% of stakeholders surveyed were aware of the environmental risks that e-wastes pose, that these e-wastes can be profitably recycled, and some hazardous factions need special treatment before disposal. However, there exists a major gap in data and statistics pertaining to e-waste quantities and flows in the country, particularly since there wasn't any stakeholder identified who specifically tracks and reports on this data.

A full understanding of the end-of-life (EoL) practices for appliances will contribute to the creation of sustainable frameworks that will not only support safe and proper disposal but also contribute to the greater circularity goal of better-designed products that last for longer, are easier to repair, and use less hazardous materials. The aim of this report is to share the learnings from this study, to inform future efforts to address growing amounts of e-waste and advance the state of practice in the sector.

This report can inform the action of various stakeholders involved in e-waste management including recyclers, investors, sector support programs and governments, each of whom has a crucial role to play in ensuring that solar e-waste is responsibly managed. Based on the common

barriers identified, our recommendations can also provide insight to policymakers, contribute to theory, and offer opportunities for future research.

Introduction

1 Introduction

1.1 Project background

A wide range of electrical cooking appliances are becoming increasingly accessible and affordable to (predominantly urban) populations across low- and middle-income countries (LMICs). As these markets continue to attract the attention of appliance manufacturers and distributors, the MECS programme is working pro-actively to understand the economic and environmental implications of these trends in priority countries. The growing supply of (and demand for) modern cooking appliances will lead to an increase in the volume of waste, and e-waste, as products reach their end of life. However, it is preferable that appliances are not simply produced, sold, used, and disposed of. Value can and should be generated through circular processes of reuse, repair, and recycling of both components and materials.

This study explores the end-of-life ecosystem in Kenya, as it should be applicable to modern energy cooking devices but drawing experience and expertise from the existing systems surrounding the end-of-life (EoL) of televisions. This generates a description and understanding of the ecosystem, how it works, what happens to products at each stage of their end-of-life pathway, and the associated impacts.

1.2 Research objectives

The primary objective of this study is to assess the EoL ecosystem of televisions in urban and rural environments in Kenya. This is intended to act as a proxy for e-cooking appliances given their nascent market. The research includes:

- Contextual study and customer behavior survey – to understand current behavior and practices when an item fails, what options are perceived to be available, what drivers lie behind actual behavior, and what barriers exist to more sustainable behavior that would extract value from failed devices.
- End-of-life ecosystem mapping – to identify the comprehensive range of stakeholders engaged in handling materials at all stages of EoL pathways, to assess the capability and capacity of each, to estimate materials flow volumes handled by each, to identify barriers constraining the operations of each, and to assess the influence of prevailing policies.

2 Research methodology: study set up and area, selection (maps)

2.1 Research Study Design

Data for this study was collected through a literature review, household surveys and stakeholder interviews. Additionally, a local research partner, E-WiK, was enlisted to provide contextual understanding and to assist in the data collection process. E-WiK is a registered NGO that works closely with the informal sector to provide safe disposal options for e-waste. They also carry out technical training, waste collection and public awareness to enhance sustainable e-waste management towards a circular economy.

The household survey instrument was structured to collect different data points including respondent background information, purchase attitudes and behaviors, appliance ownership and usage, appliance failure behavior and general waste and e-waste disposal practices. Within each of these key areas, the instrument was devised to investigate perceived available options, behavioral drivers, and barriers that hamper more sustainable behavior. An inclusive approach was used to formulate the survey, with questions added to gather data on gender, income levels and disability. This would provide a deeper understanding of differences in appliance end of life perceptions and behaviors. Data collected using this survey was primarily qualitative. The data was collected through in-person interviews by trained data collectors using the ODK tool.

The stakeholder survey instrument was uniquely designed to cater for all the possible stakeholders within the e-waste management ecosystem. It was informed by findings and gaps from the literature review and research partner insights. This survey was devised to collect data on roles played by different stakeholders within the ecosystem, stakeholder behavior and attitudes and stakeholder partnership and collaboration. This survey was also structured to aid in the development of a materials flow analysis by capturing data on the quantities of the appliances and electrical materials handled by each stakeholder. Moreover, questions relating to challenges faced by each stakeholder and barriers preventing more sustainable behavior were included. The stakeholder survey was administered in a hybrid manner, with virtual interviews carried out with government and multilateral stakeholders; and in-person interviews conducted with other players such as repairers and retailers in the ecosystem.

A net-map toolkit was used to map out the interviewed stakeholders to help draw out and visualize the relationships and influence between the different actors and attempt to assess the level of strength across these two aspects. The inputs to the net-map tools factored observations, perceptions drawn from interactions with household and stakeholders as well as stakeholder categories. The relationships were chiefly determined and analyzed based on the roles and responsibilities of the actors in relation to the study topic. The assessment of the level of strength across relationships and influence was informed by situational analysis. The influence rating in Net-Map methodology is a qualitative approach which is subjective, and context-dependent based on the perceptions and interpretations of the actors involved. It provides an indicative representation of the network and insights into the dynamics of influence rather than a precise calculated rating. This net-map approach is depicted in the figure below.

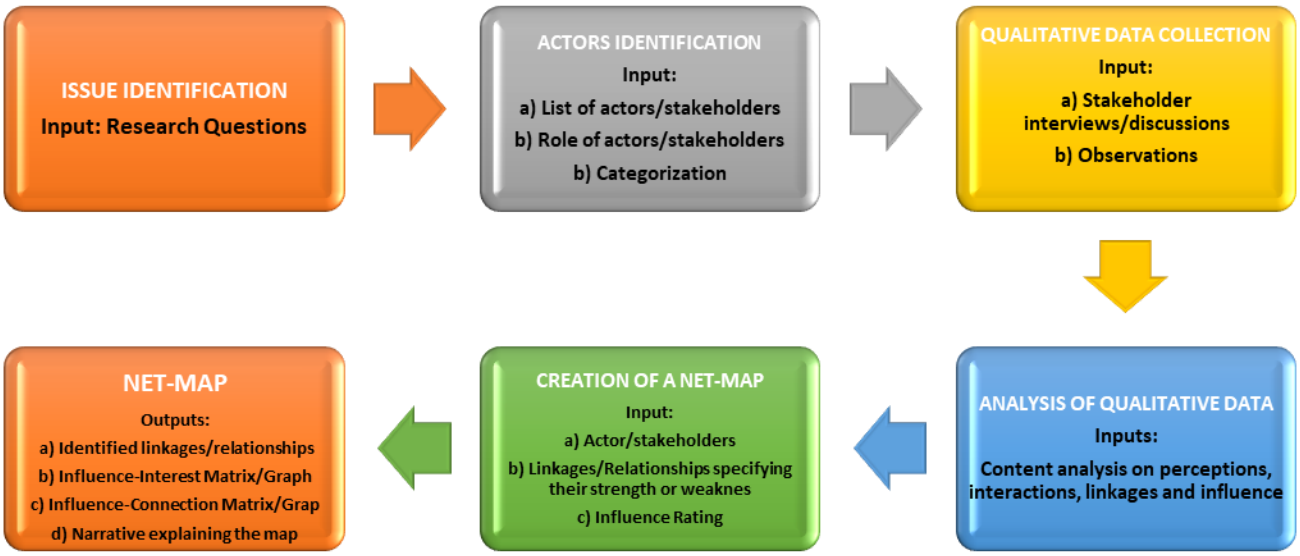


FIGURE 1:NET-MAP METHODOLOGY MAPPING STAKEHOLDERS INVOLVED IN PROPER APPLIANCE END-OF-LIFE AND E-WASTE DISPOSAL PRACTICES IN KENYA

It is important to note that the linkages are mainly determined and analyzed based on the roles and responsibilities of the actors in relation to the issue at hand. Further, the strengths and weaknesses of the links as well as the actor goals are informed by the situational analysis. The influence rating in Net-Map methodology is a qualitative approach which is subjective, and context-dependent based on the perceptions and interpretations of the actors involved. It provides a visual representation of the network and insights into the dynamics of influence rather than a precise calculated rating.

CLASP carried out in person enumerator training for E-Wik on 5th January before formal kick-off of the data collection. The training entailed:

- An introduction to the background of the study
- Data collection guidance; an in-depth review of the questionnaires
- Introduction to ODK tool, installation across the enumerator phones
- Pre-testing on selected households

Data quality checks were carried out continuously as the data was uploaded from the field. The benefit of the training was immediately evident as the uploaded data met the requirements. Data cleaning and analysis was carried out immediately after the data collection process was finalized. Quality assurance included confirmation and removal of outlier data, correcting data that was proven to be erroneous by enumerators and amending improper use of the “other” option in the survey. Data was then analyzed using MS Excel software.

2.2 Literature Review

The literature review was executed using a systematic approach with sources drawn from academic material, grey literature, media, local and national policy, and social media. We researched the different aspects of e-waste management in the country including collection and disposal i.e., recycling, repair, and refurbishment, take-back and collection, and awareness raising. Using the keywords that included e-waste management or recycling or policy in Sub-Saharan Africa, or Kenya, we searched for articles from various databases. We analyzed 40 papers to answer the research questions. These included policies, strategies, reports, protocols, regulations, studies, and other related documents. The research team also conducted desk-based research into standards relating to quality, materials, and performance (efficiency) of electrical cooking products, and standards relating to recycling and/or waste disposal. The team then mapped the list of stakeholders in the e-waste management ecosystem.

2.3 Research Sample Populations

A simple random sampling method was utilized to select the household survey respondents for the study. To calculate the ideal sample size, a confidence level of 95% and a margin of error 5% were applied. Through collaboration with the research partner, the research team identified four focus areas for the study. These areas were selected to provide both an urban and rural context. The selected areas were Nairobi, Nakuru, Bungoma and Kitui and varied in population size, key economic activities, income levels, electrification rates, household characteristic, appliance ownerships, agroclimatic conditions, and infrastructural development. These areas were each stratified into three based on income levels and population sizes.

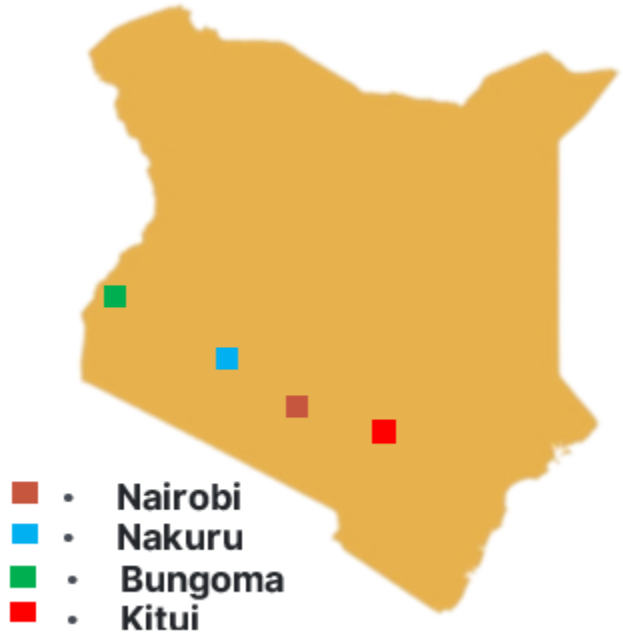
Name	Context	Locations	Households
Nairobi	Urban – capital city	Westlands, South B, Githurai	1,506,888
Nakuru	Urban – provincial city	Nakuru Town, Gilgil, Karagita	616,046
Bungoma	Rural area	Kanduyi, Chwele, Bumula	358,796
Kitui	Rural area	Kyuso, Usweni, Tseikuru	262,942

Table 1: Study locations selected for surveys.

Household data referenced in this report was collected from a total number of 933 respondents in Kenya, from January 6th to February 8th, 2023. There was a wide degree of variability in demographics which brought forth differences in observed attitudes and behaviors towards appliance failure and end-of-life practices. Table 2 below shows the initial survey plan with the number of targeted respondents for each of the locations and the actual number of responses that were collected.

Location	Targeted Sample Size	Target Survey Achieved
Nairobi	384	209
Nakuru	384	240
Bungoma	384	248
Kitui	384	236
Total	1536	933

Table 2: Study locations selected for surveys.



2.4 Demographic Profile from Sampled Households.

Overall, majority of the respondents were from rural counties (52%) with urban counties accounting for 48% of the total respondents. Table 3 below summarizes the observed household characteristics based on the variables earlier identified.

Household Characteristics	Overall	Urban (Capital & Provincial)	Rural
Gender			
Male:	58%	61%	56%
Female:	42%	39%	44%
Average age	36	35	37
Average household size	4	4	5
% Of households with person/persons living with disabilities	7%	2%	12%
Highest level of education attained by person living in household.			
• **Tertiary:**	43%	43%	43%
• **Upper Secondary:**	39%	41%	36%
• **Lower Secondary:**	3%	3%	3%
• **Primary School**	14%	11%	16%
• **Never went to school**	0%	0%	0%

Table 3: Household characteristics of respondents. (Source: Kenya Household Surveys)

From the household survey, 67.81% of respondents indicated that they were self-employed, followed by 15.02% in casual employment and 11.7% in formal/full time employment. 4% had no occupation. Monthly household income for 80% of respondents was below KES 30,000 (~USD 230) per month. This is reflective of the national income average estimated to be KES 20,123 (~USD 154)[1]. This was trailed by 10% of respondents who earn KES 30,001-40,000 (~USD 231-308), 4.47% earning KES 40,001-50,000 (~USD 309-385), 2.46% between KES 50,001-60,000 (~USD 386-462), and 3.35% earning above KES 60,000 (~USD 463) per month.

[1] https://www.businessdailyafrica.com/bd/economy/kenyans-average-income-of-sh20-123-hits-six-year-high--4043204

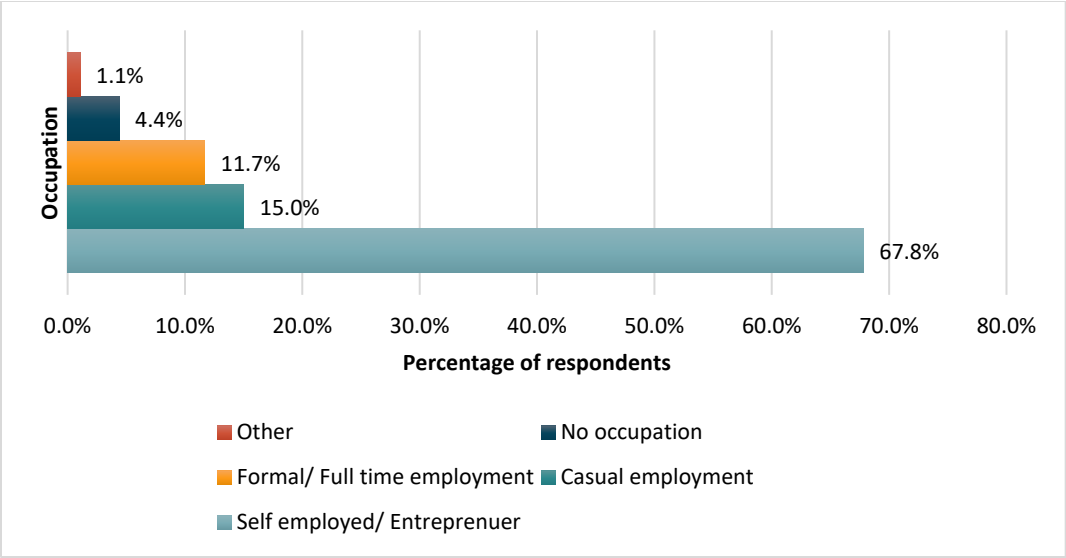


Figure 1: Occupation of respondents (Source: Kenya Household Surveys, n=932)

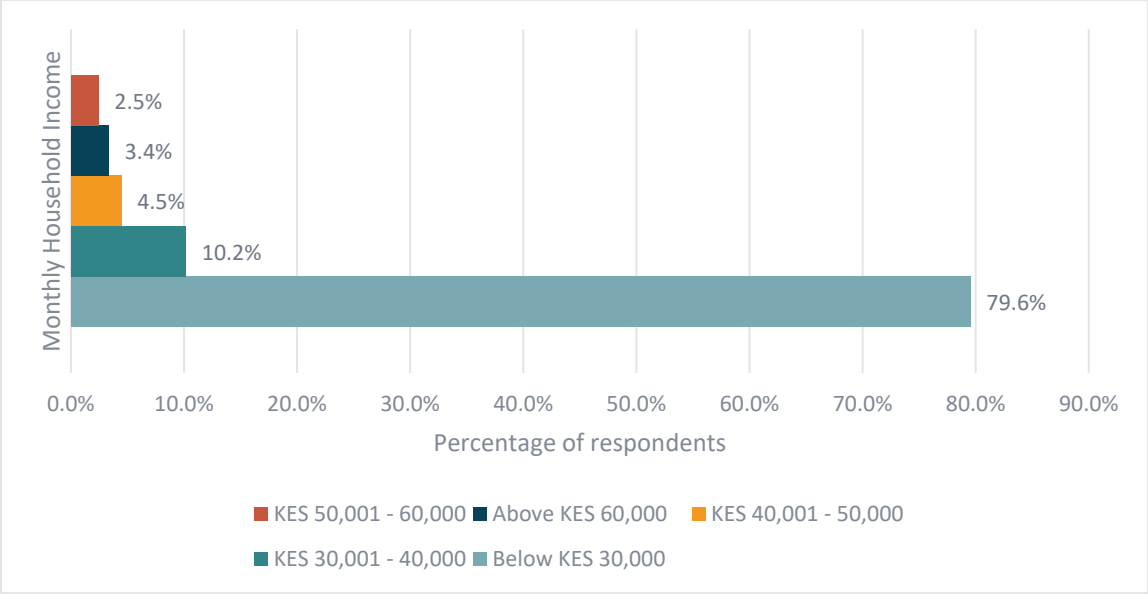


Figure 2: Household income of respondents (Source: Kenya Household Surveys, n=895)

Country Outlook

3 Country Outlook

Kenya is one of the most populous countries in Africa with a population of more than 56 million, with approximately 27% living in urban areas, with the rest 73% in rural Kenya[2]. Kenya is one of the largest economies in Sub Sahara Africa and the largest in East Africa[3]. In East Africa, Kenya has led key developments for the off-grid solar industry including PayGo solutions and modern SHS[4]. Kenya represents 47% of off-grid solar TVs sold by affiliate[5] companies globally between 2019 and 2021.

Kenya	
Population	56,602,576
Access to electricity (% of population)	71%
• Urban access to electricity (2020)	94%
• Rural access to electricity (2020)	63%

Table 4: Kenya Demographic information[3].

Findings from the household surveys indicated 71% of respondents using the national grid as their primary energy source, followed by solar home system (28%).

Indicator name	**Results**
Percentage of households with national grid electricity as main source of lighting	71%
Percentage of households with solar power as main source of lighting (solar home systems & rooftop solar)	28%
Percentage of households with mixed energy sources	1%

Table 5: Household Survey Data on Electrification rate in Kenya (Source: Kenya Household Surveys n=932)

In the urban areas, the proportion of respondents connected to the main grid was 92% and 50% in rural areas. Trailing these were solar home system kits at 5% or respondents in urban areas and 49% of respondents in rural areas. Some of the respondents had multiple sources of energy powering their household needs e.g., both grid & solar

[2] (Worldometer n.d.)
[3] (Regional Economic Outlook Sub-Saharan Africa 2022)
[4] (Off-Grid Solar Market Trends Report 2022: State of the Sector 2022)
[5] Affiliate products are sold by companies that are connected to any of the partner organizations involved in the semi annual GOGLA sales data collection and which share their sales data

3.1 Appliance ownership and the Clean Cooking landscape

3.1.1 Appliance Ownership

The Kenya home appliances market attained a value of USD 184.48 Million in 2018 and it's expected to increase to USD 363.92 Million by the end of 2027 growing at a compounding annual growth rate (CAGR) of 7.8%. The demand for home appliances in Kenya is increasing on account of significant rise in per capita disposable income, coupled with an influx of high-end appliances in the country and rapid urbanization coupled with a rising middle class population.

The presence of global home appliance market players such as Bosch, Samsung, LG and Von across the country is also rising accompanied by increasing presence of local manufacturers. Kenya registered sales of around 403.16 thousand units of home appliances in 2018. The demand for these appliances is also increasing on the back of significant growth in working women population. The increasing working women population is driving the demand for the appliances such as washing machines, refrigerators and electric pressure cookers that assists women with household chores[6].

The television segment accounts for the maximum share of home appliances accounting for 41% in the year 2018[7]. Growth in this segment is attributed to increasing consumer purchasing capacity and rising urbanization which in turn drives the demand for technologically advanced products like Smart TVs. Additionally, Kenya is among the few countries in the African continent that have successfully completed the digital switch over (DSO) which has opened new opportunities in the TV sector. This has led to the launch of new free-to-air (FTA) community TV channels and the emergence of new local and international digital content providers[8].

According to the survey findings, mobile phones (91%) are the most common appliances among the respondents surveyed, with radios (85%), lighting appliances (80%) and TVs (77%) closely trailing. Other common appliances among the respondents are clothes iron (33%), electric kettles (19%), fridges (19%), computers/laptops (15%), and microwaves (11%). Only 4% of respondents reported owning an EPC. Appliances were primarily purchased by the male heads of households (70%), female heads of households being the primary purchaser of appliances in 22% of the respondents. This responsibility was shared by both the male and female heads of households among 6% of the respondents surveyed. This trend is common among both urban and rural area households. Among female respondents, 45% indicated that the female head of the household was the primary purchaser of appliances, and the male head was the primary purchaser in 42% of the cases. However, this changed to 89% of cases where the male head was the primary purchaser of appliances and only 6% of cases where the female head of household was the primary purchaser amongst male respondents. This difference points to a possible gender bias in the responses as a result of perceived societal gender roles.

[6] Kenyan Home Appliances Market Review 2014-2019 and Forecast (globenewswire.com)
[7] https://www.globenewswire.com/news-release/2019/08/30/1908972/0/en/Kenyan-Home-Appliances-Market-Review-2014-2019-and-Forecast-to-2027-A-363M-Opportunity.html
8 (GlobeNewswire 2019)

Appliance type	% of households that own
Mobile phone/charger	91%
Radio	85%
Lights	80%
TVs	77%
Clothes iron	33%
Kettle	19%
Fridge	19%
Computer/laptop	15%
Microwave	11%
Electric Oven	6%
Toaster	6%
Electric fan	5%
Electric pressure cooker	**4%**
Hair dryer	4%
Electric hot-plate cooker	4%
Washer/Dryer	4%
Printer	4%
Toaster/sandwich maker	4%
Rice-cooker	2%
Vacuum cleaner	2%
Dish washer	2%
Air conditioner	2%
Coffee machine	2%
Air-fryer	1%

Table 6: Appliance ownership by households (Source: Kenya Household Surveys n=931)

3.1.2 Clean Cooking

Kenya faces a daunting clean cooking challenge with majority of the population (81%) still cooking using polluting fuels such as firewood (65%), charcoal (10%), and kerosene (6%). Reliance on polluting cooking fuels has led to an array of interlinked development challenges: the Government of Kenya estimates that 21,560 deaths/year are caused by household in-door air pollution; 8-11Mton/year woody biomass is lost due to forest degradation, and 13.6 MtCO2e/year is emitted. Women and girls are disproportionately affected, with greater exposure to cooking smoke, as well as the drudgery of collecting fuel and lighting/tending fires, which results in missed educational and economic opportunities[9].

e-Cooking presents a potentially transformative opportunity for Kenya's clean cooking sector to break out of this 'business as usual cycle. 75% of the Kenyan population is now connected to some form of electricity but doesn't yet use this power for most of their cooking needs[9]. Currently, 0% of Kenyan's use electricity as their primary cooking fuel highlighting the enormous untapped potential. Kenya Power has implemented programs such as the Last Mile Electrification Programme to stimulate demand for its almost exclusively renewable electricity and has connected many new customers with very low demand. KPLC also implemented the 'Pika na Power' programme raising awareness and creating opportunities for e-cooking appliance retailers to demonstrate and sell their products to their 7 million customers.

[9] (Leary 2022)

Findings from the household surveys painted a similar picture with less than 1% of the respondents using electricity as their primary cooking fuel. LPG/cooking gas (51%) is the most used type of cooking fuel, with wood (26%) and charcoal (19%) coming second and third respectively. In urban areas, LPG/cooking gas (78%), charcoal (12%) and wood (4%) are the leading primary cooking fuel types with electricity being the primary fuel for 2% of respondents. In contrast, rural areas have wood (47%), LPG/cooking gas (25%), charcoal (25%) and electricity (0%) as the primary cooking fuel for respondents. This difference in primary cooking fuel between urban and rural-area respondents can be attributed to the ease of availability and cost of the primary choice of fuel. Urban dwellers have easy access to numerous LPG/cooking gas vendors compared to rural dwellers who can easily collect firewood for cooking at little to no financial implication.

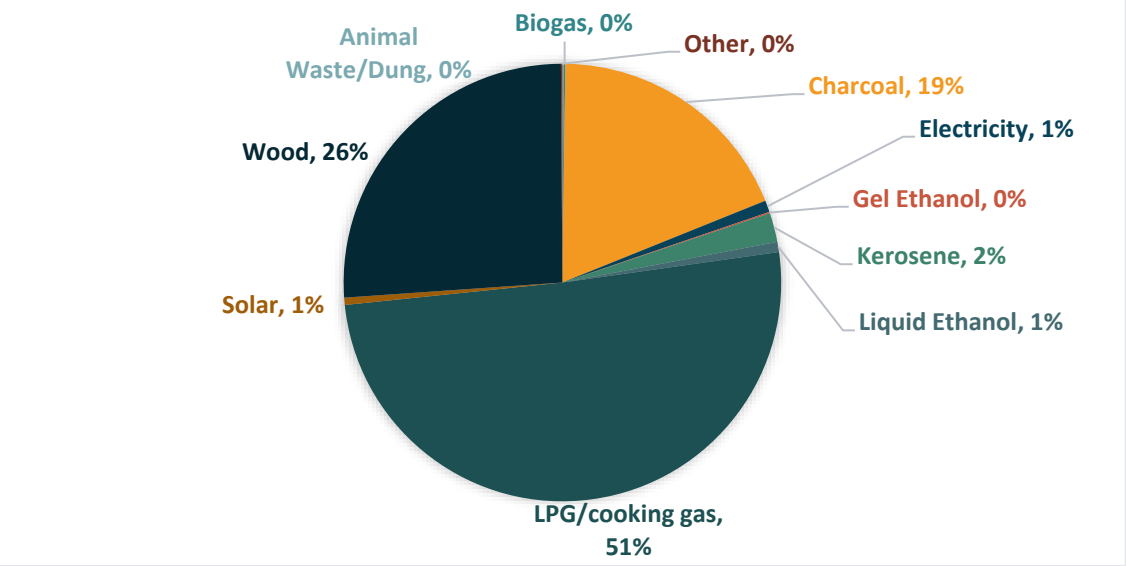


Figure 3a: Primary cooking fuel for household survey respondents (Source: Kenya Household Surveys n=931)

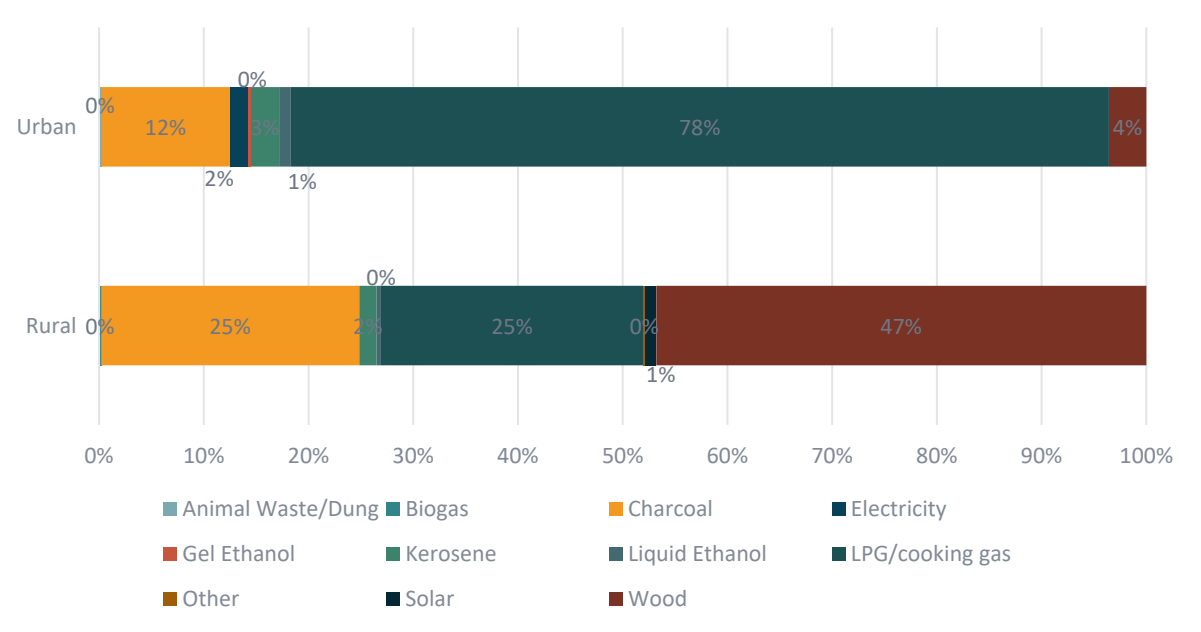


Figure 3b: Primary cooking fuel for household survey respondents, rural-urban comparison (Source: Kenya Household Surveys n=931)

3.1.3 Survey Findings on Purchasing Preferences and Behaviors

Majority of the respondents interested in purchasing electric cooking appliances picked microwaves (40%) as the appliance they would purchase. Other highly wanted appliances were electric kettles (33%), electric ovens (21%), electric hot-plate (21%) and EPCs (20%). 33% of respondents had **no interest** in purchasing e-cooking appliances. A similarity in the types of wanted appliances was observed for both rural and urban areas, with the exception that 52% of rural households had no interest in e-cooking appliances while only 36% of urban households expressed a similar sentiment. This lack of interest in purchasing e-cooking appliances stems from the perception that owning such appliances would significantly impact their electricity consumption and subsequently the amount of money spent on energy bills. On the other hand, there seems to be higher interest among rural-area dwellers to purchase e-cooking appliances more than urban-area dwellers as most urban dwellers already own many of these appliances thus have no interest in buying them again.

	Rural	Urban	Overall
Microwave	42%	**38%**	**40%**
Kettle	42%	23%	33%
Electric oven	20%	23%	21%
Electric hot-plate cooker	23%	20%	21%
Electric Pressure Cooker	22%	19%	20%
Toaster/sandwich maker	11%	12%	11%
Rice Cooker	10%	15%	12%
Air Fryer	8%	6%	7%
No interest	**52%**	36%	33%
Other	9%	6%	7%

Table 7: Share of respondents with a desire to purchase e-cooking appliances (Source: Kenya Household Surveys n=931)

Cost (65%) was stated as the **greatest barrier to purchasing e-cooking appliances** for those who expressed 'no interest', with access to electricity (19%), appliance electricity consumption (16%) and preference to current cooking appliance (12%) being other significant barriers.

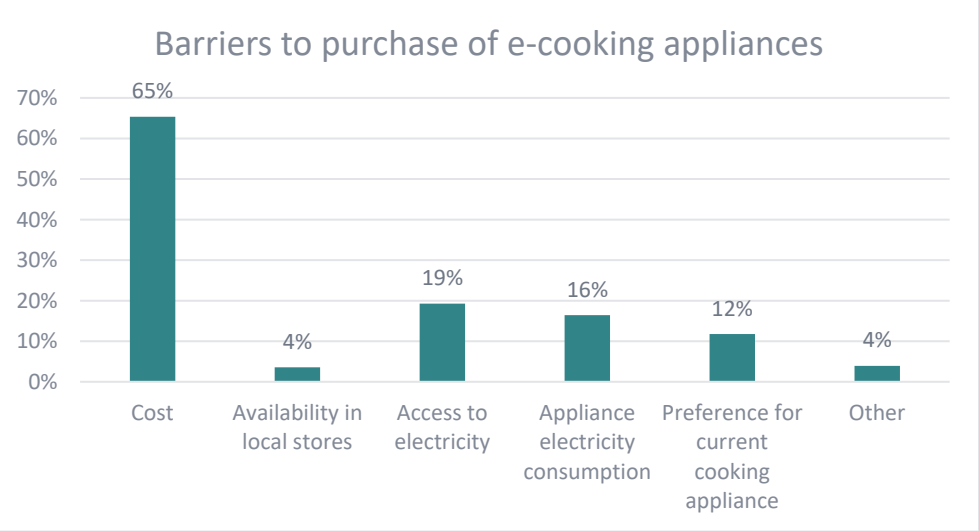


Figure 4: Barriers to purchase of e-cooking appliances (Source: Kenya Household Surveys n=280)

The **male head** of the household was the **primary appliance purchaser** in 70% of the respondents. Another 22% of respondents identified the female head of household as the primary buyer of appliance while 6% of respondents said this was a shared responsibility between the male and female heads of the household. Among households owning a TV, the **female head** of household was the **primary user of the TV** in 42% of the respondents. This was followed by the male head of the household (21%) and both male and female heads of household (16%). Children, house helps, and other relatives (13%) were also significant primary TV users.

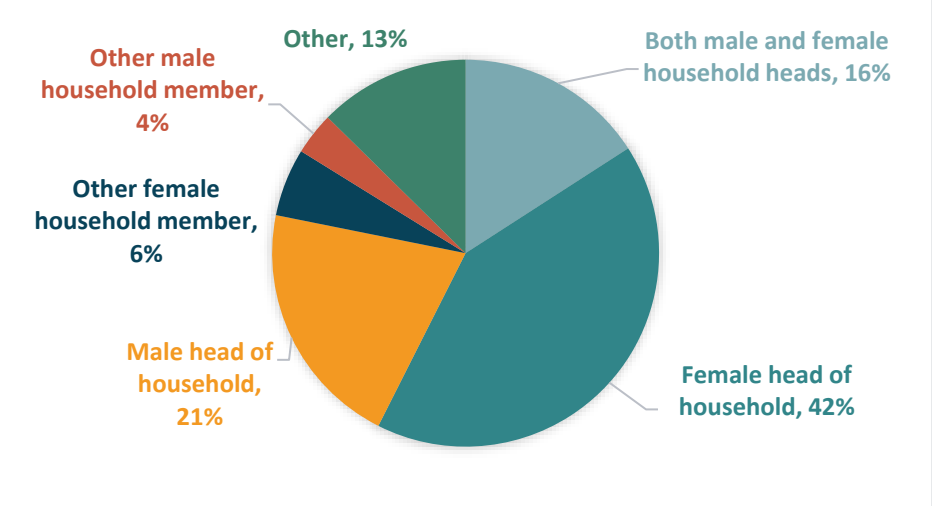


Figure 5: Primary TV user in the households (Source: Kenya Household Surveys n=705)

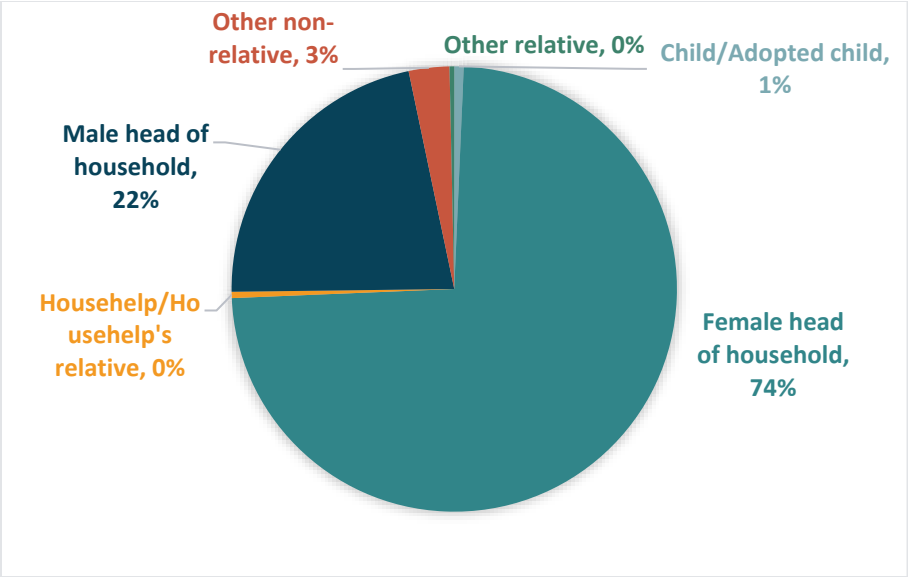


Figure 6: Primary user of e-cooking appliances (Source: Kenya Household Surveys n=881)

Female heads of households (74%) were predominantly **the primary users of e-cooking appliances** with male heads of households (22%) coming in second. When respondents are disaggregated by gender, this trend remains. However, among female respondents, the primary user of e-cooking appliances being the female head compared to male head is 85% to 6%, while among male respondents, it's 59% to 31%. This is not surprising considering that women predominantly handle most of the cooking in most Kenyan households.

82% of respondents didn't have a preferred retailer for their appliance purchases. Manufacturer/new appliance retail stores (85%) were the most preferred among the 18% of respondents who had a preferred retailer. The second most common was online retail stores (10%), followed by second-hand appliance stores (3%). This trend is mirrored by both rural and urban area households.

Nearly all respondents (87%) prefer **upfront cash payments** when purchasing electrical appliances while PayGo (12%) was the second most preferred mode of payment. Many of these respondents were not confident they would complete the payment plans and risked debt to the retailers, hence, the preference for upfront cash payments.

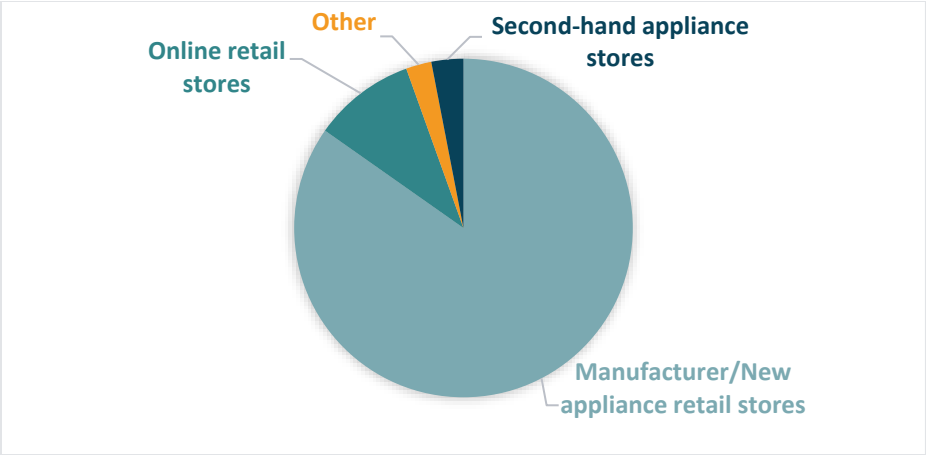


Figure 7: Preferred retailer of electrical appliances (Source: Kenya Household Surveys n=931)

Information (ref. Figure 8) on the appliances respondents wished to purchase was primarily obtained from **recommendations from other users** (44%), social media (42%) and at manufacturer/retail stores (42%). Product brochures (13%) and manufacturer websites (10%) were stated as other leading sources of information. Respondents typically consulted multiple sources before making the decision to purchase an appliance.

To make **appliance purchase decisions**, cost of the appliance was ranked first as the **most significant** consideration by 43% of respondents (ref Figure 9). This was followed by product quality/durability/longevity – how well a given appliance works and how long its lifespan is expected to be before considering a replacement - (33% of respondents raked 2nd), appliance brand (ranked 3rd by 37% of respondents), product size (53%), colour/style (57%) and presence of product warranty (60%).

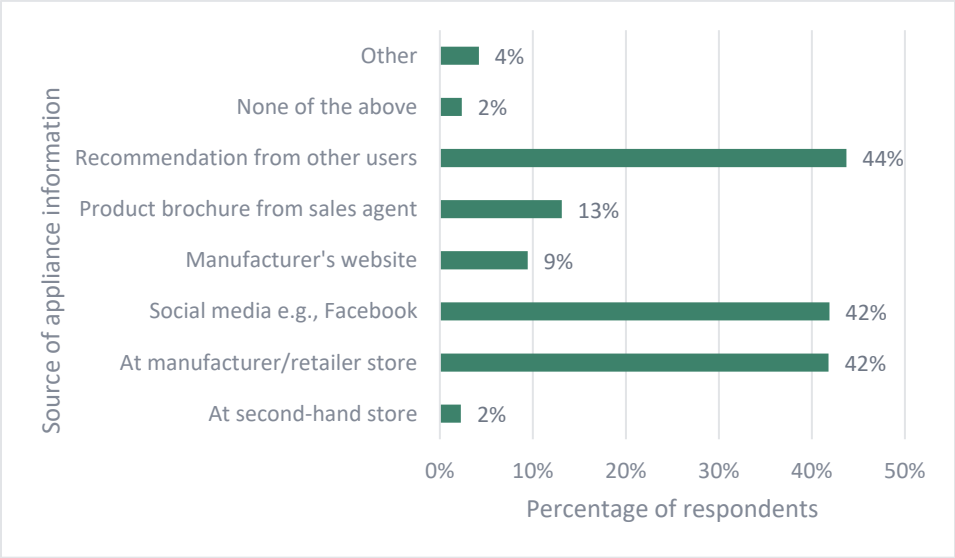


Figure 8: Sources of appliance information (Source: Kenya Household Surveys n=931)

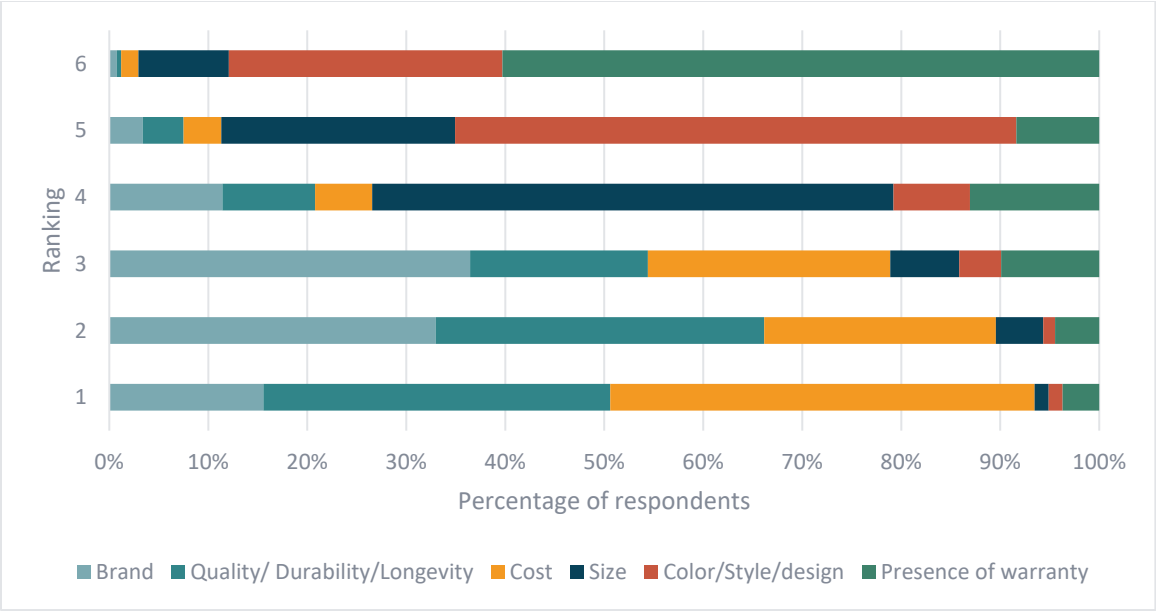


Figure 9: Factors influencing appliance purchase decisions (Source: Kenya Household Surveys n=919)

New appliances were preferred over secondhand appliances with 76% of respondents expressing an **unwillingness to purchase secondhand appliances**. This was 78.4% in rural areas and 73.4 in urban areas. Appliance quality concern (100%) was the greatest reason for this unwillingness, followed by concerns about store legitimacy (67%) and concerns about the age of the product (56.2%). In rural areas, the top three concerns were given as quality concerns (100%), concerns about store legitimacy (57%) and product warranty concerns (56%) whereas in urban areas the top concerns were quality concerns (100%), concerns about store legitimacy (79%) and concerns about product age (66%) (ref. Figure 10).

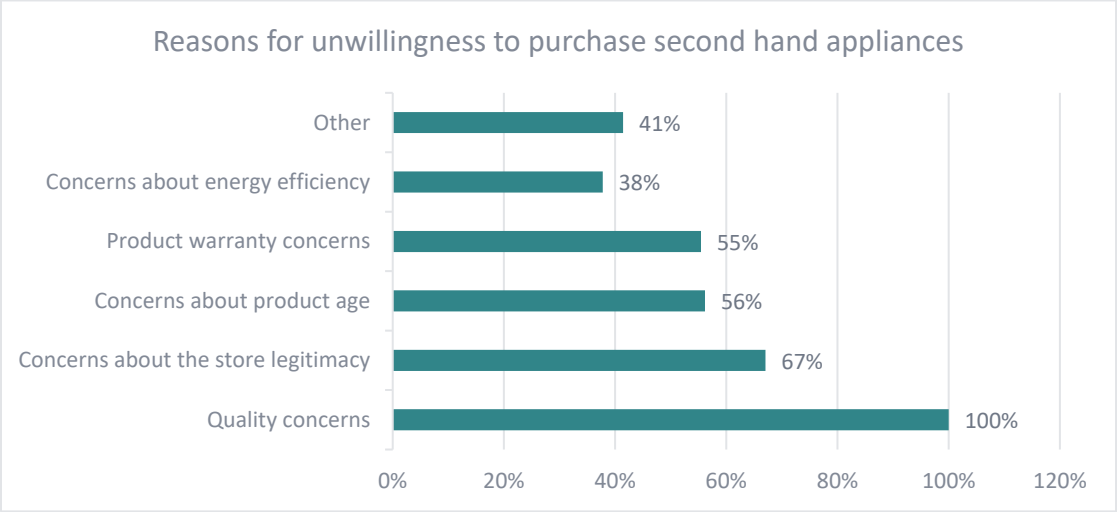


Figure 10: Reasons for unwillingness to purchase secondhand appliances (Source: Kenya Household Surveys n=707)

Cost of the appliance (63%) was ranked as the **most important factor** influencing purchase of secondhand appliances amongst the respondents. Ease of accessibility to stores/seller location

(39%), peer recommendation (36%) and brand availability (48%) were ranked 2nd, 3rd, and 4th respectively among the factors. All respondents considered more than one factor before deciding.

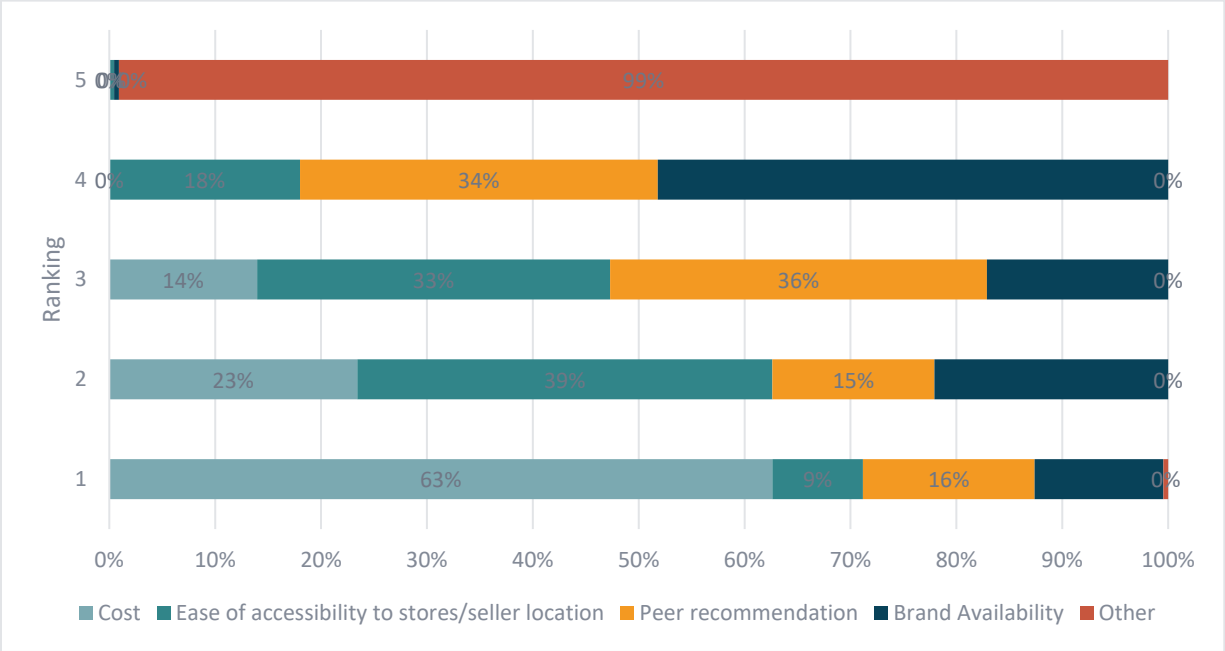


Figure 11: Factors influencing purchase of secondhand appliances (Source: Kenya Household Surveys n=222)

The performance of used appliances among respondents who had made secondhand appliance purchases was either moderate (48%) or good as new (47%). Only 6% of respondents reported poor performance, indicative overall positive experience using secondhand appliances.

On product warranties, 93% of new appliances and 36% of secondhand appliances came with a product warranty at the time of purchase. 62% of secondhand appliances didn't have any warranty. Of the respondents whose appliances had a warranty, only 13% tried to claim it while 87% of the respondents didn't make any attempts to claim. However, 82% of warranties claimed were honored by the retailer.

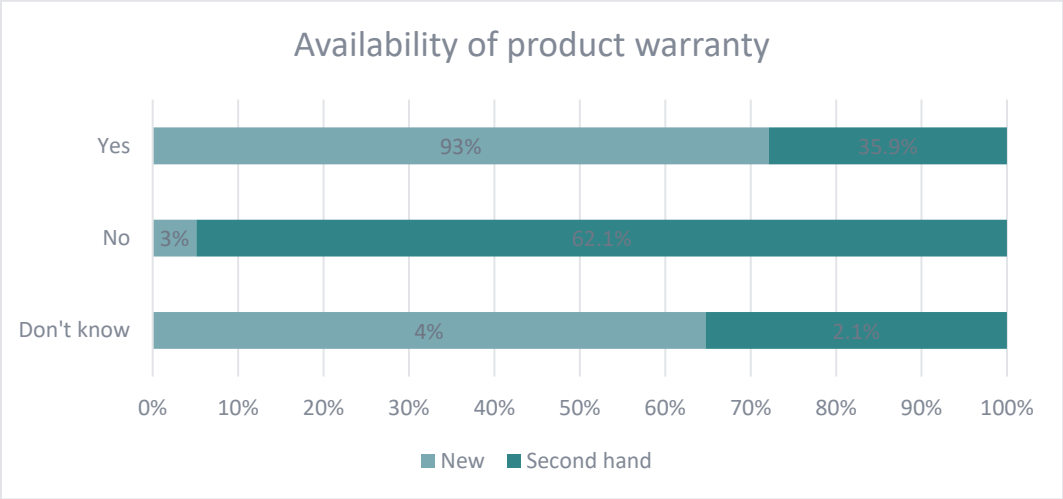


Figure 12: Availability of product warranty at time of appliance purchase (Source: Kenya Household Surveys n=804)

3.2 Policy and Regulatory Framework in Kenya

3.2.1 Quality Standards and Labeling

Standards and Labelling drive the market towards high-quality, higher efficiency products, while avoiding greenhouse gas (GHG) emissions and lowering energy spending costs for consumers [10]. Kenya has also adopted several regulations that not only govern the quality but also the energy efficiency of appliances such as TVs, refrigerators, and off-grid solar (OGS) products.

In 2013, the Energy and Petroleum Regulatory Authority initiated the Standard and Labelling (S&L) program for equipment and appliances for the Kenyan market[10]. Standards are put in place to remove the lowest efficiency and low-quality products from the market and energy labels enable consumers to make informed purchasing decisions by differentiating high-efficiency products from average and low-efficiency choices. 5-stars indicate higher-efficiency products that will lead to lower monthly energy bills for customers. More efficient appliances are denoted with more stars compared to an appliance of the same size and functionality hence more energy saving. The Kenyan Standards and Labelling program covers lighting products, refrigerators, air-conditioners and motors and are mandatory under the Standards and Labelling scheme[10]. There is currently no information available quantifying the effectiveness of this scheme in removing low quality appliances from the market.

Appliance	Applicable Standard
Ballasts for Fluorescent Lamps	KS 2447-1:2013
Double Capped Fluorescent Lamps	KS 2448-1:2013
Non-Ducted Air Conditioners	KS 2463:2019
Refrigerating Appliances	KS IEC 62552-1:2015 KS IEC 62552-2:2015 KS IEC 62552-3:2015 KS 2464:2020
Self-Ballasted Lamps	KS 2446-1:2013 KS2446-2:2013
Three-Phase Case Induction Motors	KS 2449-1:2013 KS 2449-2:2013

Table 8: List of appliances covered under the S&L programme

Kenya as a key off grid solar market is also an early adopter of the IEC quality standards for solar products, making it a good example of the value of leveraging government support in implementing national quality assurance measures[11].

Key government agencies in the creation and implementation of standards are as per the table below.

Agency Name	Role

[10] (EPRA n.d.)
[11] (Lighting Global 2021)

Energy and Petroleum Regulatory Authority	Regulator of the energy sector including energy efficiency. Administration policies to regulate the S&L programme
Kenya Bureau of Standards	Standards development, quality assurance, market surveillance and testing services

Table 9: key government agencies

3.2.2 Recycling and Disposal Policies

The world's worst environmental concerns are in developing countries. This has compelled governments to establish laws that require firms to cut down on pollution and these laws are enforced by Regulatory bodies. However, in developing countries, environmental agencies lack funding, expertise, and personnel leading to insufficient resources for environmental protection. Moreover, enforcing environmental regulations has suffered gaps as solid waste management policies are designed to cope with environmental issues but fail to incorporate economic and health perspectives[14].

Kenya is a party to several multilateral environmental agreements including the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes[12] and their Disposal and Bamako Convention on the Ban of the Import into Africa and the Control of the Transboundary movement and Management of Hazardous Wastes within Africa[13].

Kenya has adopted the **National Solid Waste Management Strategy** as a guide to sustainable solid waste management to ensure a healthy, safe, and secure environment for all. The culmination of this is a bill that is aimed to help Kenya achieve a green economy characterized by zero waste through sustainable waste management. Kenya as a green economy is envisioned in the country's Vision 2030 as well as in Kenya's National Determined Contribution (NDC) commitment to the Paris Climate Agreement. The bill aims to reduce waste, especially through incentives for the use of more efficient technologies. There are also incentives in the areas of sustainable product design, resource efficiency, re-using and recycling of materials[14]. The National Environmental Management Authority (NEMA) adopted the minimum requirements necessary for continuous improvement to help improve the poor state of waste management in Kenya. These minimum requirements are based on waste collection, transportation, disposal, and licensing. The key stakeholders involved in the legal and regulatory framework in Kenya are given in the table below, along with their mandate regarding e-waste and their role in the implementation of policies and strategies[25]. We could not find documentation providing an evaluation of the effectiveness of this strategy.

The **Environmental Management and Coordination Act (1999)** and **the Waste Management Regulations (2006)** currently regulate general waste management in Kenya and form the existing legal framework for waste management. In 2013 the National Environment Management Authority (NEMA) proposed **e-waste regulations** that build on the general waste management guidelines by introducing a legislative framework for e-waste and making good e-waste practices legally binding to both producers and consumers[25].

[12] The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989
[13] Ban on the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, 1991

Government Agency	Mandate in the e-waste legal and regulatory framework	Role in the implementation of the framework
Ministry of Environment and Mineral Resources (MEMR)	Set policy direction and enact legislation	
National Environment Management Authority (NEMA)	Draft regulations and guidelines	Implements and regulates all policies relating to the environment Director General NEMA is the Competent Authority of the Basel Convention

Table 10: Roles of government agencies in the implementation of e-waste regulations

Based on the principles of Extended Producer Responsibility (EPR), the proposed E-waste guidelines address a cross-section of the product value chain from producers/ manufacturers, importers, and assemblers to large institutional and household consumers to refurbishers and recyclers.

The guidelines for E-Waste Management issued by NEMA in 2013 is the only active government document that specifically addresses the issue of e-waste. These regulations were drafted in 2013 but are still awaiting Parliament's approval.

It is unclear if off-grid products are included or excluded from the scope of the draft regulations as the definition of Electric Equipment (Part I, Article 2) refers to[25]:

> 'Electrical equipment' means equipment for the generation, transfer, and measurement of electric currents and fields falling under the categories set out in schedule 1 of this regulation.
>
> 'Electronic equipment' means equipment which is dependent on electric currents or electromagnetic fields in order to work properly under the categories set out in schedule 1 of this regulation.

In Schedule 1 off-grid products and PV panels are not clearly mentioned. On the other hand, batteries are clearly included in the scope, as a specific element in schedule 1.

The draft Kenyan legislation on Electric and Electronic Equipment (EEE) is based on the EPR principle and the definition of producer is broad and includes[25]:

> 'producer' means any person who introduces new or used electrical and EEE into the market and may include a person who manufactures and sells EEE under own brand, resells EEE produced by other suppliers under own brand, imports EEE into Kenya, assembles EEE for sale or distributes EEE;

Once the draft regulations have been approved by parliament, producers will have to register with NEMA to put a product on the market, as well as ensure collection, take back and recycling. These draft guidelines also apply to transboundary shipments of e-waste.

3.3 Circularity and e-waste Landscape

Kenya's waste management situation is largely characterized by pollution from uncontrolled dumping of waste, inefficient public services, unregulated and uncoordinated private sector, low

waste collection and lack of key waste management infrastructure[14]. Less than half of the daily waste generated in Nairobi is collected and this collected waste lacks safe disposal methods with the majority ending into indiscriminate dumpsites[15]. Increased urban migration due to the expansion of commercial and industrial sectors has resulted in technological advancement and improved standards of living which in turn has led to increased waste generation[14].

The Nairobi Metropolitan services (NMS) collect an average of 2800 tonnes of waste per day against a target 3000 tonnes. Annual waste is reported to increase by about 20,000 tonnes every year as the population rises[16]. NMS plans to increase the daily collection to 3,200 tonnes next year by roping in casual labourers in the collection process as well as the services of street families. Waste generated in Nairobi mostly ends at the city's largest dumping site, Dandora Dumpsite, which typically holds over 1.8 million tons of waste against an expected capacity of 500,000 tons. NMS is in the process of setting up a waste regeneration plant in Ruai to relieve the dumpsite and to recycle garbage generated in the city. The date was not specified when the plant is expected to be functional. Material recovery facilities (MRFs) will be established across the 17 sub-counties in Nairobi as a way of promoting circular and green practices in the capital. These MRF facilities will ensure there are designated waste collection points that allow for secondary segregation, recovery, reuse, up-cycling, and recycling of waste generated in the capital[16].

Electronic waste or e-waste is a term used to cover items of all types of electrical and electronic equipment (EEE) and its parts that have been discarded by the owner as waste without the intention of re-use[17]. E-waste products increase in volume as they do not decompose or rot away. Unlike many other municipal wastes, they are much more hazardous as they contain thousands of components made of deadly chemicals and metals like lead, cadmium, chromium, mercury, polyvinyl chlorides (PVC), brominates flame retardants, beryllium, antimony, and phthalates[18]. Long-term exposure to these substances can damage the nervous systems, kidney, bones reproductive and endocrine systems. Some of these hazardous wastes are carcinogenic and neurotoxic. The Global E-waste Monitor 2020 shows that e-waste has grown to 53.6 million metric tonnes (t) worldwide. E-waste is predicted to reach 74 million tonnes by 2030 making it the worlds fasted growing domestic waste stream fueled mainly by higher consumption rates of electric and electronic equipment, short life cycles, and fewer options for repair[19].Only about 20% of the e-waste generated is documented to be collected and recycled[18]. The fate of the unrecorded e-waste is unknown, but it is most likely dumped, traded, or recycled under inferior conditions. A large amount of e-waste also remains in the sheds, attics and storage rooms of its owners or gets disposed of with the normal household waste[18].

As of 2021, the e-waste generated annually in Kenya was 51,000t. This has grown from 3000t in 2012 and this is due to the rapid growth in Information Communication Technology (ICT) over the last ten years[20]. Only 1% of this waste is disposed of properly with the remaining ending up stored in homes, burned, or buried in pits, posing a serious public health and environmental concern.

Most solar companies replace, rather than repair, faulty products. Most company-sponsored maintenance, servicing and repair occurs in large urban centres or capital cities such as Nairobi, Arusha, and Kampala. There are exceptions, such as Solibrium in western Kenya and Village

[14] (Edward Mungai 2020)
[15] (Oyake-Ombis 2018)
[16] (Business Daily 2021)
[17] (STEP n.d.)
[18] (Justus N. Omari 2016)
[19] (UNITAR n.d.)
[20] (Mahandara 2022)

Energy in Uganda that have agents who travel to customers' homes to perform maintenance when necessary[21].

Currently, the demand for recycling services is insufficient to drive economies of scale as the volumes of off-grid solar e-waste are still low. Figures emerging from the solar e-waste challenge projects[22] indicate that the treatment of off-grid solar e-waste costs about US$0.75 per kg[23]. Larger volumes of waste collected would help drive down this cost. The recycling capacity of Enviroserve, Hinckley and WEEE Centre is now each ~10,000 tonnes per year, yet they are currently utilizing only 30% of this[23].

Recycling of e-waste can be a great economic opportunity as e-waste usually contains various precious metals which are of high economic value. Such precious metals include gold and silver which are good conductors of electricity and commonly found in printed circuit boards. However, specialist processes are needed to recover these. Germanium, indium, and gallium are needed in semiconductor devices[24]. Other materials of value extracted from EEE for recycling include metals (steel, copper, aluminum), glass and plastics. Those that have local value are disposed through downstream vendors while the other materials are destroyed.

Local recyclers such as the WEEE centre have established linkages with other firms abroad which have the technology to handle waste that can't be disposed of locally. Such waste materials include lantern lights, efflorescent tubes, toners, and cartridges that are shipped out of the country for onward disposal[20]. Usually, local markets for final recovery can be found for base metals like steel, copper or aluminium while for more complex fractions local recyclers need to rely on international players[25]. Plastics are generally shredded, melted down, and recycled into new items, such as composite fence posts in local facilities[21]. Lead acid batteries can also be processed locally, although some are sent to companies abroad for processing. Other battery chemistries (LiFePO4 and Li-Ion) are exclusively sent to facilities abroad. PV panels are largely stockpiled or disposed of in landfills. LEDs are not currently processed separately from the rest of the non-hazardous components[21].

Informal collectors aggregate e-waste from disparate sources including businesses and individuals. In most off grid solar markets, e-waste and scrap collection is a complex hierarchical system with the biggest differentiator being the volumes collected at each stage and by extension revenue. The greatest determinant of e-waste value and eventual price paid is the weight rather than brand or type of component[23]. In the informal waste management sector women are primarily found in the lower tier, working in waste picking, and separating at landfill sites while men dominate the higher-income and decision-making roles, whether as truck drivers, scrap dealers, repair shop workers, or in buying and reselling recyclables. Women therefore bear the brunt of low wages and a lack of protection against harm to workers' health in this sector. This not only reflects the gendered division of labour in society but also shows how women are often excluded when waste management activities are formalized, missing out on protections and benefits, such as social security or higher wages[26].

According to a 2016 study, the current e-waste generated annually from different appliances in Kenya such as refrigerators and TVs stands at 11,400 and 2,800 tonnes respectively amongst other appliances[18]. The handling of appliances at point of failure or at End of Life (EoL) depends

[21] (The Global LEAP Solar E-Waste Challenge Market Scoping Report 2019)
[22] Solar E- (efficiencyforaccess.org)
[23] (Innovations and Lessons in Solar E-waste Management 2021)
[24] (Onyeje 2014)
[25] (Federico Magalini 2016)
[26] (UNEP 2022)

on multiple factors including the reputation of the merchant, the availability of product warranties, and the quality of the product. Observed in a study in Western Kenya through the Global LEAP Solar e-waste challenge, 100% of the customers interviewed confirmed that they are willing to repair their products[25]. However, poor quality and counterfeit products are most times sold with very short warranty periods (about 6 months) and can prove to be difficult to repair due to various reasons, top of the list is poor design. In cases where the warranty has expired, a product owner will utilize the local repair person who may lack either capacity/skills or tools and spare parts to do a good repair job. In such cases, without alternate options, the owner resorts to storing the broken appliance somewhere in the home or handing it over to the technician for 'scavenging' of parts usable in other appliances.

According to a study conducted in Nairobi, Kenya 48% of respondents disposed of their electrical and electronic equipment because of malfunction during use, followed by 46% who disposed the products because its lifespan had elapsed i.e., appliance had been used over the entire course of its usable state, and 37% due to the high cost of repairing the equipment. Due to increasing affordability of new products and technological advancements, individuals found it easier to purchase new EEE rather than repair outdated products. They often found it much cheaper and more convenient to buy a new EEE to accommodate a newer generation of technology than it is to upgrade an outdated EEE[18].

Consumers often expect to receive financial incentives to give up or return products at their EoL this is especially the case for products of high sentimental or monetary value. However, the percentage cost they expect to recover is not clear. Consumers may also need to travel long distances to collection points and therefore need incentives to return products at their EoL. Consumers are happy to return very old, well-used products that performed well and those that were beyond repair as they had exhausted the products value.

OGS consumers prefer to take their faulty appliance to the distributor/manufacturer within the warranty period. Outside of the warranty period consumers prefer to take their appliances to local repair technicians. There is a vibrant repair economy in sub-Saharan Africa that predominantly serves rural areas. These rural solar users take their electronics to a robust network of independent shops for repair. This network is the sole recourse for non-certified products or those distributed through general electronics retailers – i.e., most products in sub-Saharan Africa today[21].

100% of OGS customers are willing to pay to repair a broken product if the cost of repair is not too high as compared to the price of a new product. Consumers will pay between 50-60% of the cost of a new product for a repaired or refurbished product[23].

In many societies, women are traditionally responsible for managing household waste as part of their daily chores, meaning they have greater engagement with domestic waste management and waste management services.[26]

3.3.1 Appliance Failure Behavior & E-Waste Disposal Attitudes: Findings from Household Survey

Appliances owned by respondents were functioning properly in 70% of surveyed households. For the remaining households (30%) had at least one failing/failed appliance, the percentage of each appliance failing among the respondents is shown below.

Appliance type	% of household with failed appliance
Mobile phone/charger	52%
Radio	33%
TV	31%
Lights	19%
Clothes iron	4%
Fridge	3%
Kettle	3%
Microwave	2%
Computer/laptop	1%
Printer	0%
Toaster	0%
Hair dryer	0%
Other	9%

Table 11: Percentage of households with failed/failing appliances (Source: Kenya Household Surveys n=276)

Take it for repair (72%) is the most chosen action for respondents when an appliance fails, and the second most common option is to store failed appliances in the household (30%). Local repair shops (90%) are the most used option for repair of appliances with specialized repair shops (8%) and distributor/manufacturer repair (6%) being other commonly used options amongst the respondents.

Majority of the respondents (70%) who take their failed appliances for repair are willing to pay less than 20% of the appliance cost as the service/repair fee. We expect that the repair fee will vary across appliances and the type or level repair needed. An additional 25% of these respondents are willing to pay between 21-40% of the original appliance cost with less than 6% of them willing to pay more than 40% of the appliance cost.

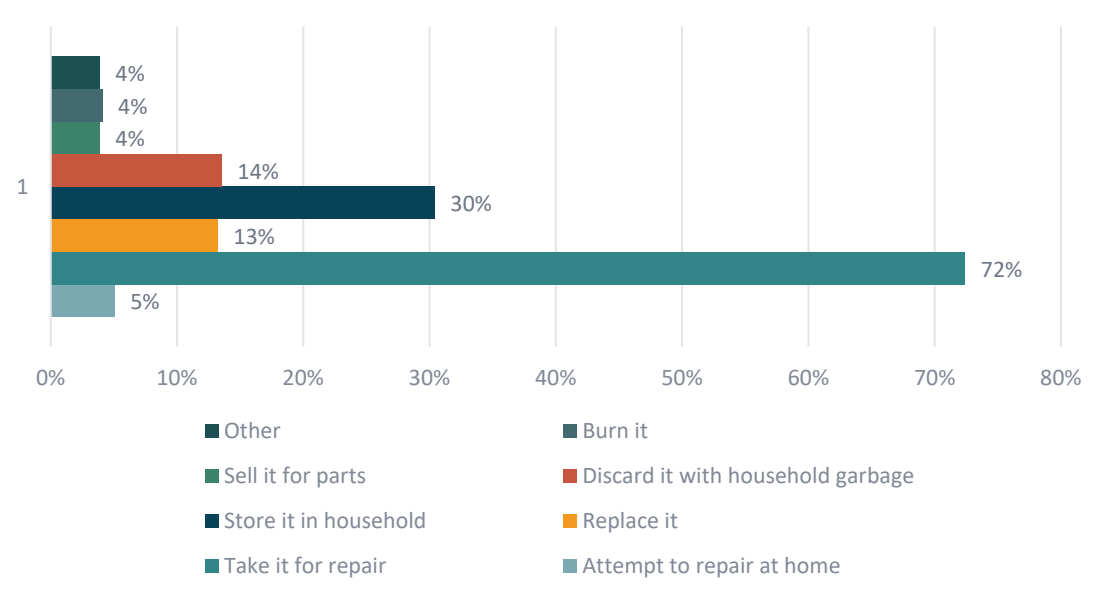


Figure 13: Respondent behavior upon appliance failure (Source: Kenya Household Surveys n=931)

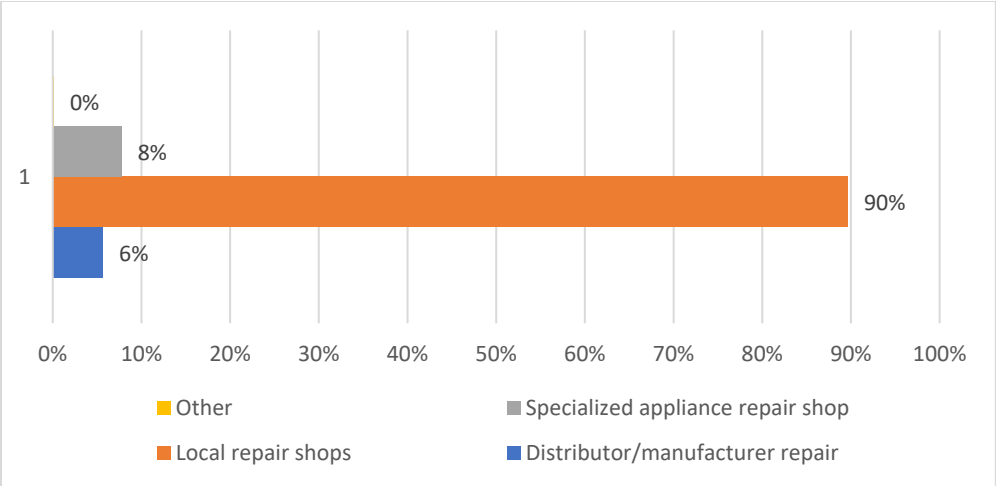


Figure 14: Respondent choice of repair shop upon appliance failure (Source: Kenya Household Surveys n=668)

Cost of repair (31%), reputation of repair shop (28%) and proximity to household (38%) were respectively ranked 1st, 2nd, and 3rd most significant considerations for the choice of repair shop used. Authorization to carry out repairs (20%), familiarity with repair shop (40%) and appliance type (86%) followed at 4th, 5th, and 6th rankings respectively.

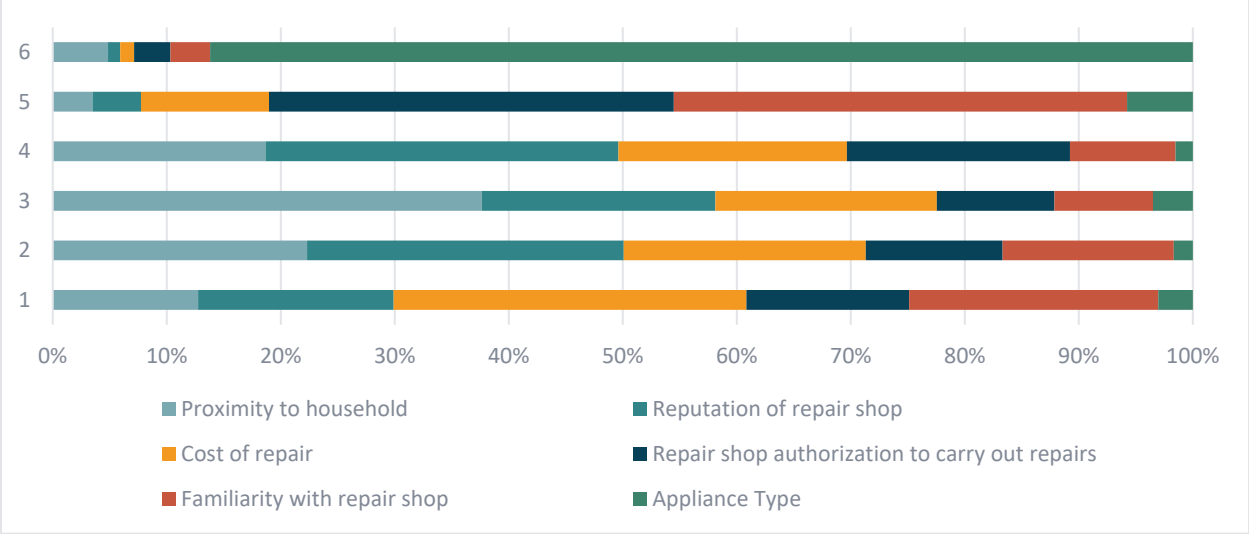


Figure 15: Factors influencing choice of repair shop for appliances (Source: Kenya Household Surveys n=659)

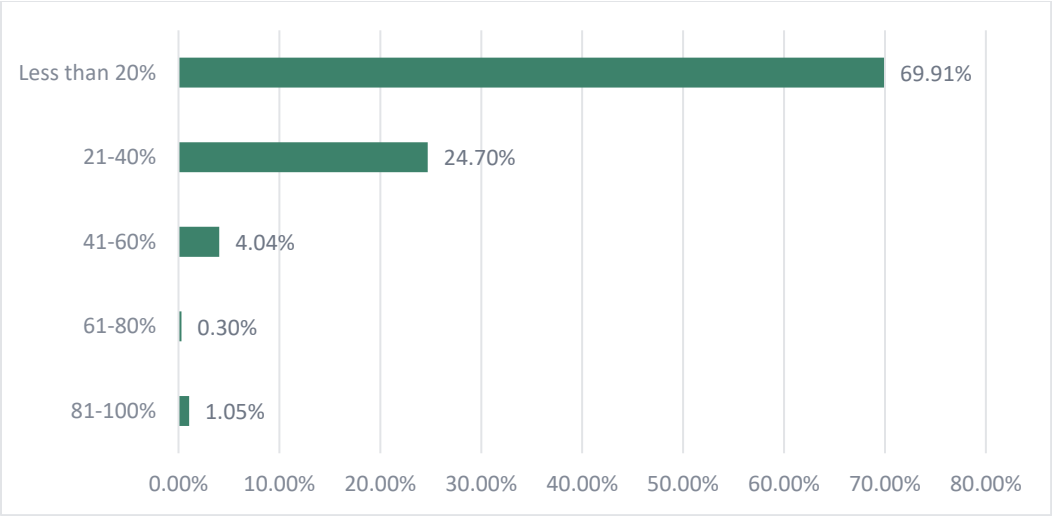


Figure 16: Percentage of original appliance cost respondents were willing to pay for repair (Source: Kenya Household Surveys n=668)

Of the respondents who opted to replace their failed appliances by purchasing another, 49.2% said they opted for this option since it was cheaper to replace the appliance while 41.5% had appliances that could not be repaired. Another 5% of these did so because the product warranty covered replacement of the appliance.

Overall choice of behavior upon appliance failure is dominated by cost effectiveness of the options available (77%), with lack of awareness on repair/disposal processes (26%) and ease of accessibility to repair/disposal centers (23%) also significantly impacting the choice taken.

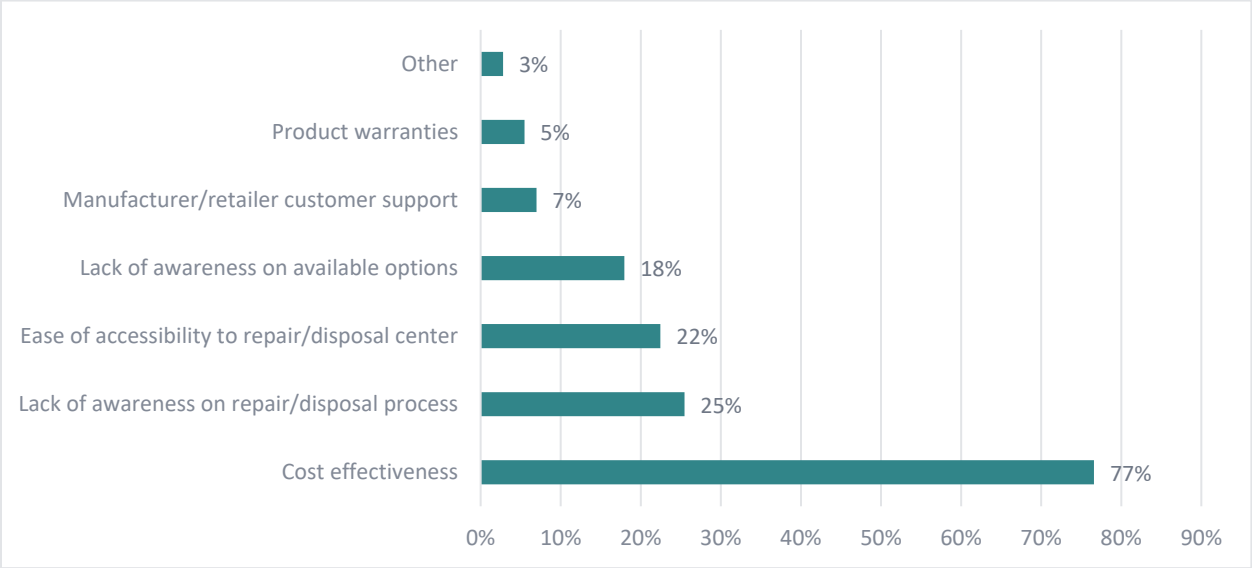


Figure 17: Factors influencing appliance failure behavior (Source: Kenya Household Surveys n=931)

The **male head** of the household (69%) was the most influential in appliance **disposal decisions**, followed by the female head of household (21%) and a shared responsibility between the male and female heads of household for 8% of the respondents.

For general waste disposal, female head of the household (50%) was the most influential household member, followed by male heads of the household (32%) and a shared responsibility between the two for 17% of the respondents. This behavior is replicated for both rural and urban

settings. This by extension affects the choice of appliance disposal behaviour in the households where appliances are disposed of with general household waste.

General waste disposal options available for respondents across all the geographical regions indicate burning (48%) is the most widely used disposal method followed by collection and disposal by private waste management companies (36%) and local council (22%). Private waste management companies (54%) are the leading option in urban areas while burning (67%) is the leading option in rural areas. This indicates to some level depending on available disposal options it will influence the choices households make to get rid of their waste.

E-waste disposal method	Percentage of respondents using method		
	Rural	Urban	Overall
Local council collection and disposal	18%	25%	22%
Private waste management company collection and disposal	20%	54%	36%
Burning	67%	29%	48%
Recycling	4%	3%	3%
Other	21%	7%	14%

Table 12: Percentage of households using the available waste disposal options (Source: Kenya Household Surveys n=931)

95% of respondents mentioned they were **unaware of any designated e-waste disposal options** in their communities. 27% of respondents had previously disposed of a faulty/dead TV; 40% of which disposed with household garbage, handed over to collector/repair shops for parts (26%), burnt (17%), or other (27% - either stored or donated to someone else).

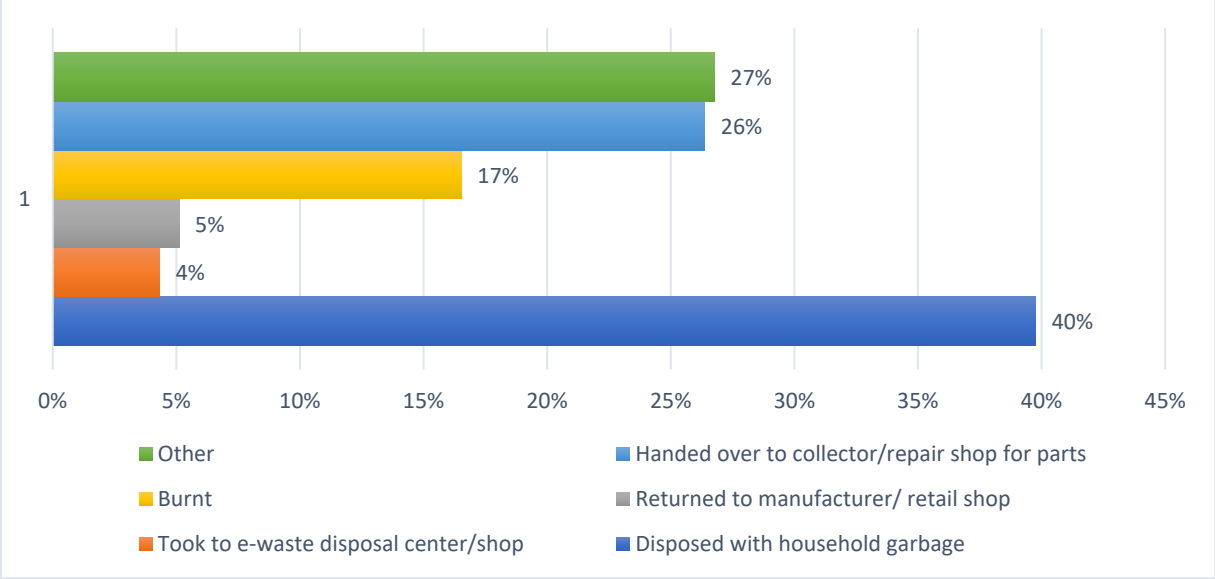


Figure 18: TV disposal methods used by respondents (Source: Kenya Household Surveys n=254)

Of the 73% of respondents who had not disposed of TVs, 97% mentioned that their TVs were **still functioning properly** as the reason **for non-disposal**. Other than TVs, 57% of respondents had disposed of other appliances in the household. Some of these appliances were as shown in table 10 below.

Appliance type	% of respondents disposed
Mobile phone/charger	76%
Lights	70%
Radio	32%
Kettle	3%
Computer/laptop	2%
Clothes iron	2%
Fridge	2%
Microwave	2%
Printer	0%
Hair dryer	0%
Washer/Dryer	0%
Other	1%

Table 13: Percentage of appliances other that TVs disposed (Source: Kenya Household Surveys n=518)

Of the 43% respondents who hadn't disposed appliances other than TVs, the main reason for their lack of disposal was that the appliances still functioned properly (53%), seconded by a lack of awareness on proper disposal methods (37%).

47% of respondents said the appliances were disposed with household garbage, 16% was burnt and 15% handed over to collector/repair shop for parts. Most of the respondents (66%) believed their current disposal practices were not environmentally friendly. Lack of information on available options (74%) was the most common barrier to using more environmentally friendly behavior, closely followed by a lack of proper disposal options near respondents/households. This can be inferred to explain the choices to dispose appliances with household garbage or by burning.

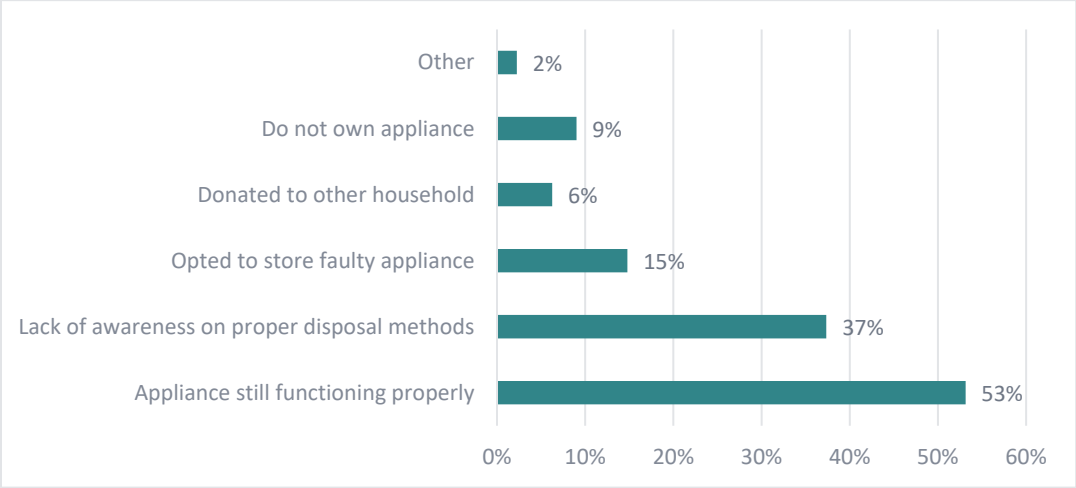


Figure 19: Reasons for non-disposal of appliances (Source: Kenya Household Surveys n=399)

Additionally, 84% of respondents currently using environmentally unfriendly behavior expressed a willingness to switch to more sustainable behavior. Environmental impact i.e., reduction in environmental pollution (67%), financial incentives (60%), increased awareness/education on waste disposal (55%), and ease of disposal (28%) were highlighted as the major factors that would promote more sustainable behavior.

	Believe that current method is environmentally friendly	Willingness to use more sustainable means
No	66%	16%
Yes	34%	84%

Table 14: Awareness of environmental friendliness of waste disposal & willingness to change (Source: Kenya Household Surveys)

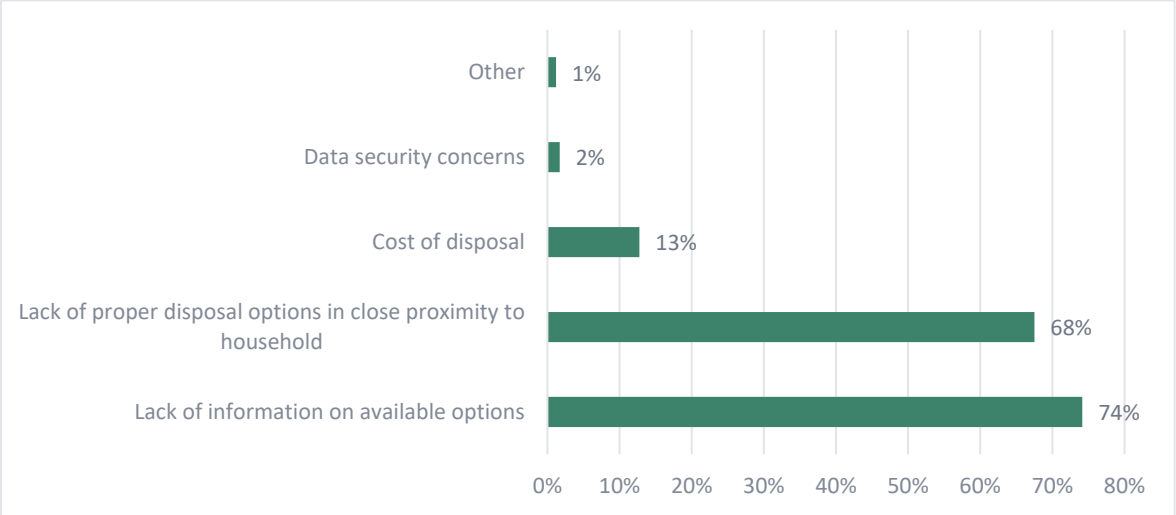


Figure 20: Barriers to more environmentally sustainable e-waste disposal behavior (Source: Kenya Household Surveys n=588)

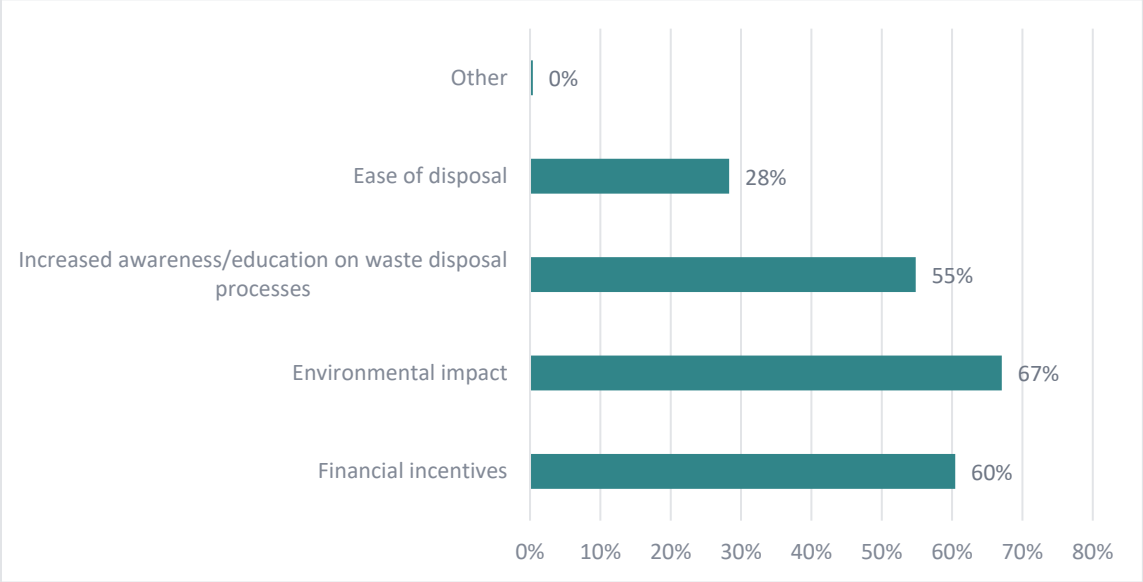


Figure 21: Factors that would promote environmentally sustainable e-waste disposal behavior (Source: Kenya Household Surveys n=498)

Almost all respondents (96%) stated that local leaders had no influence on their appliance disposal behavior. For those who had been influenced, creation of awareness on appliance waste disposal (56%) and increase in appliance waste disposal options (30%) were the main modes of influence reported.

3.3.2 Challenges for e-waste management in Kenya[25][27]

[27] (Omwenga 2015)

The section below summarises the main challenges related to e-waste management in general and those specific for off-grid products; at the same time some opportunities related to the EOL management of off-grid products are presented.

- Low consumer awareness of the harmful effects of WEEE on the environment, their health and safety. There is also little to no information provided on proper waste disposal. Some customers are also unwilling to give up their e waste for free.
- Lack of legislative framework to control the flow of used consumer electronic products and ineffective implementation of existing regulatory and legislative framework. The government has not streamlined mechanisms for the Local Authorities to separate WEEE from other solid wastes, store, collect, transport and process it in a structured manner. A proper waste collection system where waste is separated at the source is needed in all Local Authorities to effectively address this challenge.
- Lack of government support for collection and recycling infrastructure. The government has failed to put in place adequate infrastructure and resources for Environmentally Sound Management (ESM) of WEEE. E waste management has largely been left to the informal sector that conducts crude recycling, refurbishment and dismantling to extract precious metals and parts used for repair.
- The technical expertise needed to properly depollute and dismantle EOL products is inadequate in the country. Most of the players in this sector both small and medium scale work without any formal training and therefore are unaware of best environmental practices, best available technologies or even simple measures that not only are environmentally sound but also more economically profitable.

Some of the barriers facing some of the stakeholders in the e waste value chain include:

Recyclers

- Unsafe disposal of e-waste or landfill due to the prevalence of unstructured collection by informal refuse collectors. E-Waste Initiative Kenya (EWIK) is trying to tackle this problem through cooperation between the informal sector and multiple private sector companies.
- A lack of availability of recycling services and a lack of awareness of responsible recycling practices among both companies and individuals.
- A lack of proper disposal infrastructure both in public and private spaces.
- Solar companies in Sub–Saharan Africa have reported that the high cost of disposal about $0.75 per kg of e-waste was inhibitive, and as a result they had large quantities of EoL products in storage.
- There are insufficient legislative frameworks, government agencies and a lack of capacity to enforce regulations. EPR legislation is often not implemented properly even where it is adopted by governments.
- There is a lack of alignment between access to energy programmes, which are driving the adoption of off-grid products, and e-waste policies, that can clarify the status of EoL off-grid products and their coverage in e-waste bill.
- There is a large market of generic or unbranded solar products, which not only have a lower quality and lower product life, but also invisible producers, often local assemblers, who would resist any imposition of producer responsibility and potentially distorts the market.

- Unlike EEE such as refrigerators many OGS products have lower volumes and low material value (possibly to keep production costs low). The very low volumes coupled with the low intrinsic material value of the products makes them particularly difficult to collect or economically viable to process.
- The widespread dispersion of OGS products in remote rural areas is also a challenge at EOL for collection and take-back.
- Although GOGLA members are committed to using standardised materials and components that would facilitate recycling, products on the market currently use various types of materials that complicate the recycling processes where only single material types can be processed together.

Producers and Producer Responsibility Organizations (PROs)

- Depending on the legal regulations in a country, producers or manufacturers may be obliged to comply with certain collection and recycling targets in the context of EPR systems[28]. Larger producers of electrical and electronic equipment (EEE) often have internal collection or recycling targets in line with Corporate Social Responsibility (CSR) policies. Responsibility for collection and/or recycling is delegated to so-called Producer Responsibility Organizations (PROs) in some EPR systems. These PROs act as specialized compliance service providers which organize e-waste management on behalf of producers in line with legal targets. However, to meet these targets, PROs must have access to enough e-waste[28].
- The export of waste and used products into the country is a challenge for PROs. These exports create loopholes in various markets and damage the efficiency of EPR schemes. In addition, the illegal export of waste and used hazardous materials into developing countries especially in Sub Saharan Africa that do not have the capacity to enforce safe processing can generate negative impacts for the environment and the health of the local population[29].
- Collection of products at their end of life is a challenge for many EEE producers including OGS distributors as they lack in-house capacity and have difficulty in identifying qualified partners to manage product collection for a fee. EEE producers face difficulty organizing a logistics network for the take back and collection of the e-waste. Solar companies distributing through third parties are unable to track their products after the point of sale[30]. Customers are then left to bear the responsibility of finding a repair technician, which poses challenges around quality control of refurbished products[31].
- The treatment of plastics, metals, cables, PV modules, and batteries is an ongoing challenge for local recycling companies. Most of these materials are exported to processing hubs in the Middle East or Europe. The limited capacity of local recycling companies is a concern for companies as the volume of OGS product waste is rising[31].
- OGS distributors report significant competition with other OGS suppliers of lower quality products, often Chinese-made, that appear similar but perform poorly, have a shorter lifespan, and offer no warranty protection. These products are purchased in higher volumes as they are often sold at a slightly lower cost than a VeraSol-certified product and discarded after use. This compounds the collection issue as this waste stream is not managed by any direct supplier[31].

[28] (Hinchliffe 2020)
[29] (The State of Play on Extended Producer Responsibility (EPR) 2014)
[30] (Khetriwal 2007)
[31] (Sustainable Solar E-waste and Battery Technology Management n.d.)

Repairers and Refurbishes

- Local repair technicians often lack the tools and knowledge necessary to repair and refurbish OGS products**Error! Bookmark not defined.**.
- Import costs are still too high to enable affordable access to good quality spare parts, and minimum order quantities are prohibitive for small actors in the e-waste repair ecosystem.
- Many EEE products are designed to be especially robust to withstand harsh external environments (like dust and rainwater) they are also made to be tamper-proof in the case of PAYGo products. Third-party distributors and external repair shops therefore find many of these products to be difficult to repair as they cannot easily access internal components for diagnostics or repair instructions. During a survey of the OGS repair ecosystem in Kakamega County, Kenya, Solibrium found that designs requiring special tools for access and those based on a single printed circuit board (PCB) were especially difficult for poorly equipped technicians to effectively repair[7].

Informal Collectors

- Informal collectors and recyclers come under increasing threats from enforcement activities and the police. This leads to being further marginalized, increased harassment or bribes, and eventually being pushed either further underground or out of the business.
- They are exposed to health risks arising from daily operations as they are exposed to very hazardous materials, and they do not have access to appropriate equipment and protective gear.
- They aren't acknowledged as relevant stakeholders therefore their economic activities aren't protected.
- Given the right support and training, informal collectors can learn about other products such as lighting equipment etc. which could be included in the portfolio of collection and as a result, increase their income.
- They lack access to downstream formal markets as many buyers in the industry are subject to strong regulations and follow internal CSR-policies, which prohibit cooperation with informal entities.

Stakeholder Ecosystem

4 Stakeholder Ecosystem

Waste Management is a major environmental and public health concern in many developing countries. The situation in Africa, especially in the large urban towns, is severe. The public sector lacks the capacity and resources needed to deliver services effectively, regulation of the private sectors is limited, and illegal dumping of domestic and industrial waste is a common practice. The responsibility of providing waste management services is at the hands of Institutions that have found it increasingly challenging to play their role14.

Local authorities of the major cities and towns in Kenya can fix their waste disposal problems with good governance and the implementation of systems that ensure changes outlive one administration. Possible interventions include15:

- Implement an improved collection and transportation plan that incorporates civil society groups and the private sector.
- Establish disposal facility to reduce secondary pollution from the city's dumps.
- Implement the re-use, reduction, and recycling of waste.
- Establish intermediate treatment facilities to reduce waste and its hazards.
- Create an autonomous public corporation.
- Put in place legal and institutional reforms to create accountability.
- Implement a financial management plan.
- Implement private sector involvement.

There is no public infrastructure for the collection of e-waste in Kenya. According to one study, recycling activities in Kenya are largely executed in the informal sector25. Informal business models would typically acquire products for free when scavenged from a dumpsite or require a small fee for items21. These businesses operate in the open air, thereby avoiding the need to rent a premises or pay for a business license. However, Kenya has several formal recyclers including the WEEE Center and Enviroserve Kenya who are involved in the collection and proper disposal of e-waste.

The WEEE center has been in operation for over 8 years in Kenya and has a specialized e-waste recycling plant in Nairobi and has thirteen collection centers across major cities and towns in Kenya[32]. These collection centers act as temporary storage sites for e-waste. The e-waste is accumulated over time to get meaningful volumes that can be transported to Nairobi for recycling. The WEEE center has also began operations in Uganda and Tanzania. The WEEE center has employed over 600 people and recycles waste for several companies in Kenya through contractual agreements. The recycling capacity of the WEEE Centre is 10,000 tonnes each per year yet they are currently utilizing only 30% of this23.

The founders of Enviroserve Kenya have a background in the banking sector and many of their first customers were banks, such as Kenya Commercial Bank (KCB), for whom they have recycled ATMs and office waste. Solar e-waste represents more than 50% of the waste they collect by weight, and over half of that comes from one manufacturer: M-KOPA. Enviroserve also collects e waste from schools, lodges, and electronic manufacturers (e.g., Hotpoint)21.

The collection infrastructure in Kenya is limited and will most times rely on informal collectors who are more interested in valuable parts for 'scavenging'. E-waste Initiative Kenya (E-WiK) is a

[32] (WEEE Centre n.d.)

registered non-profit working closely with the informal sector to provide safe disposal of e-waste. They have a technical capacity building program and carry out awareness campaigns. E-WiK's focus on the informal sector is not misplaced; the informal sector plays a significant role in the collection and management of e-waste, particularly in low and middle-income countries. Other players in the e-waste sector include East African Compliant Recycling, GOGLA, Aceleron, and Mobile Network Operators (MNO) such as Safaricom and Airtel and Supermarkets such as Carrefour. East African Compliant Recycling is an electronics waste recycler in East and Central Africa. The company offers collection and recycling services and operates a network of collection centers. GOGLA has developed an E-waste toolkit that provides resources to companies and investors aimed at helping address the main challenges in setting up sustainable recycling chains[33]. Aceleron UK is a developer of sustainable and reusable battery solutions. Safaricom in partnership with the WEEE centre and Ministry of Environment and Forestry has placed collection boxes at over 50 of its retail centres and offices countrywide where customers can deposit their old phones, chargers, batteries, toys, laptop computers, music players and other obsolete electrical equipment[34]. As of 2019, 1287 tonnes of e-waste had been collected[35]. Airtel Kenya has partnered with the WEEE centre to initiate programs that will expand recycling schemes and build employees awareness around protection of natural resources[36]. The WEEE Centre has partnered with Carrefour stores in Kenya and together they have set-up e-waste bins in all the eight Carrefour stores in Nairobi with the aim of providing centralized drop off points for e-waste that include but are not limited to; phones, batteries, laptops, lamps, cables, and other house appliances[37]. The stores also have provision for larger items that cannot fit into the bins through the information desk. All equipment dropped in these bins will be collected and transported to the WEEE Centre for safe disposal.

There are several producer responsibility organizations (PROs) that have built their e-waste management capacity such as d.light that have set up 222 collection points all located at existing d.light experience centres. Dlight has also been using reverse logistics already in place for in-warranty returns. WeTu a social enterprise providing innovative clean energy solutions has also been able to leverage their existing distribution infrastructure and added WeCollect facilities to their hubs in Western Kenya following the recommendation for option for companies who already have extensive distribution networks. Solibrum has developed an e-waste tracking tool and used this data to design a targeted SHS take-back and repair model that seeks to extend the lifespan of SHS and PSPs. They also repair and refurbish SHSs and sell, repaired or refurbished components to the informal repair sector. We did not find documentation speaking to the effectiveness of above systems.

Outside of company processes, there is a vibrant repair economy that predominantly serves rural areas. These rural solar users take their electronics to a robust network of independent shops for repair. This network is the sole recourse for non-certified products or those distributed through general electronics retailers – i.e., most products in sub-Saharan Africa today[38].

Key stakeholders and their roles in the e-waste management ecosystem in Kenya are elaborated in table 15 below.

[33] (GOGLA n.d.)
[34] (Safaricom 2012)
[35] (Koech n.d.)
[36] (Kanali 2022)
[37] (WEEE centre 2019)/
[38] (The Global LEAP Solar E-Waste Challenge Market Scoping Report 2019)

CATEGORY	ACTORS	ROLE/RESPONSIBILITY
Importers (New and used appliances)	Gadgets & gizmos ltd	Source electrical and electronic appliances from foreign countries
Retailers (New and used appliances)	Rexnet entertainment Credible sounds electronics Wasafi Creative electronics Jambo electronics Gikuyu electronics SK electricals Discount electricals Mobi centre Dubai Gadgets &gizmos ltd CT Tecnel E-waste Initiative Kenya	Distribute and sell electrical and electronic appliances
Collectors (Formal & Informal)	Sustainable ICT solutions Sure Success Computer Sales & Services (SSCS&S) E-waste Initiative Kenya (EWIK) Safaricom PLC Airtel Carrefour	Collect, process,and dispose old/broken/dead appliances, appliance parts and other obsolete electrical equipment
Repairers	Rexnet entertainment Stantech Credible sounds electronics Jose electronics Creative electronics Thunder electronics SK electricals Imani refrigerators and electrical services Mwangi Electricals Mobi centre Karanga electronics Hope electronics and electrical installation. Tecnel Gadgets &gizmos ltd Sustainable ICT solutions E-waste Initiative Kenya	Restore broken/damaged appliances to good working condition
Refurbishers	Creative electronics	Recondition and renovate appliances for resale and/or reuse
Recyclers	SSCS&S E-waste Initiative Kenya WEEE Center Enviroserve Kenya	Convert appliances and appliance parts into

	Aceleron East Africa Compliant Recycling	reusable components and material
Materials Recovery	Gjenge Makers Ltd Creative electronics Imani refrigerators and electrical services Mobi centre Hope electronics and electrical installation. Tecnel Sustainable ICT solutions SSCS&S E-waste Initiative Kenya Safaricom PLC	Salvage usable parts and components from appliances for reuse and recycling
General waste disposal	E-waste Initiative Kenya	Collection and disposal of general waste
Government agencies	National Environment Management Authority (NEMA) Communications Authority of Kenya (CAK) Ministry of energy, environment, forestry, natural land and minerals resources Ministry of Interior - State Department of Citizen services Nairobi Metropolitan Services (NMS)	Set policy direction and enact legislation. Draft regulations and guidelines Implement and enforce regulations and standards. Coordinate waste collection efforts.
Producer Responsibility Organizations (PROs)	Solibrium WeTu d.light	e-waste tracking, collection, processing, and safe disposal
End users	Individuals Households Institutions e.g. CIC Insurance.	Purchase and utilise appliances

Table 15: Summary of stakeholders in the e-waste ecosystem

4.1 Findings from Stakeholder Interviews

A total of 73 surveys were collected from 36 unique respondents representing 11 stakeholder sub-categories (i.e., some of the stakeholders represented more than one sub-category). These stakeholders were engaged across the counties of Nairobi, Nakuru and Kitui. Local repair shops (20) had the most representation closely trailed by new appliance retailers (16).

Of the 36 respondents, 32 were in the private sector with only 4 in the public sector. Of the 32, only 8 identified as being in the formal sector with 28 being in the informal sector. In this context, the public sector refers to institutions that are either in-part/fully owned or controlled by the government, while private sector refers to institutions not under government ownership. The formal sector includes institutions that are primarily regulated by the government and are required to operate within specific rules and regulations whereas the informal sector consists of establishments that are not regulated by the government thus are not forced to abide by laws and

regulations. 31 of all respondents said they worked with other organizations in the e-waste space. All but 2 respondents admitted to being aware that e-wastes pose environmental risks, can be profitably recycled, and that some hazardous factions need special treatment before disposal.

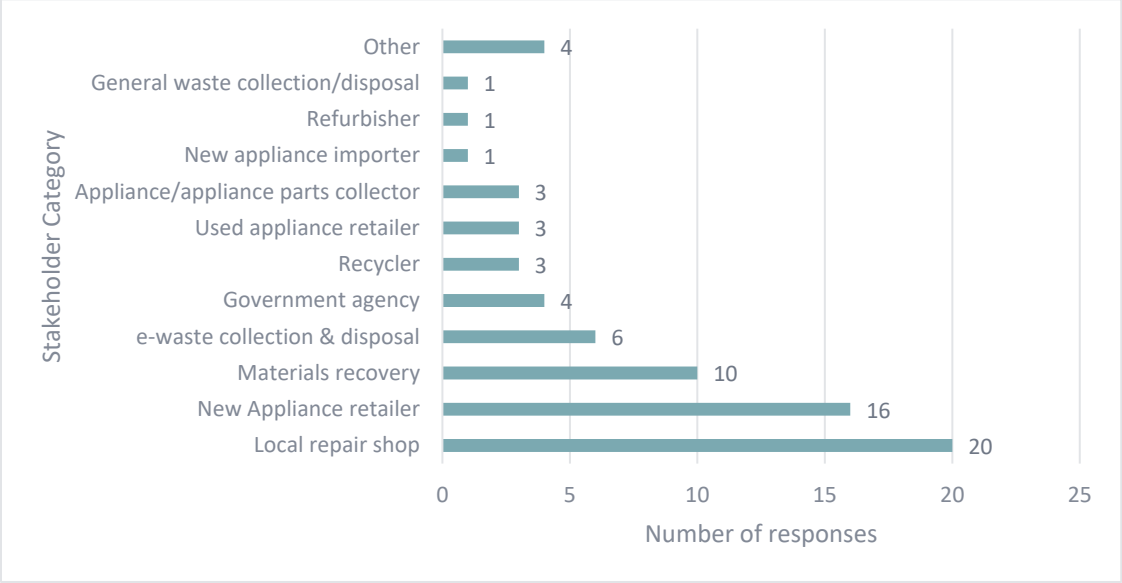


Figure 22: Number of stakeholders surveyed under each category (Source: Kenya Stakeholder Surveys)

4.1.1 Appliance Importers

Importers bring into the country appliances from manufacturers and foreign wholesalers for distribution and retail within the country. **One respondent** was interviewed under this category, a small-scale shop with 3 employees that has been in operation for the last 15 years. They identified themselves as belonging to the private and informal sector and did not collaborate with other stakeholders. There was no explanation provided for the choice not to collaborate with other stakeholders. They confirmed awareness of environmental hazards of e-wastes. Only new appliances sold to households are imported. **15 TVs were sold** between 2019 and 2021. No problems were experienced in selling off new appliances. The respondent reported being unaware of appliance standards and government regulations, receives no support from wholesalers and doesn't face any problems as a business.

4.1.2 Appliance Retailers

Appliance retailers typically source EEEs and sell them to end users who could be individuals, households, or institutions. A **total of 19 retailers** were surveyed with 17 of these being in the private and informal sector with only 2 being private and formal, all being small to medium scale, and with an average of 3 individuals working at the premises. Of the 19 appliance retailers surveyed, 15 retailed new appliances while 2 retailed used appliances, and 1 retailed both new and used appliances. All but 2 admitted to working with other organizations that handle EEEs. These included other new appliance retailers (14 respondents), local repair shops (6), appliance/parts wholesalers (6), new appliance importers (2), used appliance retailers (1), appliance/parts collectors (1), industrial scale refurbishers (1), materials recovery (1), and appliance manufacturers (1).

88% of new appliance retailers source their appliances from appliance wholesalers and 13% from local manufacturers. Used appliance retailers in contrast primarily **source appliances from households,** with other sources being retailers, importers, local manufacturers, wholesalers, and local institutions. The UK and USA are the countries from which used appliances are imported. Both new and used appliance retailers work with repairers, collectors, refurbishers, materials recovery and waste collection & disposal companies.

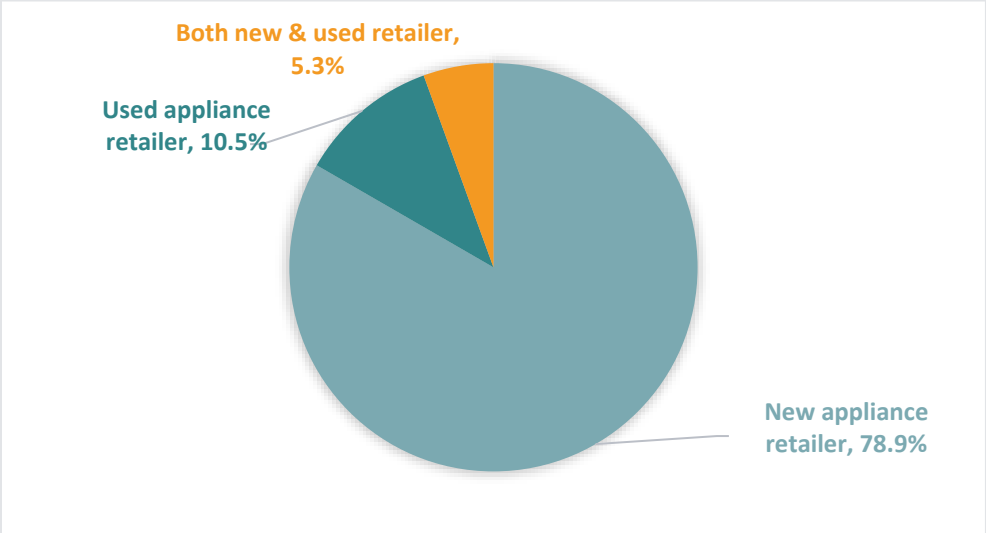


Figure 23(a): Percentage split of new and used appliance retailers (Source: Kenya Stakeholder Surveys)

A total of **1,264 new appliances** had been sold by the respondents (new appliance retailers i.e., reported estimate number by 6 of the 16 respondents) in the previous year, with the most common being lighting appliances (870) and mobile phones/chargers (305). Other appliances sold were radios (63), TVs (12), kettles (5), air conditioners (3), electric fans (3), and blenders (2). Respondents also reported selling clothes irons, computers & laptops, electric cables and accessories, phone and computer accessories, solar panels, batteries, and water heaters, but could not provide quantities of these.

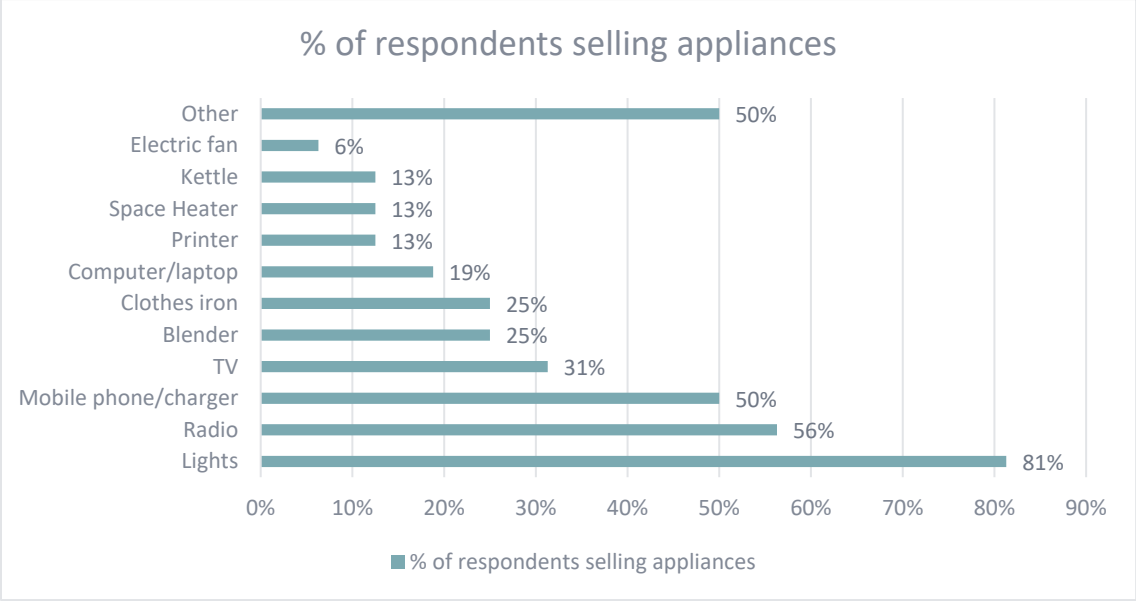


Figure 23(b): Percentage of retailers selling different appliance types (Source: Kenya Stakeholder Surveys)

Used appliance retailers **sold 49,494 units of appliances** in the previous year, from multiple brands including Samsung, LG, Panasonic, Von, Hisense, Philips, Apple, Beko, Bosch, and other unbranded appliances. Mobile phones/chargers, fridges and clothes irons were the most popular. Please note that sales number provided is an estimated and most of the sales were reported by 1 respondent. Most used appliance purchasers were reported to be typically low to middle-income individuals and are drawn to used appliances due to their relatively cheaper cost in comparison to new appliances, as well as recommendation from other purchasers. The contrast between this feedback from stakeholders and feedback from the households is interesting to note where majority expressed preference to buy new rather than used appliances.

New appliance retailers sold multiple appliance brands with unbranded appliances being sold by half of these respondents. For branded items, these were Samsung, Nokia, Ampex, Infinix, Sonytech, Pioneer, Kenwood, and Sayona. TV brands sold included LG, Samsung, Vitron, Vision, Synex, and unbranded. The 3 retailers who reported selling TVs said that TV sales have been decreasing in recent years.

56% of new appliance retailers said their products were either **high or very high quality** with the remaining 44% reporting moderate quality. Product warranties were offered by 56% of these retailers, with 78% of these being included in the cost of the product. Warranties typically cover product replacement (54%) and repair (38%), with 78% of customers utilizing them. On number of claims received per year, retailers reported on average: 1 claim (17%), 2 claims (33%), 5 claims (33%) and 10 claims (17%) from customers. 93.8% of the new appliance retailers considered product warranties important. All respondents offered some sort of customer support to their customers with repair services (88%) and appliance replacement (56%) being the most common.

In 69% of cases, new appliance retailers received some sort of support from wholesalers/manufacturers. Product take-back (56%) was the most common, followed by repair services (44%), delivery services (31%) and financing/payment options (25%). Appliance standards were considered important by 44% of new appliance retailers. They all indicated informing their customers of appliance standards and noted the importance of the standards in making a purchase decision amongst customers.

All used appliance retailers said they processed appliances before resale – this was usually either repair or refurbishment. Screw drivers, soldering guns, pliers, multimeters, wrench sets, and wire cutters were some common tools used in the processing. Additional materials such as LCD panels, circuit boards, batteries, aluminium, copper, glass, and plastic were usually needed. **1518 units of appliances had not been sold** the previous year (aggregate for all retailers), and these were often either stored (100%) or donated (not explicitly indicated to who), sent to landfill, sold to other retailers, or discarded with garbage. Product quality was rated either high or moderate.

Only one respondent among the used appliance retailers offered a product warranty which covered repair and replacement, at an additional cost to the product price. On average, they did indicate receiving **15 warranty claims annually**. They offer repair and replacement to their customers as after-sales services but receive no support from wholesalers/manufacturers.

Only a third of used appliance retailers were aware of appliance standards, considered them important and informed their customers of them. 2 out of the 3 admitted an awareness of government regulations.

4.1.3 Repairers

Repair shops and technicians fix faulty and broken appliances to restore them to good working condition. The 20 respondents interviewed under this category largely represented local repair shops situated near residential neighborhoods and urban centers. They were small-scale repair shops with an average of 3 employees working at each shop. All but one identified belonging to the private and informal sector (with the one being private and formal) and were aware of the environmental hazards of e-wastes. 85% of these respondents said they worked with other organisations in the sector. Respondents reported **having repaired an aggregate total of 40,279 appliances** in the previous year – 37% of which were computers/laptops, 19% TVs, 12% mobile phones/chargers, 10% fridges, and 8% microwaves.

TVs, mobile phones, radios, lighting appliances, microwaves and kettles were reported to be common appliances brought for repair by the respondents as with shown in figure 24 below.

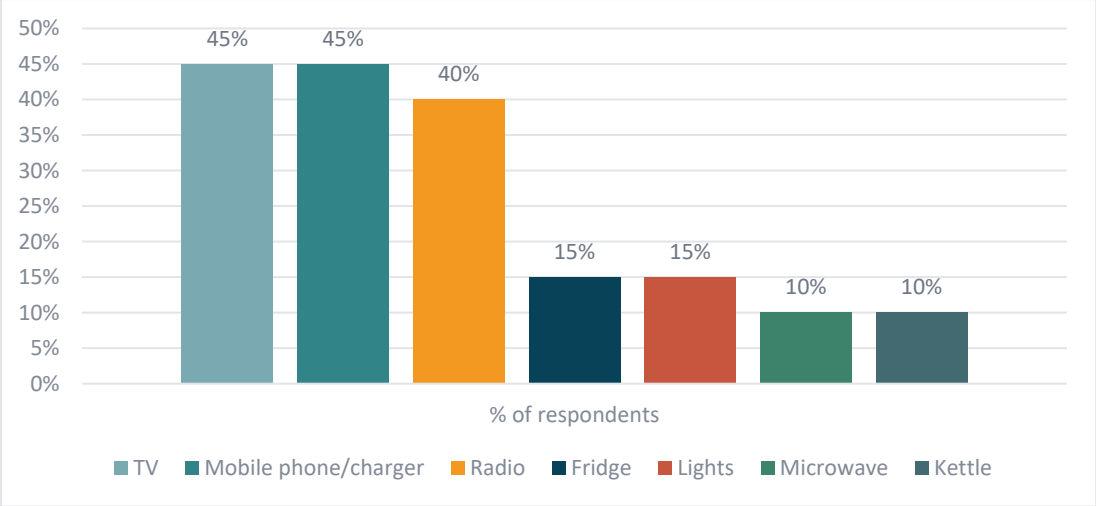


Figure 24: Most commonly repaired appliances by percentage of respondents (Source: Kenya Stakeholder Surveys)

Screen damage (62%), wiring/cable failure (31%), and audio issues (23%) were identified as the most common types of TV failures and usually caused by electrical surges (100%), short-circuiting (89%), poor maintenance (54%), incorrect usage (44%), and frayed cables (22%). 150kgs of parts are sourced for repair every month – 85% from retailers, collectors (25%), e-waste disposal centers (15%) and appliance manufacturers (10%) being other sources. 80% of respondents had appliances they could not repair, with computers/laptops (50%), fridges & electric pressure cookers (38% each), and microwaves (31%) being the top 3 – perhaps due to an unavailability of spare parts and expertise required to repair these appliances.

On average, **1,645 appliances are unrepairable** each year cumulatively by 16 of the 20 surveyed respondents. These are salvaged for parts (81%), stored (69%), disposed with garbage (63%), sent to e-waste centers (25%), or burnt (13%) (n=16) as shown in figure 25 below. 885kgs of waste is generated annually from the appliance repair processes, of which 94% is disposed with garbage, 56% salvaged for parts, 50% stored, 31% burnt, and 25% sent to e-waste centers(n=16).

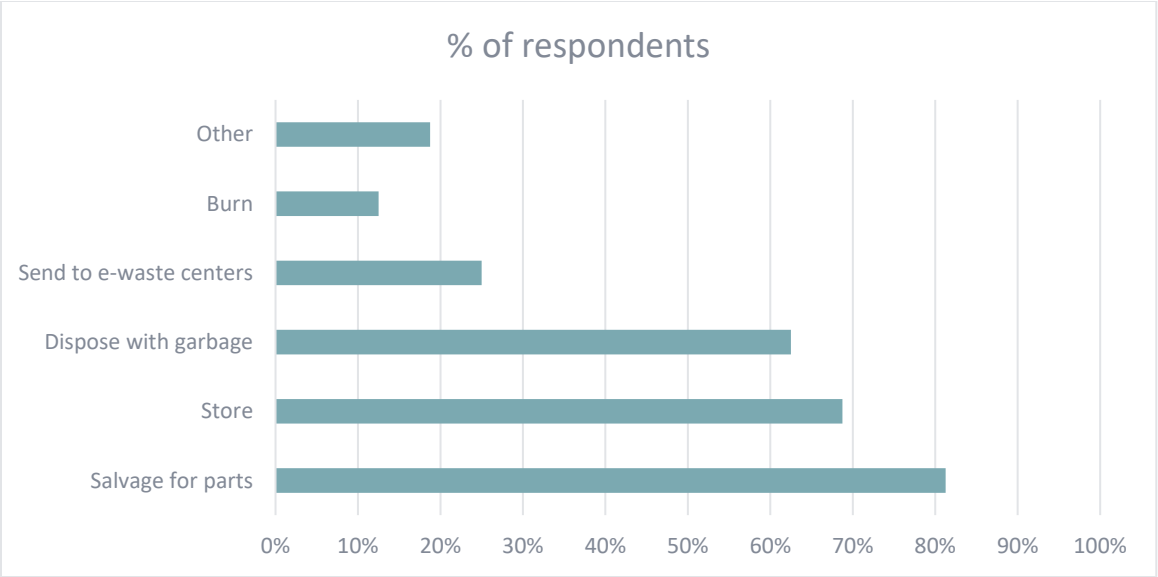


Figure 25: Disposal methods for appliances that can't be repaired (Source: Kenya Stakeholder Surveys)

Aggregate total of Kes 930,000 (~USD 7,154) was spent on sourcing parts for repair in a year among surveyed respondents. In contrast, customers are charged less than 20% of the original appliance cost (72%) or 21-40% of the original appliance cost (28%). 20 respondents reported that their customers chose to repair appliances rather than replace them either because it was cheaper to repair (90%) or repair parts were available (75%). In other cases, the appliance brand was easy to repair (20%) or not readily available in stores (10%). These customers were attracted to repair shops by the range of services offered (95%), reputation of the shop (90%), cost of repair (80%), or the location of the shop (45%) (n=20, percentages denote number of mentions for some responses).

Top 3 problems experienced by repair shops were noted as lack of tools and technologies (95%), lack of training on how to fix certain appliances (79%), and inadequate supply of parts (63%). Only 30% of respondents were aware of government regulations on e-waste handling and disposal, and 83% of these felt these regulations had a positive impact on their business but did not specify in what way.

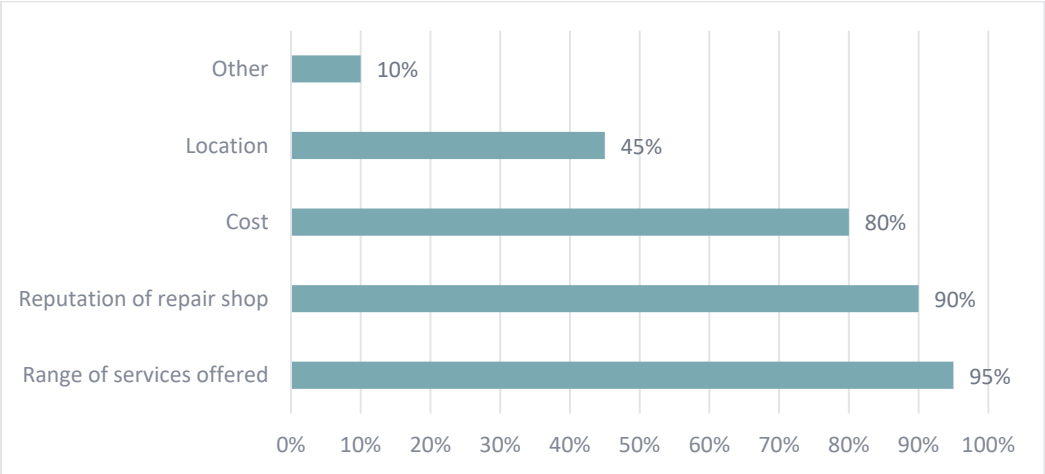


Figure 26: Factors attracting customers to repair shops by percentage of respondents (Source: Kenya Stakeholder Surveys)

4.1.4 Collectors

These include individuals/organisations that collect any discarded, faulty, or non-functioning items of value including appliances and their parts. 7 respondents were interviewed – 5 small scale, 1 medium-scale and 1 large-scale business Respondents in this category were predominantly in the private and informal sector and said they worked with other stakeholders in the sector including appliance retailers, refurbishers, repairers & materials recovery, parts wholesalers, other general & e-waste collectors & disposal, importers, and government agencies. Manufacturer take back for faulty /damaged appliances may not always be a viable option for retailers and importers. In such cases the faulty appliances are handed over to collectors if unrepairable.

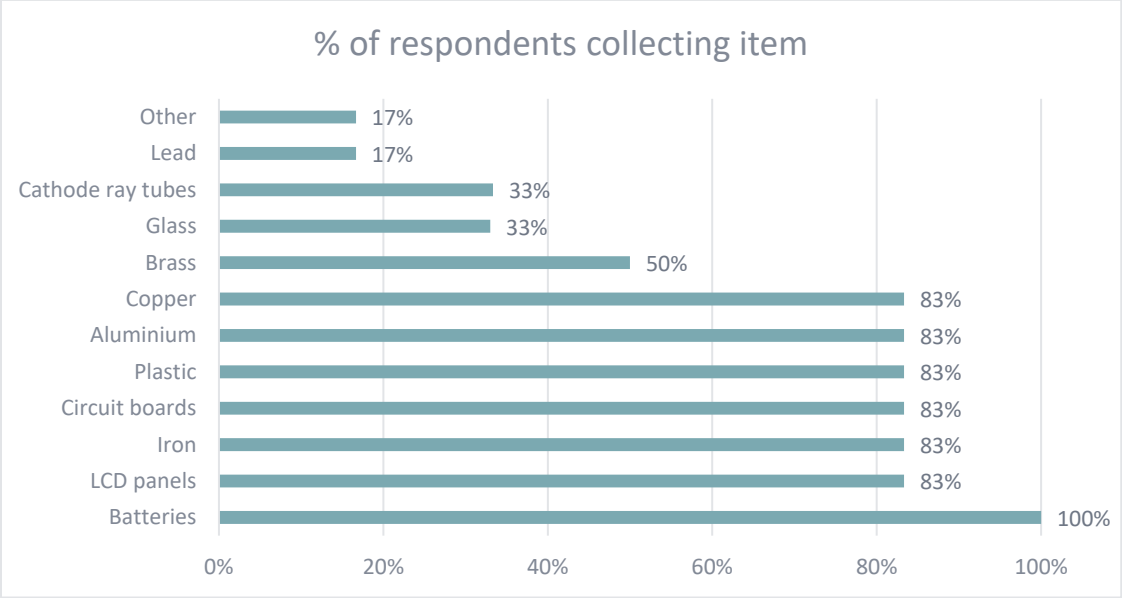


Figure 27: Percentage of respondents collecting various items (Source: Kenya Stakeholder Surveys)

Respondents reported collecting a total **342,194 units of appliances** in the previous year mostly from either households or e-waste disposal centers. From these, a total of **1,075,792kgs of materials were** harvested in the same period. These were collected from a variety of appliances including TVs, printers, computers/laptops, radios, mobile phones, fridges, and other domestic appliances.

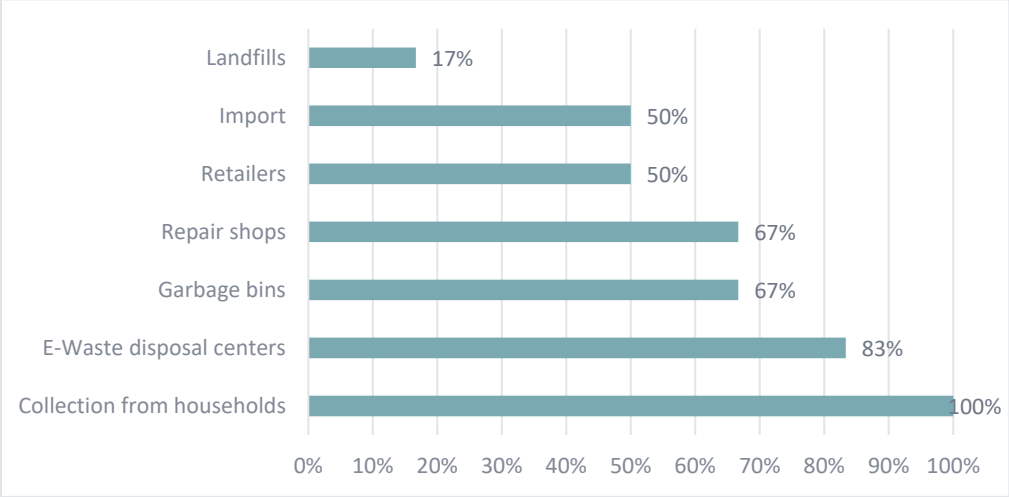


Figure 28: Sources of collected appliances by percentage of respondents (Source: Kenya Stakeholder Surveys)

These harvested items are then **sold** by the collectors multiple different stakeholders as indicated: **to repairers (100%), retailers (71%) and households (71%) (n=7).** Some of it is also exported (14%) or sold to manufacturers (14%). 10,430kgs of materials were reported not sold in a year. Materials not sold by the 7 respondents were disposed of with garbage (71% of respondents), stored (57%), donated (57%), sent to landfills (29%), or burnt (14%).

Half of the respondents processed (refurbished) materials before selling, mostly using screw drivers, soldering guns, pliers, multimeters, wrench sets and wire cutters. Circuit boards, batteries, LCD panels, aluminum, and copper were mentioned as additional components needed for refurbishment. These additional tools were sourced from retailers (67%), households, repairers, and e-waste disposal centers (33% each).

4.1.5 Refurbishers

These are organizations that dismantle appliances for their parts and then use these parts to restore products to a state that can re-enter the market. Through refurbishment, a products functionality can also be improved. The single respondent in this category was in the private and informal sector, works with other businesses in the sector and is aware of environmental hazards of e-wastes.

30 appliances were refurbished in the previous year. Materials used for refurbishment are sourced from repair shops, households, and garbage bins. Refurbished appliances are all sold and mainly to households. The refurbishment process typically uses recycled parts including cathode ray tubes, LCD panels, circuit boards, batteries, and plastic. These parts are cheap and easily accessible, hence their use. The **Cumulative mass of recycled items** used in a year was **50kgs**. High purchase costs and unavailability of new parts hinder the use of new parts. It was indicated that the refurbishing process **generated about 10kgs of waste** which is disposed of with garbage.

4.1.6 Recyclers

Recyclers can be informal or formal businesses that dismantle appliances for their parts which are later used for repair or manufacture. They are considered to function at a smaller scale than the industrial refurbishers. All 3 recyclers surveyed were private and informal, aware of the environmental hazards of e-wastes and work with other organizations.

Aggregate 41,095 units of appliances were reported recycled in the previous year with computers/laptops, lighting appliances, TVs, and air conditioners being the most popularly recycled appliances. Circuit boards, LCD panels, aluminium, copper, batteries, and plastics are some of the recovered materials used in the recycling process. The cumulative annual mass of **these recycled parts was 7000kgs.** These are used because they are easily accessible, cheap, and save energy used to manufacture new parts. In contrast, purchase costs, unavailability of new parts, ease of accessibility to new parts, costs associated with transporting parts were stated as the main reasons why new parts weren't used in the recycling process.

Recycled products are primarily sold to households and used appliance retailers, with some being exported. Parts used for repair are sourced from retailers, collectors, e-waste disposal centers and appliance manufacturers. **25,500kgs of waste was generated annually** from the recycling process. This is usually disposed of either with garbage, stored, salvaged for parts, or sent to e-waste centers. The annual cost for new parts used for repair and recycling was given as KES

1,050,000 (~USD 8,077) while customers were charged less than 40% of the original appliance cost for recycling. 2 of the 3 recyclers interviewed were aware of government regulations – the NEMA certification on e-waste disposal – and were split on whether this had a positive or negative impact on the business.

4.1.7 Materials Recovery

These organizations salvage materials from discarded appliances and return them to the market. The recovered materials are mostly sold to repair shops with some to households, appliance retailers and export. Featuring a mix of small, medium, and large-scale organisations, 9 of the 10 respondents interviewed were private and informal, and 8 worked with other organizations. All respondents were aware of the environmental hazards of e-wastes.

An **aggregate total of 25,604 units of appliances were recovered** in the previous year, with TVs, lighting appliances and microwaves accounting for about half of this. Other top appliances were fridges, kettles, mobile phones and radios. LCD panels, circuit boards, aluminium, copper, iron, batteries, and plastics were among the materials recovered. These items were sourced from households (80%), repair shops (60%), retailers, garbage bins and e-waste disposal centers (40% each), imported (20%) or landfills (10%). Respondents typically obtained materials from more than one source. Repair shops (90%) were the largest consumers of the recovered items, followed by households (60%), with exports (20%) and retailers (10%) trailing.

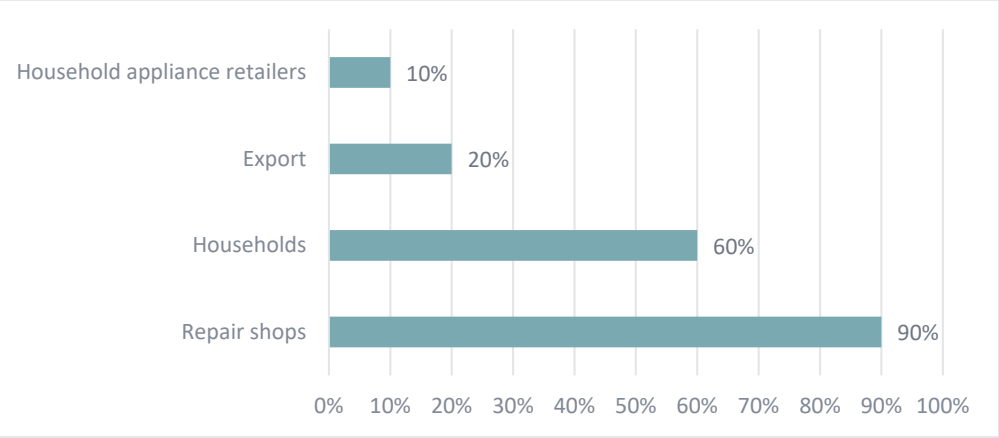


Figure 29: Consumers of recovered items by percentage of respondents (Source: Kenya Stakeholder Surveys)

Materials unable to be sold by the 7 respondents who reported having unsold materials were either stored (70%) or discarded with garbage (60%). Smaller quantities are burnt, sold to other retailers, or sent to landfills. 40% of respondents reported processing parts before selling. All the 40% of respondents who reported being aware of regulation thought that these positively impacted their businesses but did not specify how.

4.1.8 General waste disposal

These are usually private waste collection and disposal companies that collect waste from households, private organizations and public institutions and then dispose of it. The single respondent was in the private and informal sector, worked with other businesses in the e-waste sector and was aware of the environmental hazards of e-wastes. This was a medium-scale organization with 22 people working at the organization.

A total of 22,034 units of appliances were disposed at their site in the previous year with noted e-waste disposal increase over the years. E-waste disposed at the site was then either sent to recyclers, recycled, reused, or scavenged for parts. The respondent believed that these methods of disposal were environmentally friendly. Parts salvaged from this waste was sent/sold to manufacturers, repair shops and refurbishment centers**. Residual waste** including Styrofoam, cardboard, paper, plastic, glass, rubber, metal waste, kitchen waste, detergents/cleaners, pharmaceutical waste was also encountered and are either recycled by the respondent or sent to other recyclers.

4.1.9 Government agencies

Government agencies formulate and enforce policy and regulations for the industry. 4 respondents were surveyed. They all reported working with other stakeholders, particularly e-waste collectors and recyclers. The National Environmental Management Authority (NEMA) uses Environmental Impact Assessment (EIA) audits as an e-waste assessment tool. E-waste disposal data is tracked but majorly in Nairobi only.

There was an awareness of the regional and international regulations the country is a signatory to, particularly the Basel and Bamako conventions. There is a standards & labeling program for electrical appliances and no challenges have been faced in its implementation. Major challenges faced by the e-waste sector were cited as lack of awareness, inadequate e-waste management structures, lack of data, and lack of appropriate laws & regulations.

4.2 Stakeholder ecosystem mapping using Net-Map Tool

A Stakeholder Mapping (SHM) exercise to identify the key stakeholders pertinent in the support of proper appliance end-of-life and e-waste disposal practices in Kenya was carried out using the net-map methodology. Net-map analysis aids in the understanding, visualization and discussions centered in situations where diverse actors influence outcomes. It not only assisted in the identification of stakeholders currently involved in the e-waste ecosystem, but also in the definition of their roles and responsibilities relative to each other. The created network influence maps explained the diverse linkages, varied goals and different levels of influence among the various stakeholders. These linkages were drawn from literature review and interview findings.

Further, the net-maps fostered an analysis of the material-flow of e-waste amongst the stakeholders, further detailing how they inter-relate in this regard. Determining the goals, linkages, and level of influence informed which links to strengthen and which stakeholders to leverage. Net map images, narratives and influence-interest matrices for the focus areas were generated as below.

The linkages between stakeholders were defined as follows:

- **Appliances**: There exists a flow of appliances between these stakeholders
- **Repair & servicing**: Stakeholders are involved in repairing or processing appliances for other players in the ecosystem.

- **Materials Handling**: Stakeholders primarily handle materials. For example, this is demonstrated by the flow of materials to and from collectors and materials recovery companies.
- **E-waste disposal**: Stakeholders encounter e-waste at disposal sites.
- **Standards and regulations**: Stakeholders enforce regulations on other players in the ecosystem.

The links defined 136 relationships amongst the actors out of which 27 represented strong links, 98 normal/default links and the remaining 11 representing weak links. The figures below illustrate results derived from the net-mapping analysis.

Key for Illustration of Linkages/Connections	
Illustration of Linkage	Interpretation
——→	Strong link
——→	Default/Normal Link
·····→	Weak Link

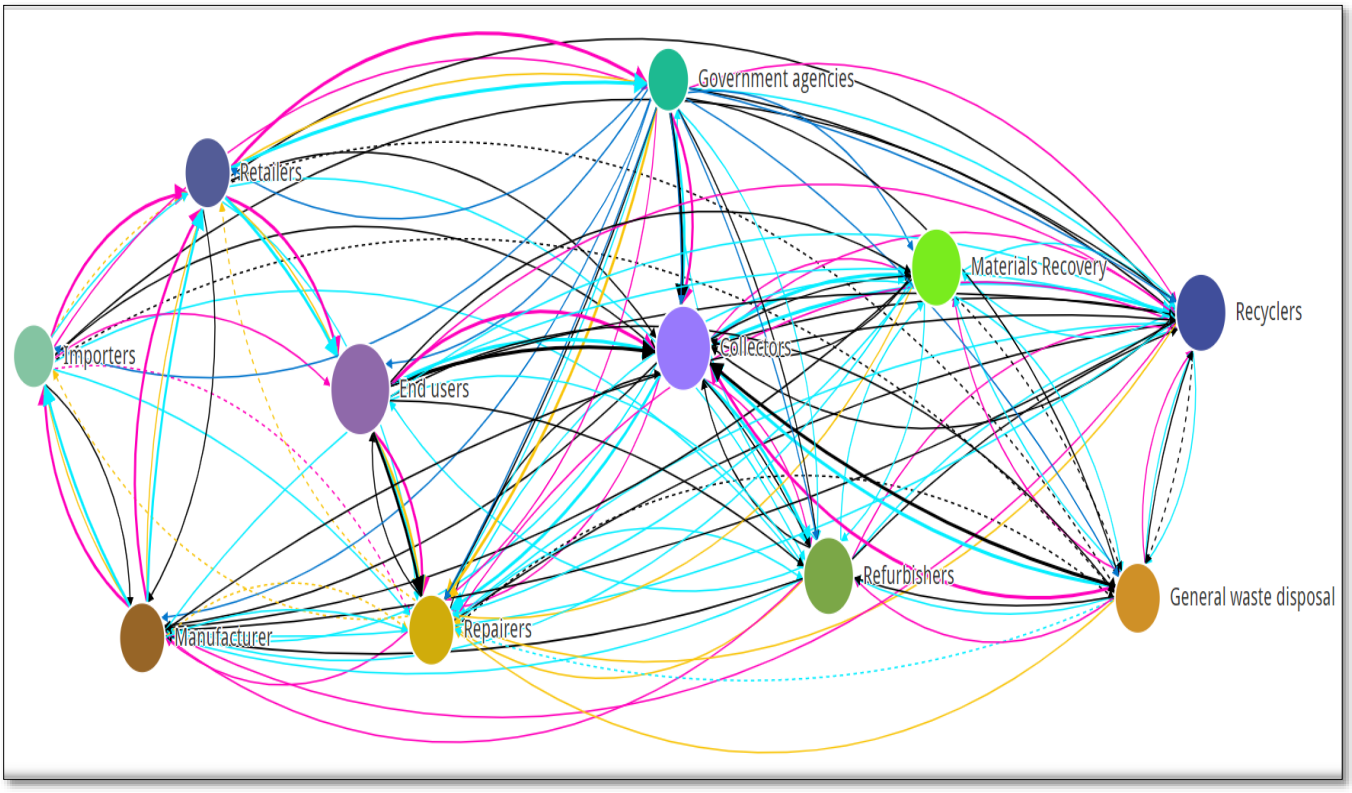
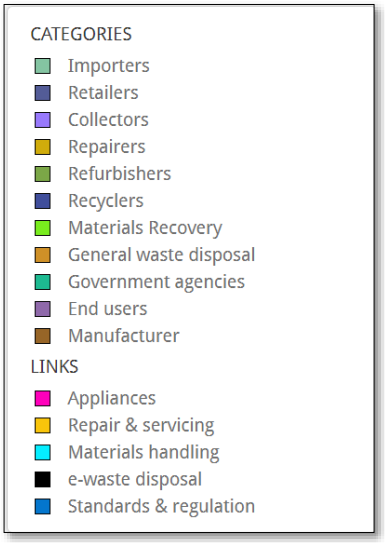


Figure 30(a): Net-Map Illustrating Stakeholders Supporting Proper Appliance EoL & e-waste Disposal Practices in Kenya

Key:



N.B. The size of the stakeholder is proportional to their influence i.e., the bigger the size of the node, the greater the influence and vice versa.

A simplified version of this map merging all the links between stakeholders is shown below.

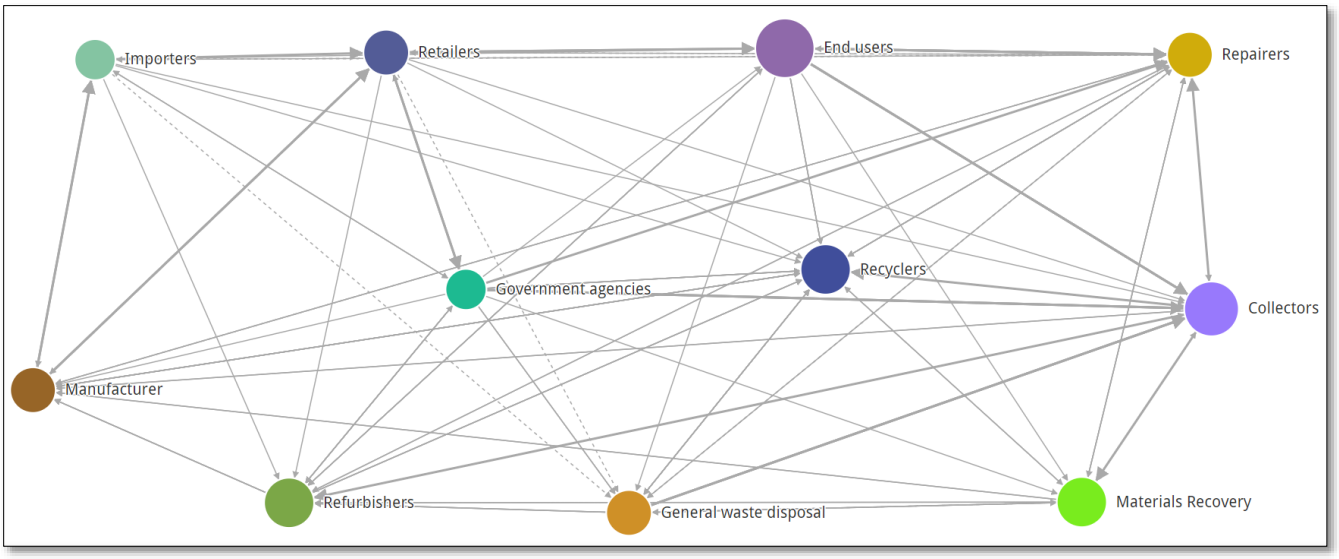


Figure 30(b): Net-Map Illustrating Stakeholders Supporting Proper Appliance EoL & e-waste Disposal Practices in Kenya.

From the net-map exercise, end users were considered as the most influential actors despite their neutrality in supporting proper appliance EoL and e-waste disposal practices in Kenya. Coming in second with an equally high influence of 9 and strongly supporting the issue at hand were the collectors. They were identified as the actors handling the greatest quantities of appliances and appliance parts/materials in a year during the stakeholder engagements. Refurbishers, recyclers and materials recovery are other stakeholder categories with high influence (8) and strong support for proper e-waste disposal. With a moderate influence of 6-7, product manufacturers, importers, retailers, repairers, general waste disposal companies and government agencies generally support proper e-waste disposal.

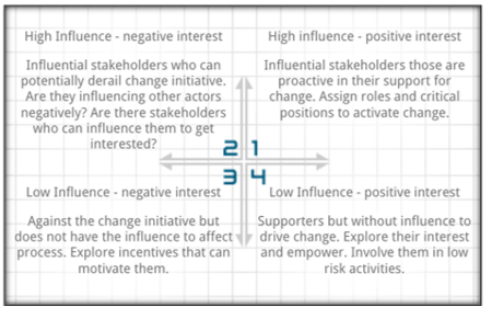
As earlier explained in the methodology section, net-map provides a visual representation of the network and insights into the dynamics of influence rather than a precisely calculated rating. This is attributed to its qualitative approach which is subjective and context-dependent solely based on the perceptions and interpretations of the actors involved. Therefore, for this study the influence rating was determined as follows:

Influence Rating	Influence Description	Justification
1-3	Low	The actors in this category: i) **Minimal Interactions:** Have limited direct interactions with other stakeholders as well as infrequent and/or insignificant connections and engagement with other actors. ii) **Limited Capacity:** Have a lower level of capacity or expertise in comparison to actors with high influence and their contributions to the decision-making process may be limited or unvalued. iii) **Minimal Leverage:** Have little leverage or ability to influence decisions or bring about significant change and their influence is often marginal or negligible.
4-7	Medium	The actors in this category have: i) **Indirect Interactions:** They may not directly interact with all stakeholders, but they have connections with some key actors with indirect influence mediated through other actors. ii) **Moderate Capacity:** They possess a certain level of relevant capacity and expertise and while their capacity may not be as significant as those with high influence, they contribute valuable insights and knowledge to the decision-making process. iii) **Partial Leverage:** Actors have the ability to influence decisions and outcomes to some extent but might face certain limitations. Their leverage is specific to certain rather than having a broad-ranging influence.
8-10	High	The actors in this category have: i) **Direct Engagement**: Actively engage and directly interact with other stakeholders avoiding passive participation. ii) **Substantial Capacity**: Demonstrate a significant expertise, resources and capabilities for decision making process making their contributions highly valued. iii) **Leverage and Impact**: Have the capacity to leverage their influence on decisions and drive change within the stakeholder network

4.2.1 Influence-Interest Matrix

The image below depicts an influence-interest matrix which further informed the analysis in a bid to better understand the significance of each actor in supporting proper appliance EoL and e-waste disposal practices.

Key:



- Horizontal axis (from left to right): **Strongly Against (-2); Against (-1); Neutral (0); Strongly Support (+2); and Support (+1)**
- Vertical axis: Top - **Greatest influence** and Bottom- **Least influence**
- Dots - **Number of actors**

matrix: influence-interest

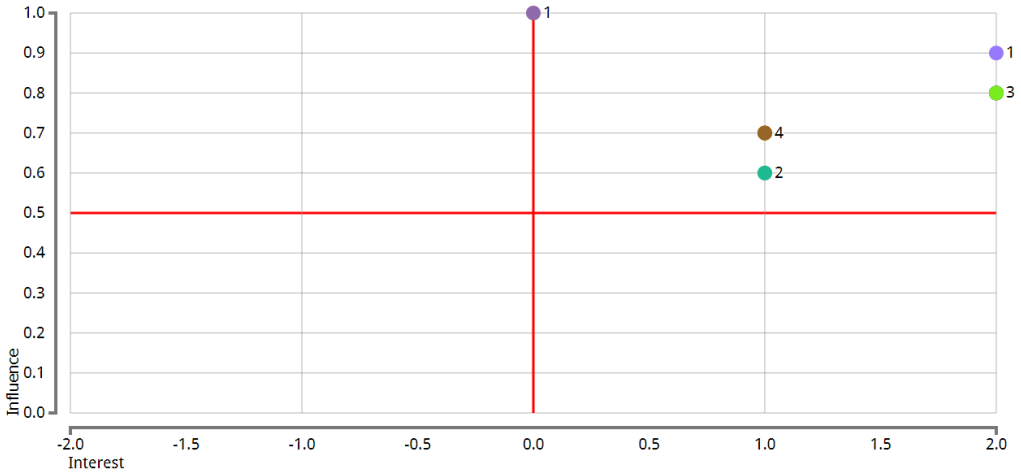


Figure 31: Influence-Interest Matrix for the support of proper e-waste disposal.

Interest Key: **SS** – *Strongly Support* **SA** – *Strongly Against* **N** – *Neutral* **A** – *Against* **SA** – *Strongly Against*

From the above matrix depicted by figure 31 and in correspondence to table 16 below, stakeholders engaged in collecting, refurbishing, recycling and materials recovery have the most interest as well as influence on the e-waste disposal practices. End users of appliances on the other hand have very high influence but neutral interest (neither support nor oppose proper e-waste disposal). This can mostly be attributed to a lack of awareness on the available options for proper e-waste disposal as identified from the household surveys conducted. Government agencies notably had the overall least influence but neutral interest on proper e-waste disposal. This is due to the fact that while there were notable levels of awareness amongst stakeholders interviewed as to the role of government in the subject matter, it was largely observed that government involvement was very low across all levels the stakeholders interviewed represented, more so at household/consumer level. This can however be reversed should the relevant government agencies make clear and deliberate efforts to better participate in the e-waste ecosystem.

TABLE 16: KEY FOR INFLUENCE-INTEREST MATRIX FOR SUPPORT OF PROPER APPLIANCE EOL & WASTE DISPOSAL PRACTICES IN KENYA

Legend	Stakeholders	Influence (y-axis)	Interest (x-axis)
High Influence (8 to 10) – Positive (SS/S) or Neutral Interest (N)			
● 1	End Users	10	0 (N)

1	Collectors	9	2 (SS)
3	Refurbishers Recyclers Material Recovery	8	2 (SS)
Moderate Influence (7 to 5) – Positive (SS/S) or Neutral Interest (N)			
4	Retailers Repairers General Waste Disposal Manufacturer	7	1 (S)
2	Government Agencies Importers	6	1 (S)

4.2.2 Influence-Connections Matrix

Repairers have by far the most connections (33) and moderate influence (7) in supporting proper e-waste disposal in Kenya. From the study findings, they with other actors in the sector by sourcing parts and repairing a significant number of appliances (40,279 in the year 2022) hence restoring faulty appliances to working condition. Repairers are therefore deemed key drivers in the improvement of the industry given their ability to contribute to reduction of e-waste by extending the lifespan of appliances through their repair services. Recyclers (32,8), collectors (29,9), government agencies (28,6) and refurbishers (26,8) are other stakeholders with high connections and moderate to high influence. They contribute to e-waste management through different activities. Recyclers dismantle appliances for parts that can be used for repair or manufacture, while collectors gather discarded appliances for various purposes. Refurbishers restore appliances using parts sourced from repair shops, households, and garbage bins. Government agencies formulate and enforce policies and regulations for the sector.

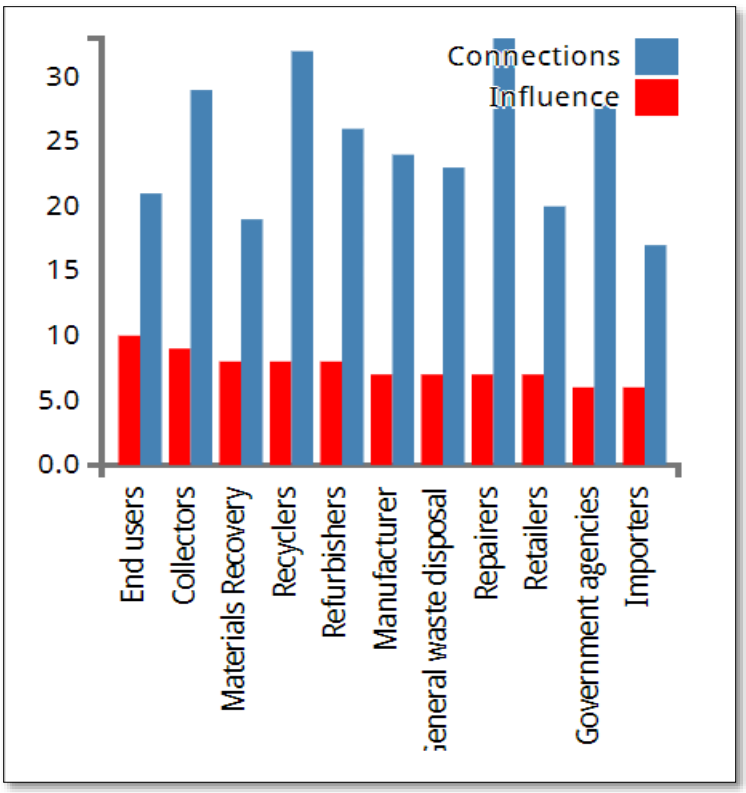


Figure 32: Influence-Connections Graph for the Support of Proper e-waste Disposal in Kenya.

Despite having the least connections (19), Materials recovery stakeholders are significantly influential (8) given their specialization in salvaging and recovery of valuable materials from discarded appliance, hence reducing e-waste.

4.2.3 Linkages/Connections

4.2.3.1 Appliances

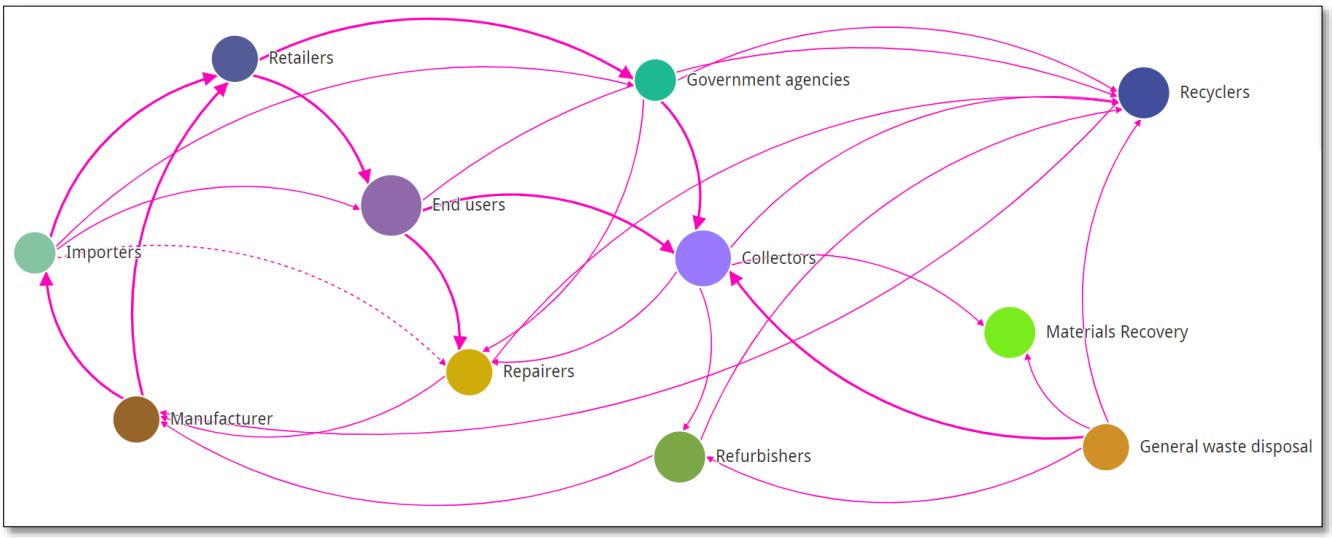


Figure 33: Net-Map showing Appliances Linkage for the Support of Proper e-waste Disposal in Kenya

From the situational analysis conducted, there exists various stakeholders who provide appliances to other stakeholders in the ecosystem. Typically, appliances move from manufacturers to importers to retailers to end users to repairers and collectors, hence the strong links between these stakeholders. From here they could move on to recyclers, materials recovery, general waste disposal companies, refurbishers, and back to manufacturers. These stakeholders have normal/default links between them. There appears to be weak linkage between importers and local repairs which could be as function of distance in terms of operations among other reasons. There is an opportunity to explore this further and possibly find ways to strengthen this link. This could lead to the development of a more robust formal repair sector - in addition to the existing informal repair sector – consequently resulting in more informed policy decisions, availability of spare parts and tools, and increased access to reliable repair services by appliance consumers.

4.2.3.2 Repair & Servicing

Spearheading the provision of repair and servicing for EEEs are repairers hence strong linkages with end users and government agencies. On the other hand, the weak linkage between manufacturers, importers and retailers indicates that they are not actively involved in the provision of repair and servicing for appliances. This can be seen from the survey findings where households rely on local shop for repair services.

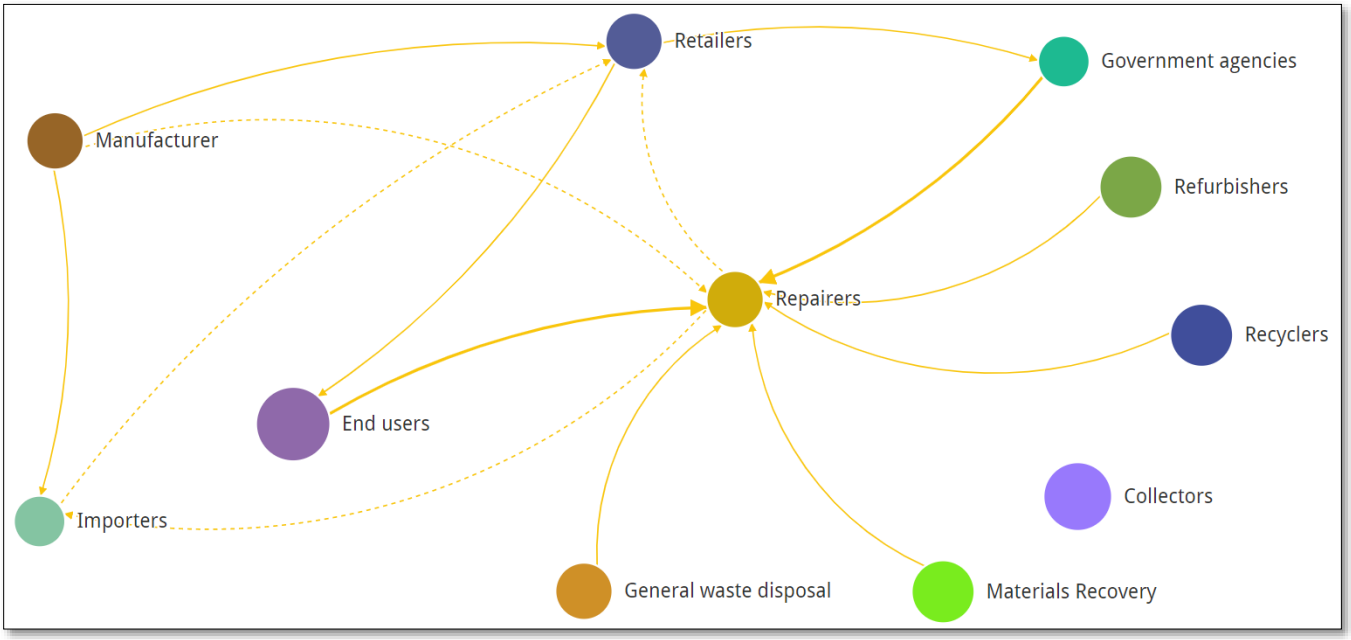


Figure 34: Net-Map showing Repair & Servicing Linkage for the Support of Proper e-waste Disposal I Kenya.

4.2.3.3. Materials handling

As depicted in the below net-map, EEEs and related materials/wastes typically move between the various stakeholders in the ecosystem with retailers, collectors, repairers, recyclers, refurbishers and materials recovery handling the largest quantities hence the strong linkages between them. Most material goes through multiple stakeholders along the value chain before finally being disposed of or recycled and returned to manufacturers for re-processing. The weak linkage existing between general waste disposal companies and repairers' points to the fact that e-waste at general waste-disposal sites is predominantly handed over to collectors.

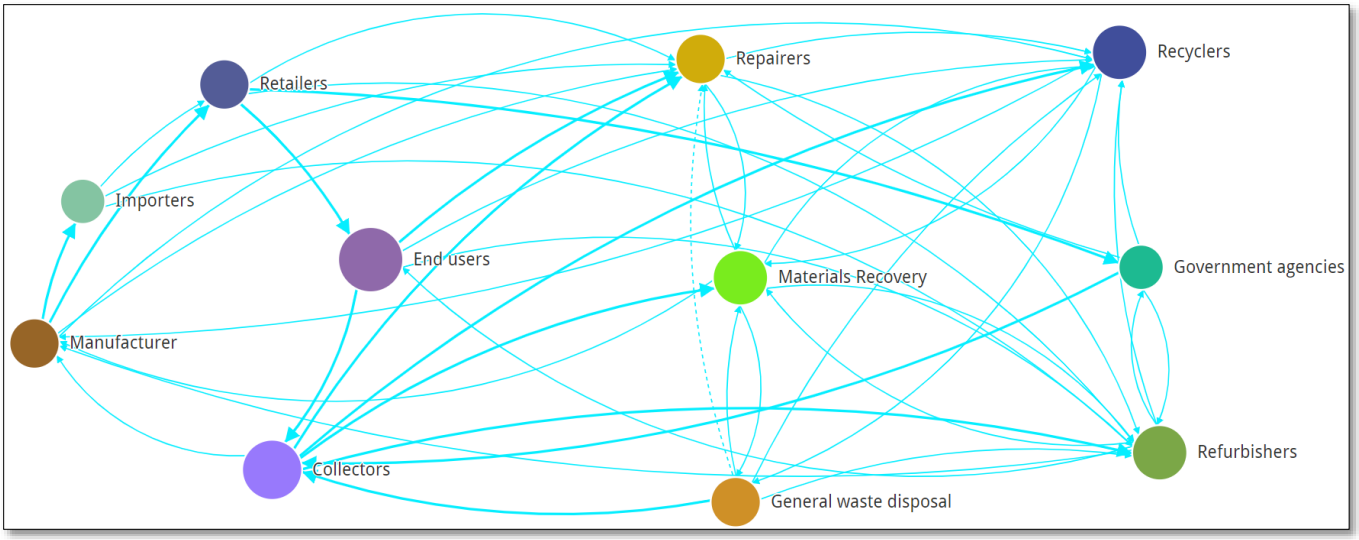


Figure 35: Net-Map showing the Materials Handling Linkage for the Support of Proper e-waste Disposal in Kenya.

4.2.3.4 E-waste disposal

Stakeholder survey findings indicated that collectors, repairers, recyclers and general waste disposal companies handle the bulk of e-waste disposals in Kenya as shown by the strong linkages in the below net-map. However, there exist weak linkages between general waste disposal actors with the majority of other stakeholders (retailers, importers, materials recovery, repairers, recyclers and refurbishers) within the ecosystem. This is attributed to uncontrolled dumping, insufficient waste management infrastructure and services, low waste collection as well as unregulated and uncoordinated private sector. Educating and mobilizing consumers, increasing the number of collection points, and improving the waste transportation system would likely increase the e-waste collection rate. Boosting collaboration between stakeholders could also promote environmentally friendly e-waste collection and disposal.

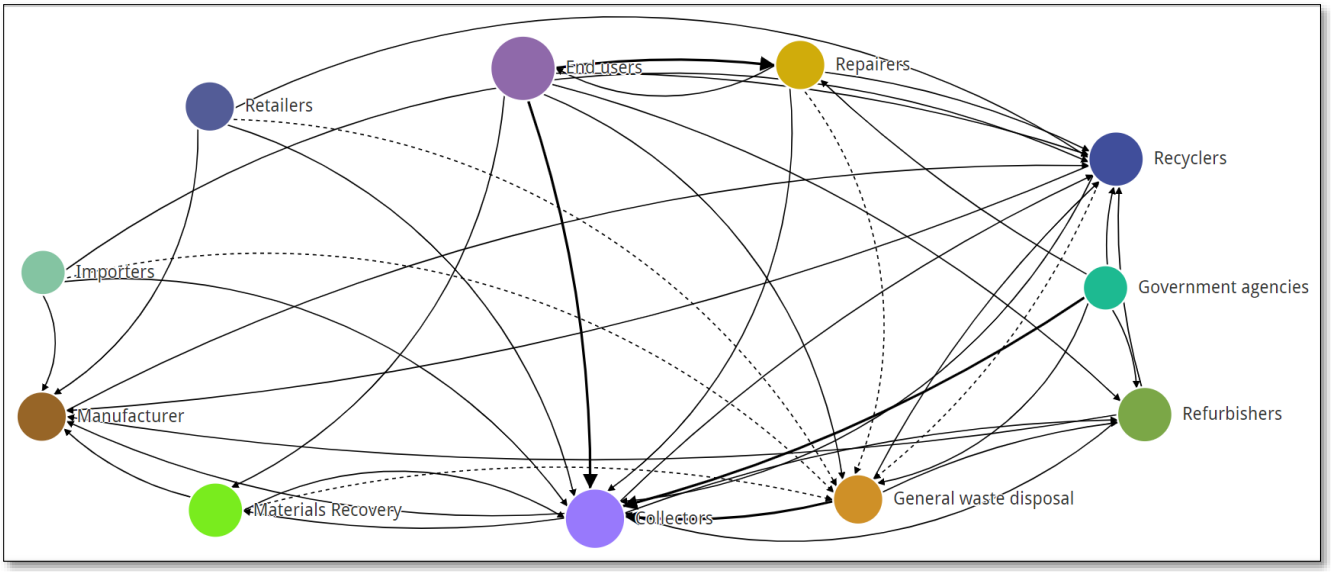


Figure 36: Net-Map showcasing e-waste Disposal Linkage for the Support of Proper e-waste Disposal in Kenya.

4.2.3.5 Standards & regulation

Figure 37 below depicts the linkage of standards and regulations between the government and other stakeholders in the appliance sector. The primary role of government agencies is to ensure awareness of the available regulations through policy guidance, provide sector oversight as well as implementation of the same through ensuring compliance by all stakeholders involved. However, it is important to note that the existing situation is marked by inadequate public services, insufficient waste collection, and a lack of essential infrastructure for waste management in the country. Further, only 30% of the respondents were aware of the government regulations on e-waste handling and disposal. This clearly depicts the moderate connections (19) the government agencies have despite having a high influence (8).

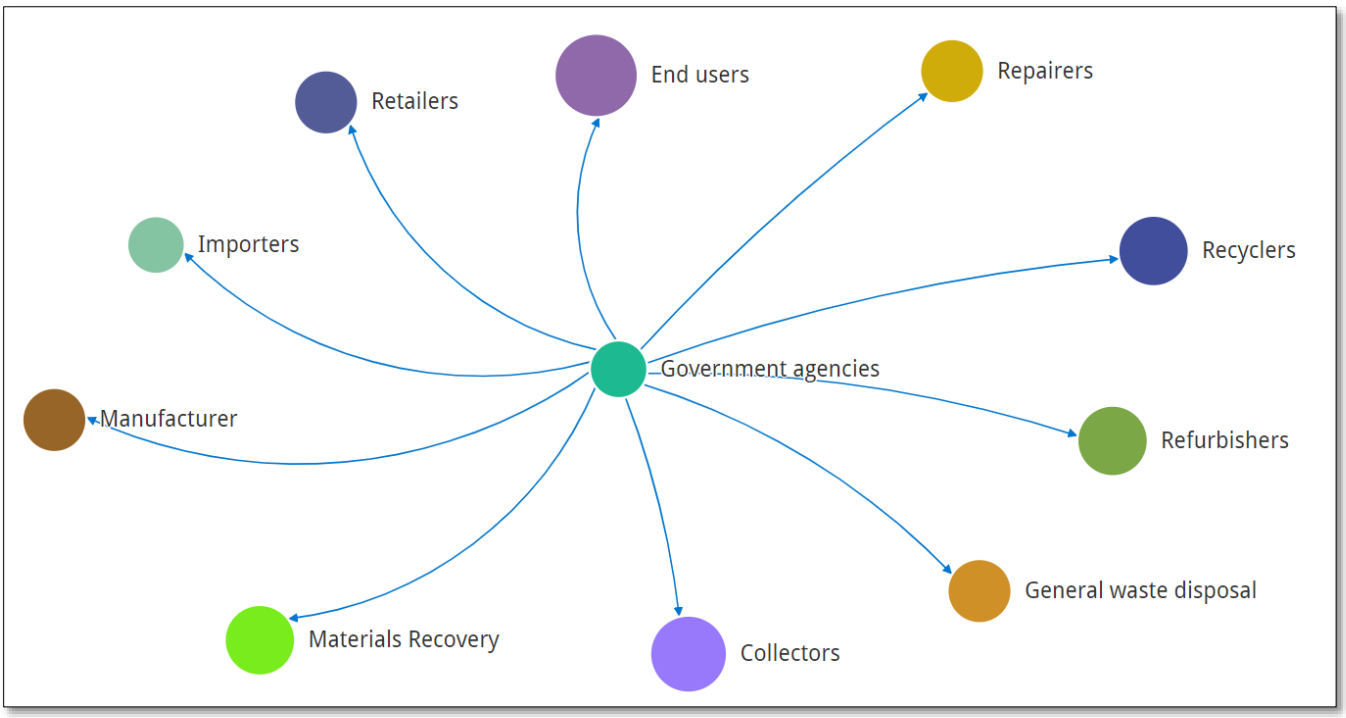


Figure 37: Net-Map showing the standards and regulation linkage for the support of proper e-waste disposal.

4.3 Materials Flow Analysis

A materials flow analysis was generated using data obtained from the stakeholder interviews. As mentioned in the stakeholder interviews findings section, the majority were unwilling to provide quantitative data, or just did not have this data available. This made it challenging to attain reliable estimates of appliances, materials, and waste flows. Figures depicted here are thus summed up across only the stakeholders interviewed as it was not possible to estimate quantities for the whole country based on these. All data presented here represents e-waste streams. The table below depicts annual summaries for cumulative quantitative data for each stakeholder category.

Stakeholder	Appliances sold/collected/repaired/encountered (units)	Materials collected (units)	Materials used in processing (kgs)	Unsold/irreparable appliances (units)	Appliance/materials waste (kgs)
Importers	15				
Retailers	50,758			1,518	
Collectors	342,194	1,075,792			10,430
Repairers	40,279		1,800	1,645	885
Refurbishers	30		50		10
Recyclers	41,095		7,000		25,500
Materials recovery	25,604				
Waste Disposal	22,034				
TOTALS	**522,009**	**1,075,792**	**8,850**	**3,163**	**36,825**

Table 17: Annual quantities handled by stakeholders (Kenya stakeholder interviews)

This is summarized in figure 38 below. 'Processing' captures all e-waste handling activities including repair, recycling, refurbishment and materials recovery.

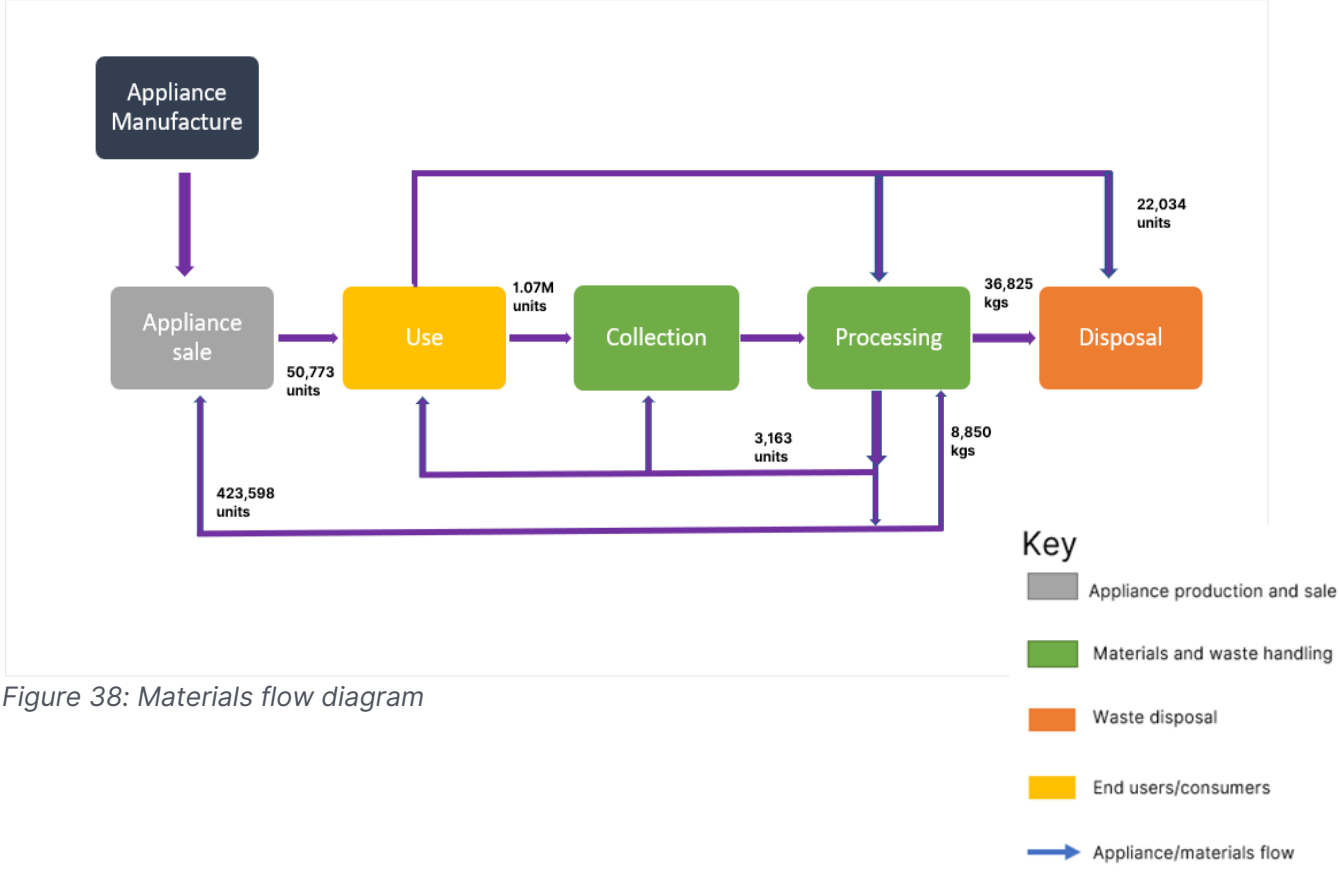


Figure 38: Materials flow diagram

5 Conclusion and Recommendations

The demand for domestic electrical appliances in Kenya is fast increasing on account of a significant rise in per capita disposable income, coupled with rapid urbanization and a growing middle-class population. The rapid growth of the ICT sector has led to an influx in telecommunication devices including mobile phones, TVs, radios, and computers & laptops. These factors in turn have led to a proliferation of e-waste in the country as these appliances inevitably fail or get to their end-of-life. While most households in the country predominantly cook using LPG/cooking gas, charcoal and firewood, the opportunity for e-cooking is immense with 75% of the population having access to some form of electricity. The research findings indicate; improving affordability of e-cooking devices and overcoming the perception that they significantly increase the electricity bills for households, could likely drive their uptake among customers. To facilitate transition towards sustainable e-waste management as also adoption of clean cooking appliances is encouraged; the conclusions and accompanying recommendations below are suggested:

- Waste management in the country is largely characterized by uncontrolled dumping of waste, ineffective public services, unregulated & uncoordinated private sector, low waste collection, and lack of key waste management infrastructure. Collection and disposal of e-waste is predominantly done by private and informal sector organisations, with local repair shops and appliance parts collectors being the most active and closest linked to the households using these appliances. Local repair shops are the go-to option whenever a domestic appliance fails due to their low cost of services, reputation, and proximity to households. While being the primary remedy for households upon appliance failure, these repairers often must cope with a lack of tools & technologies for repair, lack of training on how to fix certain appliances, and inadequate supply of spare parts for repair.

  Recommendation(s): The research findings point to potential of a mutually beneficial relationship to develop particularly among the actors mentioned above particularly along the formal and informal divide. It is encouraged for government especially to devise creative ways and instruments they can use to make it affordable and accessible for informal stakeholders to transition to formal where they can be better supported in terms of programs on training and capacity building. As channels to formalize the informal sectors are being considered and developed, in tandem, government should identify interim measures they can adopt presently to support informal actors to scale and grow recognizing their significant contribution towards collection and management of e-waste and waste lin general.

- Current demand for e-waste recycling services is insufficient to drive economies of scale due to low volumes of e-waste being collected, with the 3 largest formal recyclers – Enviroserve, Hinckley and WEEE Center - currently only utilizing about 30% of their annual capacity. While there exists a major gap in the awareness on proper and designated e-waste disposal channels and options in the country, there also is widespread willingness to dispose of e-waste properly and sustainably.

  Recommendation(s): Increasing transition to sustainable e-waste disposal habits needs to go hand in hand with setting up the necessary physical and regulatory infrastructure to improve accessibility to consumers and other stakeholders. For example, increasing the number of collection points and improving the waste transportation system would likely increase the e-waste collection rate. Innovative programs that incentivize stakeholder

action towards contributing to the development of above infrastructure spearheaded by the government together with its partners would go a long way towards achieving this goal.

- Adoption of regulations and standards on appliance quality and energy efficiency has played a role in ensuring the import and manufacture of high-quality products into the country. However, inadequate enforcement of these policies has resulted in an influx of cheap but poor-quality products in the country with short lifespans, further increasing the quantity of e-wastes generated. Additionally, most of the stakeholders surveyed had little awareness of the relevant policies and regulations in the sector, and the subsequent impact of these policies to their businesses.

  Recommendation(s): Developing stronger linkage and connection between government, appliance importers and distributors both large- and small-scale and consumers can help mitigate against some the deficiencies in the current enforcement of compliance framework. This in turn can lead to stronger policy enforcement to be coupled with regular review and revision of policies to reflect current market conditions. Collaborative awareness creation among the stated stakeholders will be helpful as an educative tool.

- Setting up effective and integrated e-waste management systems and regulations requires an understanding of the challenges and materials flowing through the ecosystem. Major challenges faced by the sector are a lack of awareness, inadequate e-waste management infrastructure, and lack of data on appliances and e-waste quantities. Data obtained from stakeholder surveys was inadequate to extrapolate reliable estimates of appliances, materials, and e-waste flows at a national level.

  Recommendation(s): There is need for cross-collaboration efforts among stakeholders in designing and delivering 360 view awareness programs that cover products regulations around quality and their disposal at the end of life. This means as regulations on standards and quality of products are developed and introduced, similar efforts should be ongoing on e-waste regulations. There needs to be accessible knowledge and information platforms that are publicly available, so customers know where different facilities for e-waste collection or processing are available and who to contact. On the other hand, government agencies need to track and avail data of appliances imported in the country, e-waste generated and other relevant information that they can avail themselves on request. This is beneficial in the following ways: i) helps ease of pressure from companies and other stakeholders from tracking certain data which in most cases we found they struggle to have the capacity needed to do; ii) partners looking to fund or design programs towards contributing to the government efforts of developing a e-waste management infrastructure etc can easily have access to this information.

Annexes

Household Survey Questionnaire

ENUMERATOR SECTION

Name of Enumerator

.....

Country

.....

County name

.....

Name of District

.....

SECTION A - RESPONDENT INFORMATION

A1. Name of Respondent

.....

A2. Gender of the respondent?

- Male
- Female

A2i. Respondent's Phone Number

.....

A3. What is the marital status of the respondent?

- Single
- Married
- Divorced/Separated
- Widowed
- Other

A4. Age of the respondent?

.....

A5. What is the relationship of the respondent to the household head? (male/female)

- Head
- Spouse/Partner
- Child/Adopted Child
- Househelp/Househelp's relative
- Other relative
- Other non-relative

A6. What is the highest level of education of the respondent?

- Primary School
- Lower Secondary
- Upper Secondary
- Tertiary, College/University/ Technical Vocational Training
- Never went to school
- Other

A7. How many people live in your household including yourself?

.....

A8. How many people in your household are living with disabilities?

.....

A9. What is the highest level of education anyone in your household has completed?

- Primary School

- Lower Secondary
- Upper Secondary
- Tertiary, College/University/ Technical Vocational Training
- Never went to school
- Other

A10. What is your occupation?
- Casual employment
- Self-employed/Entrepreneur
- Formal/Full time employment
- No occupation
- Other

A11i. What is the average monthly income of your household?
- Below KES 30,0000/ Below FRW 88,000
- KES 30,001-40,000/FRW 88,001-176,000
- KES 40,001-50,0000/FRW 176,001-264,000
- KES 40,001-50,000/FRW 264,001-352,000
- KES 50,001-60,000/FRW 352,001-440,000
- Above KES 60,000/Above FRW 528,000

SECTION B - APPLIANCE OWNERSHIP AND USAGE

B1. How is your household powered? Do you have any of the following?
- Main grid electricity
- Mini-grid electricity
- Rooftop solar power
- Solar Home System kit
- Generator/Battery
- None
- Other

B2. What is the primary energy source/fuel used by your household for cooking?
- Kerosene
- Charcoal
- Wood
- Solar
- Animal Waste/Dung
- Crop Residue/ Plant Biomass
- Saw Dust
- Biomass Briquette
- Processed biomass (pellets)/woodchips
- Gel Ethanol
- Liquid Ethanol
- Biogas
- LPG/cooking gas
- Electricity
- Garbage/plastic
- Other

B3. What other fuels are used by your household for cooking?
- Kerosene
- Charcoal
- Wood

- Solar
- Animal Waste/Dung
- Crop Residue/ Plant Biomass
- Saw Dust
- Biomass Briquette
- Processed biomass (pellets)/woodchips
- Gel Ethanol
- Liquid Ethanol
- Biogas
- LPG/cooking gas
- Electricity
- Garbage/plastic
- Other

B4. Who is the main buyer/purchaser of electrical appliances for your household?

- Male head of household
- Female head of household
- Other male household member
- Other female household member
- Both male and female household heads
- Other

B5. Please select ALL Appliances owned by the household

- TV
- Radio
- Fridge
- Mobile phone/charger
- Lights
- Microwave
- Kettle
- Rice-cooker
- Electric oven
- Electric hot-plate cooker
- Electric pressure cooker
- Toaster
- Washer/Dryer
- Computer/laptop
- Air conditioner
- Electric fan
- Clothes iron
- Vacuum cleaner
- Dish washer
- Printer
- Air-fryer
- Coffee machine
- Hair dryer
- Toaster/sandwich maker

B6 How many ${appliance_name}'s does the respondent own?

Appliance	Number owned
TV	
Radio	

Fridge	
Mobile phone/charger	
Lights	
Microwave	
Kettle	
Rice-cooker	
Electric oven	
Electric hot-plate cooker	
Electric pressure cooker	
Toaster	
Washer/Dryer	
Computer/laptop	
Air conditioner	
Electric fan	
Clothes iron	
Vacuum cleaner	
Dish washer	
Printer	
Air-fryer	
Coffee machine	
Hair dryer	
Toaster/sandwich maker	

B7i.Who is the primary user of the TV in your household?

- Male head of household
- Female head of household
- Child/Adopted Child
- Other relative
- Other non-relative
- Househelp/Household's relative

B7ii. How long have you owned the TV? (In MONTHS)

.....

B8. Which member of the household is the primary user of the electrical cooking appliances?

- Male head of household
- Female head of household
- Child/Adopted Child
- Other relative
- Other non-relative
- Househelp/Household's relative

B9. Would your household be interested in purchasing any of these electrical appliances for cooking?

- Microwave
- Kettle
- Electric oven
- Electric hot-plate cooker
- Electric Pressure Cooker
- Toaster/sandwich maker
- Rice cooker
- Air fryer
- No interest
- Other

B10. If no interest; Which of the following reasons is currently preventing the household from using electric appliances for cooking?

- Cost
- Availability in local stores
- Access to electricity
- Appliance electricity consumption
- Preference for current cooking appliance
- Other

B11. In order of priority, which of the following factors is most important to your household when purchasing an electric appliance?1-most important 7-least important.

- Brand
- Quality/Longevity/Durability
- Cost
- Size
- Color/Style/Design
- Presence of Warranty

B12. Where did you get information about these appliances before purchasing them?

- At second-hand store
- At manufacturer/retailer store
- Social media e.g Facebook
- Manufacturer's website
- Product brochure from sales agent
- Recommendation from other users
- None of the above
- Other

B13i. Does your household have a preferred retailer for the electrical appliances you buy for your home?

- Yes
- No

B13ii. If yes, which option is preferred?

- Manufacturer/ New appliance retail stores
- Second-hand appliance stores
- Online retail stores
- Other

B14. Does your household prefer to use one-time cash payments or payment plans when purchasing electric appliances?

- Cash
- Pay-as-you go system
- Other

B15i. Has your household purchased any second hand/used appliances?

- Yes
- No

B15ii. If no; Which of these reasons is preventing your household from purchasing second hand appliances?

- Quality concerns
- Product warranty concerns
- Concerns about store legitimacy
- Concerns about energy efficiency
- Concerns about product age

- Other

B15iii. If yes; Please select the electrical appliances that were purchased second-hand.

- TV
- Radio
- Fridge
- Mobile phone/charger
- Lights
- Microwave
- Kettle
- Rice-cooker
- Electric oven
- Electric hot-plate cooker
- Electric pressure cooker
- Toaster
- Washer/Dryer
- Computer/laptop
- Air conditioner
- Electric fan
- Clothes iron
- Vacuum cleaner
- Dish washer
- Printer
- Air-fryer
- Coffee machine
- Hair dryer
- Toaster/sandwich maker

B15iv. If TV selected; Were you informed how old the used appliance was/how many years of use the appliance had at the time of purchase?

- Yes
- No

B15v. If yes, how old was the appliance at the time of purchase?

.....

B16. How would you rank the performance of the second-hand TV?

- Good as new
- Moderate
- Poor

B17. In order of priority, which of the following factors influenced your decision to purchase the appliances second-hand? 1-most important 4-least important

- Cost
- Ease of accessibility to stores/seller location
- Peer recommendations
- Brand availability

B18i. Were you made aware of product warranties for the appliances you purchased at the time of purchase?

- Yes
- No

B18ii. If yes; Did the electrical appliances purchased new or unused come with a product warranty?

- Yes
- No
- Don’t know

B18iii. If yes; Did the electrical appliances purchased second-hand or used come with a product warranty?
- Yes
- No
- Don’t know

B19. If yes for either of the above; Please select the electical appliances that came with a product warranty
- TV
- Radio
- Fridge
- Mobile phone/charger
- Lights
- Microwave
- Kettle
- Rice-cooker
- Electric oven
- Electric hot-plate cooker
- Electric pressure cooker
- Toaster
- Washer/Dryer
- Computer/laptop
- Air conditioner
- Electric fan
- Clothes iron
- Vacuum cleaner
- Dish washer
- Printer
- Air-fryer
- Coffee machine
- Hair dryer
- Toaster/sandwich maker

B20. If TV selected; Did you attempt to claim the warranty after purchase?
- Yes
- No

B21i. If yes; For how long had you owned the appliance before claiming the warranty?
……
B21ii. Was the warranty honored?
- Yes
- No

B22. If no; Which of these reasons contributed to the unsuccessful claiming of the warranty?
- Inadequate/Limited warranty
- Too confusing/difficult to understand

B23. If honored, what was covered under the warranty?
……

SECTION C - APPLIANCE FAILURE
C1i. Are all the electrical appliances in the household functioning/working properly?

- Yes
- No

C1ii. If no; Which electrical appliances are not working properly?

- TV
- Radio
- Fridge
- Mobile phone/charger
- Lights
- Microwave
- Kettle
- Rice-cooker
- Electric oven
- Electric hot-plate cooker
- Electric pressure cooker
- Toaster
- Washer/Dryer
- Computer/laptop
- Air conditioner
- Electric fan
- Clothes iron
- Vacuum cleaner
- Dish washer
- Printer
- Air-fryer
- Coffee machine
- Hair dryer
- Toaster/sandwich maker

C2i. If TV selected; How old was the TV at the time of failure from purchase time?

.....

C2ii. How many times has the TV failed/broken down since purchasing it?

.....

C3. What does your household do when an appliance fails?

- Attempt to repair at home
- Take it for repair
- Replace it
- Store it in household
- Discard it with household garbage
- Sell it for parts
- Burn it
- Other

C4. If attempt to repair at home selected; Did you use any of the following materials?

- Physical/online product repair manual
- Repair tool kits
- Appliance spare parts
- Other

C5i. If take it for repair selected; What options for repair do you use?

- Distributor/manufacturer repair
- Local repair shops

- Specialized appliance repair shop
- Other

C5ii. In order of priority, which of the following factors affects how you decide which repair shop to use?1-most important 6-least important
- Proximity to household
- Reputation of repair shop
- Cost of repair
- Repair shop authorization to carry out repairs
- Familiarity with repair shop
- Appliance type

C5iii. How much do you spend on average to repair appliances as a percentage of the original appliance purchase cost?
- Less than 20%
- 21-40%
- 41-60%
- 61-80%
- 81-100%
- More than 100%

C6. If replace it selected; Which of the following factors influenced your decision to replace the appliance?
- Appliance could not be repaired
- Cheaper to replace
- Product warranty covered
- Other

C7. Which factors inform your decision to ${decision_name}
- Cost effectiveness
- Lack of awareness on repair/disposal process
- Ease of accessibility to repair/disposal center
- Manufacturer/retail customer support
- Product warranties
- Lack of awareness on available options
- Other

C8. Which member of the household is in charge of appliance failure practices/decisions?
- Male head of household
- Female head of household
- Other male household member
- Other female household member
- Both male and female household heads
- Other

C9i. Have local leaders in your community/neighborhood influenced actions taken by your household when appliances fail?
- Yes
- No

C9ii. If yes; How have they influenced the actions taken by your household?
- Created awareness on appliance waste disposal
- Increased appliance waste disposal options in community
- Other

C10i. Are you aware of any laws that regulate electric appliance repair or disposal?

- Yes
- No

C10ii. If yes; State any of these laws that you are aware of

.....

SECTION D - E-WASTE DISPOSAL BEHAVIORS AND ATTITUDES

D1. Which member of the household is in charge of waste disposal?

- Male head of household
- Female head of household
- Other male household member
- Other female household member
- Both male and female household heads
- Other

D2. Which waste (GENERAL) disposal method does your household use?

- Local council collection and disposal
- Private waste management company collection and disposal
- Burning
- Recycling
- Other

D3i. Are you aware of any options for electrical and electronic appliance waste disposal in your community?

- Yes
- No

D3ii. If yes; Which options are you aware of?

- Manufacturer/retailer take-back
- E-waste collection and recycling center
- Selling to collectors for scrap material
- Other

D4i. Has your household disposed of faulty or non-operational televisions before?

- Yes
- No

D4ii. If no; Why has your household not disposed of faulty or non-operational televisions?

- TVs still functioning properly
- Donated to other household
- Lack of awareness on proper disposal methods
- Opted to store faulty TV
- Do not own TV
- Other

D4iii. If yes; Which method of disposal did you use?

- Disposed of with household garbage
- Took to e-waste disposal center/shop
- Returned to manufacturer/retail shop
- Burnt
- Handed over to collector/repair shop for parts
- Other

D4iv. For how many years had you used the TV prior to disposal?

.....

D5i. Excluding TVs, has your household disposed of other faulty or non-operational devices?

- Yes
- No

D5ii. If no; Why has your household not disposed of faulty or non-operational appliances?

- Appliance still functioning properly
- Donated to other household
- Lack of awareness on proper disposal methods
- Opted to store faulty TV
- Do not own TV
- Other

D6i. If yes; Which of these electrical appliances has your household disposed of?

- TV
- Radio
- Fridge
- Mobile phone/charger
- Lights
- Microwave
- Kettle
- Rice-cooker
- Electric oven
- Electric hot-plate cooker
- Electric pressure cooker
- Toaster
- Washer/Dryer
- Computer/laptop
- Air conditioner
- Electric fan
- Clothes iron
- Vacuum cleaner
- Dish washer
- Printer
- Air-fryer
- Coffee machine
- Hair dryer
- Toaster/sandwich maker

D6ii. Which method of disposal did you use?

- Disposed of with household garbage
- Took to e-waste disposal center/shop
- Returned to manufacturer/retail shop
- Burnt
- Handed over to collector/repair shop for parts
- Other

D7. Do you believe the options used by your household for electric appliance waste disposal are environmentally friendly?

- Yes
- No

D8i. If no; Which of these barriers have prevented you from using more suitable means?

- Lack of information on available options
- Lack of proper disposal options in close proximity to household

- Cost of disposal
- Data security concerns
- Other

D8ii. Would you be willing to use more environmentally friendly means of repair and disposal of your electric appliance waste?

- Yes
- No

D8iii. Which factors would motivate you to use more environmentally friendly means?

- Financial incentives
- Environmental impact
- Ease of disposal
- Increased awareness/education on waste disposal processes
- Other

Please indicate any comments from the respondent.

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