MECS
Modern Energy Cooking Services

**End-Of-Life Contextual Study Report
(Electric Cooking & Domestic Appliances)**

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Quality data, Every time.

ACKNOWLEDGMENT

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List of Acronyms

AMP	Agbogbloshie Makerspace Platform
CPI	Consumer Price Index
EEE	Electrical and Electronic Equipment
ESMAP	Energy Sector Management Assistance Programme
E-MAGIN	Electronic Waste Management in Ghana
EPA	Environmental Protection Agency
GASDA	Greater Accra Scrap Dealer Association
GLSS	Ghana Living Standards Survey
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GNCPC	Ghana National Cleaner Production Centre
LPG	Liquefied Petroleum Gas
MEAs	Multilateral Environmental Agreements
MESTI	Ministry of Environment, Science, Technology and Innovation
NEAP	National Environmental Action Plan
PWBs	Printed Wiring Boards
SDG	Sustainable Development Goal
SECO	**Swiss State Secretariat of Economic Affairs**
SRI	Sustainable Recycling Industries Project
WEEE	Waste from Electrical and Electronic Equipment

1. INTRODUCTION

1.1. Background

Burning biomass is a good alternative to petroleum products and electricity, but using renewable energy has superior long-term effects on health, society, the environment, and the economy. This is because the technologies that produce energy from renewable resources do so directly from the environment. Renewable resources would not run out, which cannot be said for many types of fossil fuels. As we use fossil fuel resources, they will become increasingly difficult to obtain, likely driving up both the cost and environmental impact of extraction. Common knowledge demonstrates that access to renewable energy is growing as it becomes more affordable and creates new opportunities.

For 3 billion people living in low-income and middle-income countries (LMICs), the simple act of cooking is a major health and safety risk[1]. According to a World Health Organization report, cooking with fires contaminated with kerosene fuel, coal, firewood, and agricultural residues leads to indoor air pollution in homes, which causes a number of diseases like pneumonia, stroke, ischemic heart disease, chronic obstructive pulmonary disease, and lung cancer. These diseases cause the deaths of about 3.8 million people each year, the majority of whom are women and children. The 2030 Agenda for Sustainable Development[2] lists obtaining universal access to clean cooking as one of three aims for Sustainable Development Goal (SDG) 7, which is to "provide access to affordable, dependable, sustainable, and modern energy," in acknowledgment of these heavy burdens. Electricity is more affordable and has economic benefits for cooking. Household air pollution, which can lead to illnesses that disproportionately affect women and children, is entirely avoided thanks to the clean operation of these electric cookstoves, which do not use kerosene or biomass. According to Ed Brown, who leads the UK-backed Modern Energy Cooking Services initiative (MECS) "e-cooking is becoming more feasible around African urban centres as more people gain access to reliable electricity,"

Despite the positive outlook for using electric cooking stoves on social and environmental fronts, the main problem is the proportion of people with enough access to electricity to switch to e-cooking, as well as the growing global e-waste problem. The e-waste problem is caused by the increase in sales and short life cycles of electrical and electronic equipment such as mobile phones, televisions, electric stoves, microwave ovens, washing machines, dishwashers, and many others. In both urban and rural settings. The distribution, repair, and waste management systems are also affected by the rising availability and circulation of electrical appliances. It is estimated that 57.4 Mt (Million Metric Tonnes) of e-waste were generated globally in 2021[3]. The market for electrical cooking products is only just taking off in many countries, so the study explored the end-of-life (EoL) of televisions and other household appliances, that is, products that contain e-waste and have a relatively mature market. The study acknowledges that there may be variations in attitudes toward cooking appliances in comparison to television. The focus of this study is Ghana.

1.2. Research Objectives

This research explored the end-of-life (EoL) ecosystem of modern energy cooking devices in Ghana, drawing experience and expertise from the existing systems surrounding the EoL of televisions and other household appliances. The following research questions guided the entire research process:

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[1] EA, I. *Tracking SDG7: The Energy Progress Report* (UNSD, World Bank, WHO, 2020)

[2] United Nations. Transforming our world: the 2030 Agenda for Sustainable Development, https://sdgs.un.org/2030agenda (2021).

[3] https://weee-forum.org/ws_news/international-e-waste-day-2021/

- What is the structure of the industry (formal and informal) that extracts value from items at each stage of 'end of life' pathways?
- How effective is the industry (the end-of-life ecosystem) at maximising value (not just the economic value and effectiveness) from failed products - how much recycling is done?
- What are the barriers that constrain the effectiveness of the end-of-life ecosystem e.g., policies, enforcement, and investment?
- What barriers are faced by each of the different types of stakeholders involved in the repair and recycling industry?
- What are the actual and predicted impacts of developed markets for cooking devices as households transition from biomass cooking to electric cooking (economic, environmental, social)?
- How do consumers respond when an appliance fails? What options are available/perceived to be available? What drivers lie behind actual behaviour? What barriers exist to more sustainable behaviour?
- How do consumers prefer to have an appliance repaired?

1.3. Socio-Economic Description of the Target Study Area

1.3.1. Location and Physical Setting of Ghana

The Republic of Ghana is a country in West Africa. It abuts the Gulf of Guinea and the Atlantic Ocean to the south, sharing borders with Ivory Coast in the west, Burkina Faso in the north, and Togo in the east.
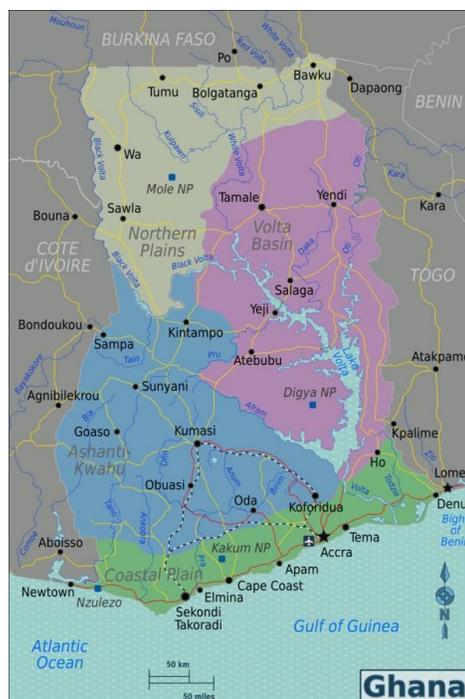
Figure 1: Study area map and sampled Regions (source: Wikipedia)

Ghana covers an area of 238,535 Km² (92,099 sq mi), spanning diverse biomes that range from

coastal savannas to tropical rainforests. With nearly 31 million inhabitants (according to the 2021 census), Ghana is the second-most populous country in West Africa, after Nigeria[4]. The capital and largest city is Accra; other major cities are Kumasi, Tamale, and Sekondi-Takoradi.

The Gold Coast, Ashanti, Northern Territories, and British Togoland were merged as one sovereign dominion within the British Commonwealth on March 6, 1957, at midnight, and given the name Ghana. The Ghana Independence Act of 1957 was used to accomplish this. This unity led to the creation of the current Ghanaian flag, which features the colors red, gold, green, and a black star[5]. Nkrumah proclaimed Ghana a republic and took office on July 1, 1960, following the Ghanaian presidential election and constitutional referendum. The country celebrates its Independence Day on March 6 and Republic Day on July 1. Ghana is politically divided into 10 Regions; Eastern, Western, Central, Volta, Ashanti, Brong Ahafo, Northern, Upper East, Upper West, and Greater Accra (Figure 1). The Greater Accra Region (Figure 2) comprises mainly Accra (the national capital) and Tema (the industrial city) and their suburbs.

Figure 2: Accra, the national capital, and Tema, the industrial city (Source: Google Maps)

The region of Agbogbloshie (Figure 3), which is home to a sizable electronic waste (e-waste) scrap yard and the majority of Ghana's informal e-waste recycling, was of particular interest for the study.

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[4] Ghana a country to study. Library of Congress Cataloguing-in-Publication Data. 1995. p. 63.

[5] "Ghana flag and description". worldatlas.com. Archived from the original on December 24, 2012. Retrieved 24 June 2013

Figure 3: The Agbogbloshie Scrap Yard in Accra (Source: Google Maps)

1.3.2. Development Indicators

The People

Ghana is a multi-ethnic country with a diverse population, linguistic and religious groups; while the Akan are the largest ethnic group, they constitute only a plurality. Most Ghanaians are Christians (71.3%); almost a fifth are Muslims; a tenth practice traditional faiths or report no religion. Ghana is a unitary constitutional democracy, led by a president who is both head of state and head of government. Ghana has maintained since 1993 one of the freest and most stable governments on the continent, and it performs relatively well in healthcare, economic growth, and human development so that it has a significant influence in West Africa[6] and is highly integrated into international affairs, being a member of the Non-Aligned Movement, the African Union, the Economic Community of West African States, the Group of 24, and the Commonwealth of Nations[7].

Ghana is currently growing at a rate of 2.15% per year, which has slowly decreased from 2.95% in 1985 but still remains high[8]. Ghana recorded a 13.9% unemployment rate in the 2nd quarter of 2022[9] and the unemployment rate is projected to trend around 5% in 2023 and 4.70% in 2024[10]. Average household sizes stand at 5 people, according to the Ghana Statistical Service. Taking into account the 2011 poverty level of 1.90 U.S. dollars, the international poverty rate in Ghana was predicted to be 11.3 percent by the year 2021. The same figure, which constituted a modest increase from 2019, when the poverty rate was calculated at 11.1 percent, was predicted for 2022[11].

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[6] Ateku, Abdul-Jalilu. "Ghana is 60: An African Success Story with Tough Challenges Ahead". The Conversation. Retrieved June 27, 2021

[7] "Ghana-US relations". United States Department of State, February 13, 2013. Archived from the original on April 5, 2013. Retrieved June 1, 2013.

[8] https://worldpopulationreview.com/countries/ghana-population

[9] https://www.ghanaiantimes.com.gh/ghana-records-13-9-unemployment-rate-in-2nd-qtr-of-2022-gss-report/

[10] https://tradingeconomics.com/ghana/unemployment-rate#:~:text=Unemployment Rate in Ghana is,according to our econometric models.

[11] https://www.statista.com/statistics/1222084/international-poverty-rate-in-ghana/#:~:text=The%20international%20poverty

The Environment

Ghana has a predominantly urban population of 58% and a rural population of 42%, according to World bank statistics. The largest city is Accra, the capital city, which has a projected population size of 2,660,000 in 2023, a 2.11% increase from 2022. Gross Domestic Product (GDP) per Unit of Energy Use: PPP per Kg of Oil Equivalent data was reported at 12.163 Intl. $/kg in December 2014. While the Energy Use: Kg of Oil Equivalent per Capita data was reported at 335.051 kg in 2014[12] Ghana's electricity access for 2020 was 85.87%, a 2.37% increase from 2019[13]

The Economy

The Gross Domestic Product (GDP) in Ghana was worth 77.59 billion US dollars in 2021, according to official data from the World Bank. Ghana has a relatively large labour force, reported at 14,094,672 in 2021, with 29.75% of the employees active in the agricultural sector, 21.05% in industry, and 49.21% in the service sector. The Consumer Price Index (CPI) in Ghana averaged 51.28 points from 1997 until 2022, reaching an all-time high of 172.99 points in July of 2022 and a record low of 4.47 points in October of 1997[14].

2. STUDY METHODOLOGY

2.1. Data Acquisition

In order to collect the study's data, a mixed (hybrid) technique was used. In addition to desk research, both quantitative and qualitative methodologies were utilized. The components included a literature study, key stakeholder meetings and workshops, questionnaire surveys, and on-site visits to the locations of importers, repairers, and other downstream processors. There is also a supply chain from the collectors of e-waste to the recyclers. Collectors are people or organizations that transport waste of electric and electronic equipment from consumers to recyclers or to a disposal site, and they include the following: Informal Collectors: mobile and sedentary (located at formal dump site) scavengers and Formal Collectors: City Waste Recycling Limited and Domestic waste collectors: ABC Waste, Zoomlion, Chagnon Limited, etc.[15] A materials-flow diagram that also showed the flow of e-waste from initial acquisition to disposal was created.

%20rate%20inwas%20measured%20at%2011.1%20percent.

[12] https://www.ceicdata.com/en/ghana/energy-production-and-consumption/gh-gdp-per-unit-of-energy-use-ppp-per-kg-of-oil-equivalent

[13] https://www.macrotrends.net/countries/GHA/ghana/electricity-access-statistics

[14] https://tradingeconomics.com/ghana/labor-force-total-wb-data.html

[15] Ghana e-Waste Country Assessment‑SBC E-waste Africa project, March 2011

Table 1: Stakeholders Roles and Ownership

Stakeholders	Roles	Ownership
Manufacturers/Assemblers	Produces components by assembling parts and subassemblies.	Partnership
Brand-new Retailers	A person or business that sells brand new electronics to the public in relatively small quantities for use.	SME/MSME
Second-hand Retailer[16]	A person or business that sells used or sometimes brand-new electronics to the public in relatively small quantities for use.	SME/SMME
Repairers	A skilled worker who mends or repairs electrical appliances.	Sole Proprietorship
Formal Collectors ● Recyclers ● Waste Disposals	A person or organization that collects and sorts e-waste in order to produce useful materials.	SME/MSME
Informal Collectors ● Scrap Dealers ● Scavengers	A person whose primary business is to buy, and deliver scrap items to salvage yards or recycling depots.	Sole Proprietorship
Academia	A teacher or scholar on e-waste management	
Consumers	Individuals who buy and use electronic appliances.	

2.1.1. Statistical Data

Information from government websites and other sources, such as United Nations reports on e-waste and data from the Global E-waste Monitor 2020, were used. Relevant documents, including the Ghana e-Waste Country Assessment, socio-economic assessment of feasibility study on sustainable e-waste management in Ghana, were reviewed, which provided tangible insights towards understanding the investment environment, policy, and legislative framework, as well as international obligations or agreements on e-waste management and disposal in Ghana. Along with standards for recycling and/or waste disposal. Industries such as Appcyclers, Electro Recycling Ghana Limited, Envirowise Waste Systems Waste Recycling Ghana Limited, and Neweco E-waste Recycling have invested in reprocessing and recycling e-waste into marketable products. We also identified several standards related to various electrical appliances in terms of quality, materials, and performance (efficiency). Additionally, we mapped out the stakeholders in this industry, including the organizations responsible for developing standards as well as the

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[16] Second-hand retailer in this context is a seller of used electrical appliances

regulators, enforcement agencies, and testing facilities. The statistical data from Index Box's appliance market analysis and forecast were also used to evaluate the current market conditions of electrical appliances and their usage by households in Ghana.

2.1.2. Meetings and Workshops

We held a stakeholder mapping workshop in Ghana with 20 stakeholders to gather information to augment our findings from the review of literature and desk research. All of this served as a framework for conducting more in-depth, targeted stakeholder interviews.

Table 2: Stakeholders` participation in the workshop

Stakeholders	Number of Participants
Retailers	7
Repairers	6
Recyclers	1
Collectors	2
Scrap Dealers	3
Academia	1

2.1.3. Surveys

The surveys focused on examining consumer attitudes, behaviours, and perceived restrictions on electrical appliances. 337 household surveys were conducted in numerous urban and rural cities across the northern (Kumbungu, Nanumba, Sagnerigu, and Tamale) and southern (Boti, Greater Accra, and Shai Osudoku) regions of Ghana. In order to ascertain how the dynamics of these regions would affect the attitudes, behaviours, and perceived limits of the customers, these areas were both rural and urban locales with a variety of cultural nuances.

Table 3: Strata-based Distribution of Study Households

Region	Frequency	Percentage
Urban	100	61%
Semi-Urban	30	9%
Rural	207	30%
Total	337	100%

Table 4: Distribution of Households by City

Region	Urban[17]	Semi-Urban[18]	Rural
Southern Region	Greater Accra		Boti
			Shai Osudoku
Northern Region	Tamale Municipality	Kumbungu district	Nanumba
		Sagnerigu	Kumbungu

2.1.4. Key In-Depth Informants' Interviews

The key informant interviews were conducted among stakeholders in the electrical appliance ecosystem, which included retailers of brand-new appliances, second-hand retailers, scrap dealers, collectors, repair shops, breakers and parts wholesalers, industrial processors (recyclers), materials recovery, and waste disposal. This approach helped in understanding the operation of all stakeholders involved in the ecosystem, as well as gathering the information needed to generate a material flow analysis.

Table 5: Total Number of Key Informant Interviews Conducted

Stakeholders	Number of Interviews
Retailers	2
Second-hand Retailers	2
Repairers	4
Manufacturers/Assemblers	1
Recycler	2
Scavengers (waste disposal)	2
Scrap Dealers	4
Consumers	2
Academia	1

2.1.5. Case studies

We conducted five (5) vignettes/vox pops to collect descriptive stories from willing

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[17] The classification of a locality as urban or rural is based on population size. Urban areas in Ghana are defined as settlements with a threshold population of 5000 or more, while rural areas have a threshold population of less than 5000. (Ghana Statistical Service, 2014).

[18] Semi-urban: partly urban; between urban and rural; somewhat but not wholly characteristic of urban areas (collinsdictionary.com)

participants, accompanied by a series of images and a short video, with consent for the collection and use of personal images provided by MECS

Table 6: Total number of case studies

Stakeholders	Number of Interviews
Repairers	1
Retailer	2
Scrap dealers	2

3. FINDINGS
3.1. Literature review

Current market conditions
Solid fuels remain the main energy source used in cooking by Ghanaian households. About 76% of households cook mainly with polluted fuels like firewood, charcoal. In rural areas, over 90% of households use polluting fuels for cooking, while 35% of households in urban areas use LPG for cooking, and less than 1% of Ghanaian households in rural and urban areas use electricity as their primary source of cooking[19]. Given the low cost and ongoing supply of polluting fuels like firewood and charcoal, it is evident that despite a significant increase in the use of electrical appliances, the use of electrical cooking appliances is still relatively low. This has led to the electrical cooking appliance industry continuing to be undeveloped as penetration is hampered by consumer ignorance of the economic, social, and environmental benefits of electrical cooking equipment as well as by consumer perceptions that the item is expensive. However, the continuous use of biomass, though cheap and easily affordable, is a major contributor of harm to the environment. In a 2016 report, 25% of global emissions of black carbon were as a result of the use of biomass and household cooking fuels, which were reported to cause further environmental damage that exacerbates the global climate change menace. In Ghana, Household Air Pollution (HAP) derived from polluting fuels has been linked to increased hospitalizations, disability, and early death from respiratory diseases, heart disease, stroke, lung cancer, and diabetes, as well as communicable diseases like pneumonia. In 2017, HAP was the 7th leading risk factor and recorded a total of 9780 deaths across the nation[20]. With the high usage of biomass in Ghana, it could be best believed that the usage of electrical appliances is insignificant in most households.

Ghanaian households are mostly dependent on the importation of electrical appliances for domestic usage, as the manufacturing of electrical appliances is low in the country. The leading supplier of domestic appliances to Ghana is China, which accounts for 82% of total imports. In second place was India, with a 5.7% share of total imports. India was followed by Turkey with 2.9%[21]. The market for domestic electronic and electrical appliances in Ghana can be divided into two

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[19] https://www.jstor.org/stable/pdf/resrep33100.9.pdf

[20] https://www.stateofglobalair.org/sites/default/files/2019-09/soga_fact_sheet_ghana_20190828_v04.pdf

[21] https://www.indexbox.io/store/ghana-domestic-appliances-market-analysis-forecast-size-trends-and-insights/

categories: the onsite market and the online market (e-commerce). However, there are no specifics on the percentage of electronic items manufactured in Ghana that are available for purchase. The onsite market consists of markets where electrical appliances are supplied, sold, distributed, and exchanged. The online market, which is the eCommerce market sub-segment of household appliances, covers the online sale of home appliances usually used in private households.

The increase in the importation of cheap and used electrical devices, electronics, and equipment has also contributed to the surge in the usage of these appliances in various households in Ghana. Importation grew from 34,612 tons in 2010 to 215,000 tons in 2015, but findings from the Basel Convention E-waste Africa Programme report that about 150,000 tonnes of used electrical and electronic equipment are imported into Ghana annually[22]. However, there has been a recent decline in the importation of second-hand products due to the Ghanaian government's ban on some secondhand electrical appliances[23]. Secondhand products have a shorter lifespan compared to new products, which leads to a higher generation of e-waste per year. In 2022, 2.9% of electronic and electrical appliances were purchased online, indicating that the vast majority of electrical appliances are purchased in physical retail stores. These household appliances can be further divided into major appliances (e.g., washing machines, dishwashers, and refrigerators) and small appliances (e.g., coffee machines, microwaves, ovens, electric kettles, vacuum cleaners, and irons). Other household appliances include, among others, floor steamers, garbage disposals, pasta makers, and curling irons[24]. Electrical and electronic appliances, including cooking appliances, can be purchased online from the following popular online stores: Jumia, Shopbeta, Kikuu, Electroland Ghana, Afrikart, Tonaton, Superprice, Jiji, Melcom, and Goodluck Africa[25].

Electrical appliances, including cooking and other household appliances, get to consumers through a chain of supply from the manufacturers. These manufacturing companies are mostly assemblers, compiling electrical parts to produce new electrical products. One major assembler of electrical appliances in Ghana is Crownstar Electronics Industrial Limited, under the Melcom group of companies, and Omatek Ghana Limited. There are suppliers that import new electrical appliances to sell to various retail shops or directly to consumers, such as Bridgehon BV, Alowave Electricals, Electroland Ghana Limited, David Electronics Co. Limited, Gifrik Ventures, Kimo Home Limited, and Dyeson Electronics. According to existing data, 85% of Ghanaians have access to electricity[26]. Hence, the importation and use of electrical appliances, particularly electrical cooking appliances that encourage a cleaner energy source for cooking, may also be made possible by this high degree of electricity access.

In addition to the increasing demand for cheap products by consumers, changing global trends also determine their interest in purchasing electrical and electronic appliances. According to the Kasi Insight COVID-19 tracker, demand for electronics in Ghana was heavily impacted by the pandemic. Only 10% of Ghanaians were looking to purchase new electronics in 2020, but the appetite was fluctuating month over month. In March 2020, at the beginning of the lockdowns and economic slowdown, only 4% of consumers were looking to spend on a new device[27]. During this period, the majority of consumers spent more on second-hand products or repairing the existing

[22] https://www.sciencedirect.com/science/article/pii/S0921344920304948

[23] https://www.graphic.com.gh/news/general-news/ghana-bans-importation-of-some-substandard-used-appliances-list.html

[24] https://www.statista.com/outlook/dmo/ecommerce/electronics/household-appliances/ghana

[25] https://shopbeta.com.gh/list-of-best-online-shops-in-ghana-in-2022/

[26] https://mecs.org.uk/wp-content/uploads/2021/02/The-landscape-of-energy-for-cooking-in-Ghana-A-review.pdf

[27]https://www.kasiinsight.com/post/2021/10/06/consumer-electronics-ghana-cash-strapped-consumers-in-need-of-essential-electronics

faulty ones, as well as using alternatives.

Transitioning from biomass to electric cooking requires access to both quality electric appliances and reliable and affordable electricity. Cooking with electricity saves money, and environmental degradation due to deforestation and climate warming pollutants caused by burning biomass are reduced. In a recent study in Nepal, one major impact of the use of electrical cooking devices is the time saved on cooking energy expenditure. 95% of households were discovered to have 15% of their cooking energy saved while using electric induction stoves[28]. Electric pressure cookers (EPCs) are revolutionizing the concept of e-cooking, making it affordable to cook with electricity due to high thermal insulation and cooking at pressure, compared to inefficient devices such as electric hotplates. These give a summary of the benefits of switching to e-cooking using EPCs. Switching to e-cooking means no smoke or adverse impact on the health of the cooks, and the process of cooking is faster and requires far less oversight, freeing up time. Time and money are saved by eliminating the need to collect or buy firewood, and if schools are using charcoal, they may be encouraged to switch from charcoal to gas to also save time and money.

As it is, the economies of African nations are among the fastest-growing in the world, which has increased the demand for electrical and electronic equipment, and a proportional rise in the production of local e-waste may result from this. In general, e-waste describes old, end-of-life electronic and electrical equipment (EEE) or waste generated from any equipment running on electricity or a battery, including computers, laptops, TVs, DVD players, mobile phones, MP3 players, etc., which have been disposed of by their original users. Although, there are opportunities for the market for electronic products to expand, a looming threat is an accompanying rise in e-waste, which, if unchecked, might have detrimental effects on the environment and its population.

Informal e-waste recycling

The e-waste recycling industry in developing countries is mostly unregulated due to a lack of sufficient treatment facilities and legislation. Documented formal collection and recycling in Africa was estimated to be 0.9%; therefore, the informal sector in developing countries like Ghana plays a vital role in the end-of-life management of e-waste[29][30]. Ghana generated 52,000 tons of e-waste in 2019, of which 93 – 97% was collected and recycled by the informal sector through the well-established door-to-door collection[31][32]. This shows that the e-waste sector in Ghana is largely informal. The old Fadama Scrapyard, better known as the Agbogbloshie Scrapyard, is Ghana's largest e-waste processing site. It occupies about 31.3 hectares and is located in the centre of Ghana's capital, Accra. Controlled by the Greater Accra Scrap Dealer Association (GASDA), the scrapyard is highly organised in hierarchies and structures, where e-waste is processed and

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[28] https://cleancooking.org/wp-content/uploads/2021/07/628-1.pdf

[29] Forti, V., Baldé, C.P., Kuehr, R., Bel, G., 2020. The Global E-waste Monitor 2020: Quantities, flows, and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted CYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. Google Scholar

[30] Mueller, E., Schluep, M., Widmer, R., Gottschalk, F., Böni, H., 2008. Assessment of e-waste flows: a probabilistic approach to quantify e-waste based on world ICT and development indicators. Proceeding R09 Twin World Congr. Resour. Manag. Technol. Mater. Energy Effic. Sept. 1416 2009 Davosswitzerl. 7. Google Scholar

[31] Y. Amoyaw-Osei, O.O. Agyekum, J.A. Pwamang, E. Mueller, R. Fasko, M. Schluep Ghana e-waste country assessment, SBC e-waste Africa Project Green Advocacy Ghana, EPA Ghana, Empa Switzerland (2011) Google Scholar

[32] Forti, V., Baldé, C.P., Kuehr, R., Bel, G., 2020. The Global E-waste Monitor 2020: Quantities, flows, and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted CYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. Google Scholar

recycled by more than 300 small informal enterprises or shops[33]. Numerous occupations such as collectors, dismantlers, scrap dealers, burners, refurbishers, repairers, intermediaries, blacksmiths, and toolmakers can be found on-site as valuable fractions and materials, such as iron or aluminum, generated by dismantling e-waste and scrap, are treated and extracted for downstream markets[34].

However, in July 2021, the scrapyard was demolished by the Ghanaian government as part of the decongestion exercise themed 'Let's Make Accra Work'. This vision is aimed at remaking Accra's urban landscape-utopian imagination by putting the urban poor and the spaces they inhabit in the crosshairs[35]. In 2022, the barren site is home to the GIZ's technical training facility on e-waste management as well as Pure Earth's recycling bins. Despite the demolition, most scrap dealers are found around the scrapyard environs, carrying out their usual day-to-day activities. The informal processing of the e-waste from the Agbogbloshie scrapyard generates an annual mass flow ranging between 13,090 t/a and 17,094 t/a. Based on the data for Ghana from the Global E-waste Monitor, an average of 15,092 t/a of e-waste (approximately 39% of the Ghanaian e-waste generation) is treated at the scrapyard. This e-waste and scraps are usually transported into the scrapyard by bikes, motorbikes, hand carts, or tricycles, as well as trucks originating from households and street collection[36]. The output fractions and materials extracted (e.g., aluminum, copper, printed wiring boards (PWBs), etc.) from these wastes are also transported out through the same means of transportation for further usage. Condemned electronic appliances are handled using crude techniques, including manual disassembly and open burning, as the most valuable and easily extracted parts of the appliances are removed, and converted into directly usable parts or secondary raw materials through a range of refining and conditioning procedures. The remaining parts are dumped or stockpiled in the scrapyard.

Basically, the informal sector of the e-waste industry is responsible for the majority of the extraction of valuable items from faulty electrical products, i.e., scrap dealers and scavengers. Compared to formal organizations, scrap dealers and scavengers have easier access to these items. Most of the time, these recovered spare parts or e-waste items are sold to large companies around the city without much or any knowledge of their intended uses. Findings from the in-depth interviews confirm the domination of the informal sector in the extraction of various e-waste items:

"…we realised that there are a lot of informal sector collectors in the country, they go around homes with their scales and tricycles and they are weighing electronic waste and are paying a premium…" **- Formal collector**

"….. I go around to buy scraps from house to house, churches, mosques, hospitals, marketplaces, institutions, factories, and organizations. I chose to do it because I saw my friends or people in my area doing it and they were making a profit from it, so I felt it was better to do it as well…" **- Informal collector**

Capacity Building Opportunities

There are provisions for capacity building opportunities with regard to proper e-waste disposal and management in Ghana. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

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[33] E.F. Amankwaa, K.A. Adovor Tsikudo, J. Bowman 'Away' is a place: the impact of electronic waste recycling on blood lead levels in Ghana Sci. Total Environ., 601–602 (2017), pp. 1566-1574, 10.1016/j.scitotenv.2017.05.283

[34] Y. Amoyaw-Osei, O.O. Agyekum, J.A. Pwamang, E.Mueller, R. Fasko, M. Schluep Ghana e-waste country assessment, SBC e-waste Africa Project Green Advocacy Ghana, EPA Ghana, Empa Switzerland(2011)

[35] https://www.muntaka.com/agbogbloshiedemolition/#:~:text=Despite%20supporting%20thousands%20of%20livelihoods,totally%20demolished%20the%20Agbogbloshie%20Scrapyard.

[36] https://www.sciencedirect.com/science/article/pii/S0956053X21006711

GmbH organized and led a workshop in Ghana in 2019 titled "Introduction to Sustainable E-waste Management in Ghana," which focused on an overview of the Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917). Following the workshop, the following actions were taken: intensive awareness creation and engagements on Act 917 provisions to pave the way for full operationalization. Target Groups include Scrap Dealers, Trade Associations, Importers, and training of scrap dealers in environmentally sound dismantling of electrical and electronic wastes under the Ghana National Cleaner Production Centre (GNCPC) and GIZ project[37]

There are recent initiatives aimed at providing training, skills acquisition, development, and capacity building for a range of different stakeholders in the e-waste sector in Ghana. For Scrap dealers, the Sustainable Recycling Industries Project (SRI) funded by the Swiss State Secretariat of Economic Affairs (SECO) and locally implemented by EPA and Ghana National Cleaner Production Centre held a training workshop on sustainable e-waste dismantling and business models in Sunyani to help scrap dealers find a safe and economically profitable way of retrieving components of electronic and electric waste and complying with the "no burn" policy from 19th- 21st of June 2018; the hands-on training workshop equipped scrap dealers with skills to realise the importance of proper dismantling to isolate useful component in e-waste and how they can profit from the selling of this useful component to recycling companies. Electro Recycling Ghana Limited participated in the WEEE (Waste from Electrical and Electronic Equipment) Forum in 2021, an international association that is involved in the management of waste electrical and electronic equipment in Accra, Ghana. The organization created media awareness of e-waste on national television, radio stations, newspapers, and social media and also, shared e-waste recycling solutions flyers for electronic repairers and e-waste collectors. Other organizations in this workshop that contributed were the Appcyclers and E-waste Roundtable Association[38].

Additionally, the E-MAGIN (Electronic Waste Management in Ghana) Consortium included in its skills development report in Ghana the following as parts of the training offered; the Kumasi Hive Makerspace and the Agbogbloshie Makerspace Platform (AMP) that offer relevant information on proper Waste from Electrical and Electronic equipment handling in the form of educational pamphlets. These maker spaces bring young people together and help them gain new skills through hands-on learning. The Ghana National Cleaner Production Centre workshops, as part of implementing the project Electronic Waste Management in Ghana (E-MAGIN), the Centre and its partners (University of Cape Coast, City Waste Recycling Limited, and Adelphi) organised regional Environmental Health and Safety training for Scrap Dealer and Electronic Repairs Associations[39]. Capacity-building opportunities tailored towards the informal-sector operators are both crucial for developing a proper e-waste management system and curbing indiscriminate e-waste disposal.

"They came to us sometime back and stayed for about 3 years, they organized workshops for all the scrap dealers. They wanted us to stop burning and promised to provide us with machines for extraction, they came with EPA " - Informal Collector

The Investment Landscape

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[37] Workshop on Introduction of Sustainable E-Waste Management in Ghana, WRF, Geneva, October 2019: Overview of the Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917) @https://www.wrforum.org/wp-content/uploads/2019/11/1_WS_Ghana-e-waste-management-all-ppts.pdf

[38] https://weee-forum.org/international-waste-country/gh/

[39] Skills development in the e-waste sector: a coherent approach to capacity building for e-wastemanagement@https://e-magin-ghana.com/sites/e-magin-ghana.com/files/documents/policy_brief_skills_development_final_ v1_0.pdf

In 2021, approximately 57.4 million metric tonnes of e-waste will be generated globally[40]. Tons of electronic and electrical waste are generated annually in Ghana, as 52,000 tons of e-waste were generated in 2019[41]; in the same year, over 50 million tons were generated globally[42]. This has opened up more opportunities for investment involving material extraction and dismantling by industrial facilities in Ghana. This investment includes stakeholders such as manufacturers, industrial processors, and recyclers. Valuables such as Copper, Iron, Aluminium, and printed wiring boards (PWBs) can also be extracted to restore products in such forms that they can be re-entered and re-sold in the market. The Ghanaian government, supported financially by Switzerland, launched the Sustainable Recycling Industries Project (SRI) in 2015, consisting of the first phase (2015–2018) and the second phase (2019–2023) in Accra. The total amount invested in this project is estimated to be around EUR 6.1 million ($6.9 million)[43]. This project aims to strengthen national e-waste treatment capacities in terms of infrastructure and human resources, which also include teaching informal recyclers how to extract copper from old devices without necessarily burning them and raising awareness among producers and importers of electronic equipment about the proper management of e-waste.

Additionally, there was an investment of €10 million (over 84 million Ghanaian cedis), by the Ghanaian Ministry of Environment, Science, Technology and Innovation (MESTI), with support from the German government to inaugurate and commission an e-waste recycling centre in Agbogbloshie within the period plan of 4 years (2018 to 2022). It aims to reduce the environmental impact of e-waste recycling activities in the country, ensure the transition of e-waste through proper and sound procedures and test a pricing or financing mechanism. The centre is a result of the Electronic and Hazardous Waste Control and Management Act passed in 2016 in Ghana; the initiative also aims to create at least 22,000 jobs for Ghana's youth[44]. Although, the project is still in progress, but as of the writing of this report, there was no official confirmation of the recycling centre's completion date.

Policy and Legislative Framework

The formulation of national policies and legislative frameworks in Ghana to sustainably manage e-waste and recycling at local and national levels is the primary responsibility of the Ministry of Environment Science Technology, and Innovation (MESTI). However, in 1994, The Environmental Protection Agency Act (Act 490) led to the establishment of the Environmental Protection Agency (EPA). Of all official acts, this ACT relates most to the Waste of Electrical and Electronic Equipment (WEEE) with the mandate to regulate, coordinate and manage the environment. Section 2 of the Act requires the EPA to implement the following, among others:

- Prescribe standards and guidelines relating to the pollution and the discharge of toxic wastes and control of toxic substances;
- Coordinate activities and control the generation, treatment, storage, transportation, and

[40] https://weee-forum.org/ws_news/international-e-waste-day-2021/

[41] Forti, V., Baldé, C.P., Kuehr, R., Bel, G., 2020. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) and International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. Google Scholar

[42] https://www.unep.org/news-and-stories/press-release/un-report-time-seize-opportunity-tackle-challenge-e-waste

[43] https://www.afrik21.africa/en/ghana-switzerland-invests-e6-1-million-for-sustainable-recycling-of-electronic-waste/

[44] https://www.afrik21.africa/en/ghana-electronic-waste-recycling-centre-to-be-inaugurated-in-october-2022/

disposal of industrial wastes;
- And control the volumes, types, constituents, and effects of waste discharges, emissions, deposits or other sources of pollutants and/or substances which are hazardous or potentially dangerous to the quality of life, human health, and the environment.

In addition to the establishment of the EPA, the Hazardous Chemicals Committee was established under Section 10 of the Act, which covers monitoring and information about the use of hazardous substances. In Ghana, MESTI and EPA remain the two main political partners of the e-waste program. The Hazardous and Electronic Waste Control and Management Act provides for the control, management, and disposal of hazardous waste, electrical and electronic waste, and related products. The Act notably prohibits the transportation, sale, purchase, as well as import and export, of hazardous wastes or other waste as classified in the schedule; it also provides definitions of what used equipment is. The Act also specifies the establishment of an Electrical and Electronic Waste Management Fund (EEWMF) whose objective is to finance the management of e-waste and reduce the negative impact of e-waste on human health and the environment[45]. The Act is complemented by the Legislative Instrument on Hazardous and Electronic Waste Control and Management Regulations, which set multiple objectives, among which are the regulation of the classification, control, and management of waste or the requirements for the disposal of waste. The regulation also provides a comprehensive list of electric and electronic items which will attract a levy and their prescribed levy. It also spells out the appropriate and relevant regulations guiding the classification and implementation of the Act (GoG, 2016).

The promulgation of the Hazardous and Electronic Waste Control and Management Act, Act 917 (2016) and the Legislative Instrument (L.I.) 2250 on Hazardous, electronic and other wastes (classification) control and management regulations and the Environmental Protection Agency (EPA)'s technical guidelines for Collectors, Collection centre, Transporters, Treatment Facilities, Final Disposals appear to be the most significant attempts made by this ministry towards the regulation of e-waste disposal and recycling management in Ghana. Although, before the enactment of these acts, there were the National Environmental Policies of 1995 and 2012 and the National Environmental Action Plan, which aimed to regulate general waste and environmental management in the country. However, the Hazardous and Electronic Waste Control and Management Act, Act 917, provides for the control, management, and disposal of hazardous electrical waste, and electronic waste for related purposes. Part two of this act makes provisions for the importation and exportation of used or discarded electronic devices, the payment of the electrical and electronic waste levy, requirements for wholesalers, distributors, and retailers, and the establishment of recycling facilities in the country[46].

Other e-waste Related Policies and Legislation

(a) The 1992 Constitution of the Republic of Ghana. The 1992 Constitution of Ghana provides a broad basis for the protection of the environment in general. The relevant sections are as follows:

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[45]https://faolex.fao.org/docs/pdf/gha205550.pdf

[46]http://www.epa.gov.gh/epa/sites/default/files/downloads/publications/Hazardous and Electronic Waste Control and Mgt Act 917.pdf

- Economic Development - Article 36 (9): The State shall take appropriate measures needed to protect and safeguard the national environment for posterity, and shall seek cooperation with other states and bodies to protect the wider international environment for mankind.

- Economic Development - Article 36 (10): The State shall safeguard the health, safety, and welfare of all persons in employment, and shall establish the basis for the full deployment of the creative potential of all Ghanaians.

(b) National Environmental Policy
- The National Environmental Action Plan (NEAP), which incorporates the Environmental Policy of Ghana, was published in 1991. The environmental policy aims to improve the surroundings, living conditions, and quality of life for both the present and future generations. The policy requires the State to take appropriate measures to control pollution and the importation and use of potentially toxic substances (which include electronic waste).

- The policy among others seeks to:
    - Ensure sound management of natural resources and the environment against harmful impacts and destructive practices.
    - Guide development in accordance with quality requirements to prevent, reduce, and as far as possible, eliminate pollution and nuisances;
    - Integrate environmental considerations at all levels of development; and
    - Seek common solutions to environmental problems in West Africa, Africa and the world at large.

(c) International and Multilateral Environmental Agreements Ghana has ratified several chemical and waste-related Multilateral Environmental Agreements (MEAs) and adopted several codes and international declarations, including the following:

- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal;
- The Vienna Convention on Protection of the Ozone Layer; Montreal Protocol on Control of Substances that Deplete the Ozone Layer;
- The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure of certain Hazardous Chemicals and Pesticides in International Trade;
- The Johannesburg Plan of Implementation on Environment and Development;
- The Rio Declaration on Environment and Development - Agenda 21; and
- The Strategic Approach to International Chemicals Management (SAICM).

Other related e-waste control and management laws in Ghana include;

- The Factories, Offices, and Shops Act, 1970 (Act 328) - which seeks to protect the health and safety of workers from the dangers posed by chemicals to employees in the working environment;
- The Standards Act, 1973 (NRCD 173);
- The Draft Policy and Bill on Occupational Safety and Health, 2000 - which seeks that measures are instituted to ensure the attainment of optimum health for workers in all occupations in Ghana;
- The Mercury Act, 1989; Merchant Shipping (Dangerous Goods) Rules, 1974 (LI 971);

- Customs, Excise, and Preventive Service Law, 1992 (PNDCL 330);
- Local Government Act, 1992 (Act 458);
- Export and Import Act, 1995 (Act 528); and
- Environmental Assessment Regulations, 1999 (LI 1652)

New specific regulations with relevance to e-waste management are the LI 1932 Energy Efficiency (Prohibition of manufacture, Sale or importation of Incandescent filament lamps, Used Refrigerator, Used Freezer and Used Air-Conditioner) Regulations, 2008. They prohibit the importation as well as the sale and distribution of used refrigerators, freezers, and air-conditioners. Despite these regulations, there is currently no enforcement.

Some international development partners like Germany, Switzerland, and the EU have partnered with government agencies to introduce several interventions to support the management of e-waste in Ghana, especially in the Agbogbloshie area, which is the hub of e-waste disposal. Some of these interventions include the Environmental Sound Disposal and Recycling of e-waste in Ghana, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the Sustainable Recycling Industries Program 2015–2018, Switch Africa Green, Ghana Cleaner Production Centre capacity building, awareness creation, and the establishment of training platforms. These interventions have resulted in the creation of incentive schemes to examine both positive and negative components of e-waste, which has also significantly contributed to a reduction in e-waste burning.

Gaps in e-waste policies[47]

In Africa, thirteen countries were identified as having national e-waste legislation or policies, with Ghana included. As of 2017, Western African countries, including Ghana, had the highest regional coverage of e-waste legislation but were also destinations for significant amounts of imported e-waste. This suggests that despite legislation in place, illegal importation of e-waste continues to occur due to poor adherence and weak enforcement of laws. The main barriers to effective e-waste management include:

- Insufficient legislative frameworks and government agencies' lack of capacity to enforce regulations: Regulatory advancement across is slow, enforcement is poor, and policy, legislation, or regulation does not yet stimulate the collection and proper management of e-waste due to lack of investment and political motivation. Even, where policies have been adopted by governments, extended producer responsibility (EPR) legislation is often not implemented properly.
- Infrastructure: Currently, there is limited infrastructure for e-waste collection.
- Operating standards and transparency: It is not always clear where companies entrusted with moving e-waste products and collectors transfer them.
- Illegal imports: Linked to the above, there are issues associated with the illegal import of e-waste.
- Security: Security is a concern for e-waste managers, particularly when tasked with the destruction of hard drives from institutions and organisations.
- Data gaps: Data gaps on the quantity, location, and material make-up of e-waste create a challenge for downstream recycling partners.
- Trust: Ensuring product performance in repair processes and maintaining the trust of

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[47]https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/17152/1071_EWaste_Management.pdf?sequence=1&isAllowed=y

consumers, waste partners, and industry peers in collaborations are further challenges •

- Informality: The prevalence of unstructured collection by informal workers challenges the formalisation of e-waste management.
- Costs: High cost remains one of the most significant barriers to improving e-waste management practices, including the costs involved in accessing waste, transporting it, treating it, and, when necessary, shipping it overseas. The lack of e-waste infrastructure and service providers is another, including the absence of recycling facilities that meet minimum standards and the difficulty of finding the spare parts necessary to repair or refurbish non-functioning products.

In Ghana. measures to adequately address the management of e-waste have been implemented via various policies. However, major gaps such as those listed above are interfering with the effectiveness of integrating the effect of the policies to the general public and such has promoted the non-awareness of these policies from numerous stakeholders in the end-of-life ecosystem,

3.2. Listing of Standards

Considering the millions of tons of electronic and electrical waste generated, standards are required to regulate its collection, sorting, handling, storage, transportation, treatment, and disposal. In Ghana, for instance, the Hazardous and Electronic Waste Control and Management Act was adopted in 2016. All electrical and electronic equipment (EEE) and tires coming into Ghana must pay an eco-levy, ranging from 0.15 $/product up to 15 $/product[48]. The act was truly enforced from 2018 onward, so the impact it may have is very recent. The table below shows some related EEE waste standards in place globally and compared with current realities in Ghana.

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[48] https://www.iec.ch/blog/need-global-standard-e-waste

Table 7: List of Standards for Electronic Waste

Context/Stakeholder	Existing Standards (International and Local)	Stakeholder Adherence Practices	Comments
1. Product Quality			
Manufacturers/Assemblers	ISO – International Organization for Standardization (iso.org) IEC – International Electro-technical Commission (iec.ch) – Affiliate Plus member IEEE – Institute of Electrical and Electronics Engineers (https://www.ieee.org) CODEX-CODEX Alimentarius International Food Standards (codexalimentarius.org) WTO - World Trade Organization (https://www.wto.org) ASTM - American Society for Testing and Materials (astm.org) AOAC – Association of Analytical Communities (aoac.org/) OIML– International Organization of Legal Metrology (https://www.oiml.org/en) CEN–CENELEC – European Regional Standardization (https://www.cencenelec.eu/aboutus/Pages/default.aspx) ASME- American Society of Mechanical Engineers	In comparison with current practices in Ghana, the assembler does not conform entirely to all the standards prescribed by these local and global standardization organizations. However, the respondent follows only the standards of the International Electro-technical Commission (IEC) and the Institute of Electrical and Electronics Engineers (IEEE).	The assemblers interviewed confirmed proper performance assessment and testing of the products manufactured as well as the efficiency and effectiveness, which are the essential standards prescribed by the International Electro-technical Commission (IEC) and Institute of Electrical and Electronics Engineers (IEEE) but do not adhere to other standards; *",,,,When we build things for people, there's a period for testing that we give, so unless they test it and it's 100%, we don't release the item"* He also confirmed the existence of a policy: *"the only one I know is EPA policy, for example, if you are not registered as a collection officer, you cannot collect waste because before you can collect and store waste you have to have extraction and guidelines on how to collect waste"*

	African Organisation for Standardization (http://www.arso-oran.org/ ECOWAS Standards Harmonization Mechanism (ECOSHAM) Ghana Standards Authority Ghana's Electrical Appliance Labeling and Standards (GEALS)		
2. Materials			
Dismantlers	IEC: International Electronic Commissions Consumer Electronics Association (CEA) Electronic Components, Assemblies G Materials Association (ECA) IPC - Association Connecting Electronics Industries E-Waste Management Regulations E-Waste Recycling Standards Informal Sector Engagement:	The dismantlers are not conversant with these standards but two out of four do however, follow the local policies on E-waste management while others are not compliant	The dismantlers are not aware of these standards but two interviewed confirmed to the existence of local policies *"Yes. Ghana has an act- the electronic and hazardous wastes act."* *"Yes, they are called E-Waste Management"* While one of the respondents exhibited no knowledge of the existence of policies or standards with the response; *"I don't know".*
3.Product Performance/Efficiency			
Repairers	NSAI Electro-Technical Committee (ETC) International Electrotechnical Commission (IEC) European Committee for Electrotechnical Standardization	The repairers do not adhere to the local and global standards	Most of the repairers interviewed are not aware of the existing standards. Responses such as *"I never hear anything like that... I don't know any..."* were given by the respondents when asked about the standards in place.

	(CENELEC) Right toRepair(local) ISO 26000 (local) Repair Cafés(local)		
4. Recycling	Global E-stewards Standards (https://e-stewards.org/) R2(Responsible Recycling) Standards: Sustainable Electronics Recycling International (SERI) (https://sustainableelectronics.org/r2/) WEEELABEX (Waste Electrical and Electronic Equipment Laboratory of Excellence) Harmonized standards for recycling (https://weee-forum.org/pprojects-campaigns/weee-labex/) Recycling Industry Operating Standard (RIOS): Institute of Scrap Recycling Industries Technical Guidelines on Environmentally Sound E-Waste Management for Recyclers in Ghana	The recyclers interviewed in Ghana, confirmed adherence to the Global E-stewards and R2 standards of the Sustainable Electronics Recycling International from these listed standards but do not conform with others	From the interviews conducted, the recyclers confirmed strict adherence to safety, environmental health and protection protocols, which is one of the core standards laid down by the Global E-stewards and Recycling Industry Operating Standard. Similarly, it can be inferred from the interviews that these stakeholders follow guidelines relating to how the materials collected are separated and processed in relation to the R2 standards of the Sustainable Electronics Recycling International that state;: *"electronics recyclers shall take all practical steps to separate, as appropriate, through manual dismantling and/or mechanical processing, the materials in equipment and components that are not directed to reuse or refurbishment and direct them to properly-equipped materials recovery facilities"*. This relates to one of the respondents' statements: *"There are standards available. There are both international and national standards. Some of the standards are the segregation aspects because if you know how to segregate waste appropriately then you would know the*

			value, and you would not endanger the environment which would be hazardous to humans".
5. Disposal	Ghana Environmental Protection Agency (EPA) standards and guidelines on waste management and disposal European Standards on Collection, Logistics and Treatment Requirements for WEEE	These stakeholders do not adhere to most of the local and international standards on e-waste disposal	The stakeholders interviewed only placed emphasis on following guidelines concerning the protection of the environment, health, and safety of the people as recommended by the Ghanaian government through the Environmental Protection Agency. However, they do not comply with other standards.

			One of the stakeholders confirmed that there is the Ghana Environmental Protection Agency (EPA) standards and guidelines on waste management and disposal but lack of enforcement of the guidelines and policies appears to be the major reason why there is low adherence *"Our country has a policy on e-waste, this came into force in 2014, and even after it came into force, there's not much effort that has been done on that. The Electronic Waste Policy… To me, that policy doesn't even exist, I've not seen any effect on it."*

Although there are numerous national and international laws governing the management and disposal of electronic waste, many stakeholders in Ghana typically do not follow all of these criteria. It is important to note that, with few exceptions, those who follow these standards as determined by the KIIs conducted do so without explicitly stating that they are aware of such standards, but they nonetheless unintentionally adhere to some of the standards in their daily activities.

3.3. Stakeholders Assessment

3.3.1. The End of Life of Appliances' Ecosystem

In Ghana, electrical and electronic appliances are imported through the Tema and Takoradi sea ports, which are regulated by the Ghana Standards Authority and the Ghana Customs and Revenue Authority. These appliances either come in as brand new, slightly damaged, or in good condition and then go through various stages in their life cycle (Fig. 4). These life stages get some modifications depending on the various needs.
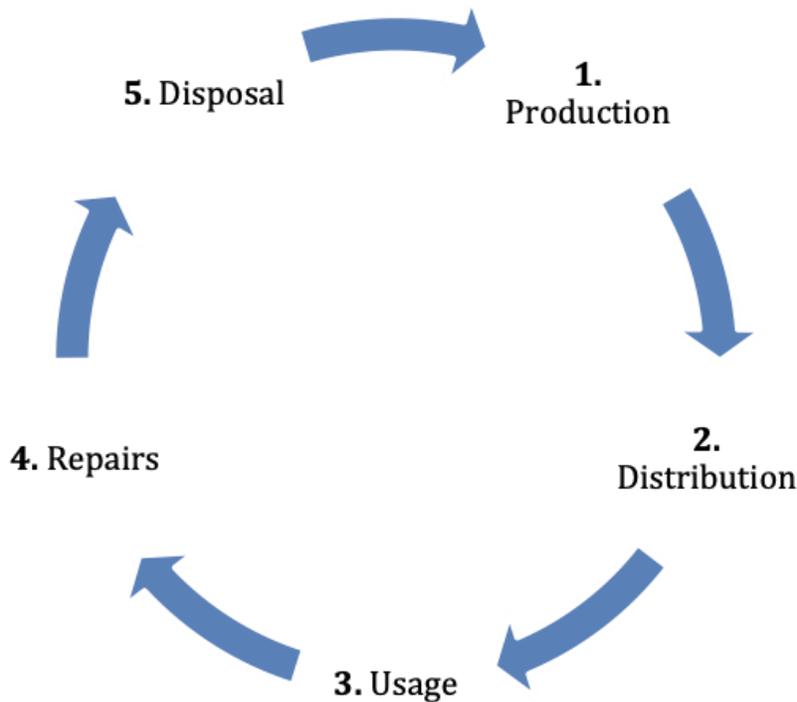
Figure 4: End of Life Ecosystem

- **Production:** this involves making or manufacturing the products from the raw or recycled material stage where they are made to meet a particular demand or solve a particular problem or need. The manufacturer aims to move it to the next stage in its functioning state. In Ghana, the country solely depends on the importation of products as there are no manufacturers of electrical products but assemblers.

- **Distribution:** this employs various channels to bring the appliances closer to the end consumer. Here, the role of wholesalers/importers, and retailers is vital, as they serve as the channel connecting the manufacturer to the consumer.

- **Usage:** once the retailer makes the product available through the open market or shops, they get closer to the consumer. Once purchased, the consumer uses electrical appliances to serve the various purposes for which it is needed either at home, school, office, etc. The use of these

appliances, though necessary, also has an impact on the health of users and the environment. They are sometimes the cause of increased power consumption, health challenges, and consequently, emissions of various kinds of chemicals into the environment.

● **Repairs:** broken items or failed electrical appliances are taken to informal or formal centres to be worked on by electrical personnel. This is done either by fixing broken parts with new parts or old parts retrieved from similar broken appliances that are not repairable.

● **Disposal (End of life):** this is where the appliance has served its purpose and is unable to function as expected. Here, they are passed through a check stage before finally disposing of them. The repairer's shop serves as the hospital of these appliances and is judged based on the repairer's assessment. They either end up with the scrap dealer, scavengers, or in the home of the consumer. When they are declared damaged, they are either disposed of by the repairer or the owner. This response from consumers leads to the decision of disposing and replacing.

3.3.2. Stakeholders Overview

The management of electronic and electrical appliances from the production phase until they have no value to the user is executed directly or indirectly by respective companies, individuals, governments, or private organizations referred to as the stakeholders. These classes of individuals are adequately integrated and involved in the management process of electrical e-waste.
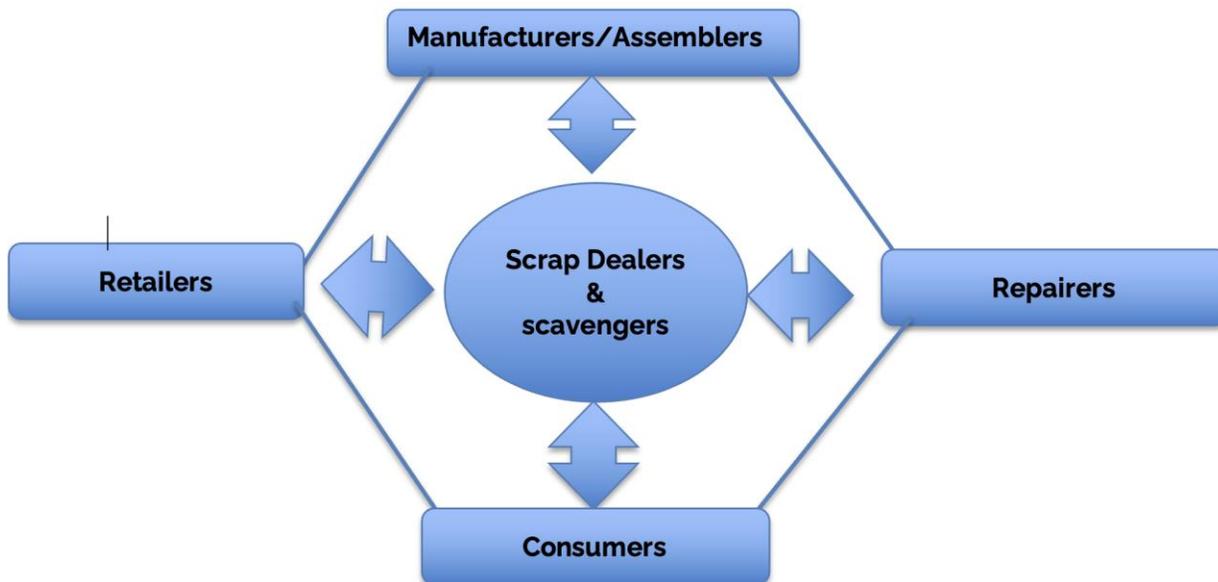
Figure 5: Stakeholders Interaction

Stakeholders Mapping

Based on the key informant interviews conducted with the various stakeholders identified in the previous section, a more detailed mapping of the other stakeholders and how they interact with each other was generated. Figure 6 displays the flow of interaction.

Stakeholder Map for End-of-Life of Electrical Appliances --- Ghana
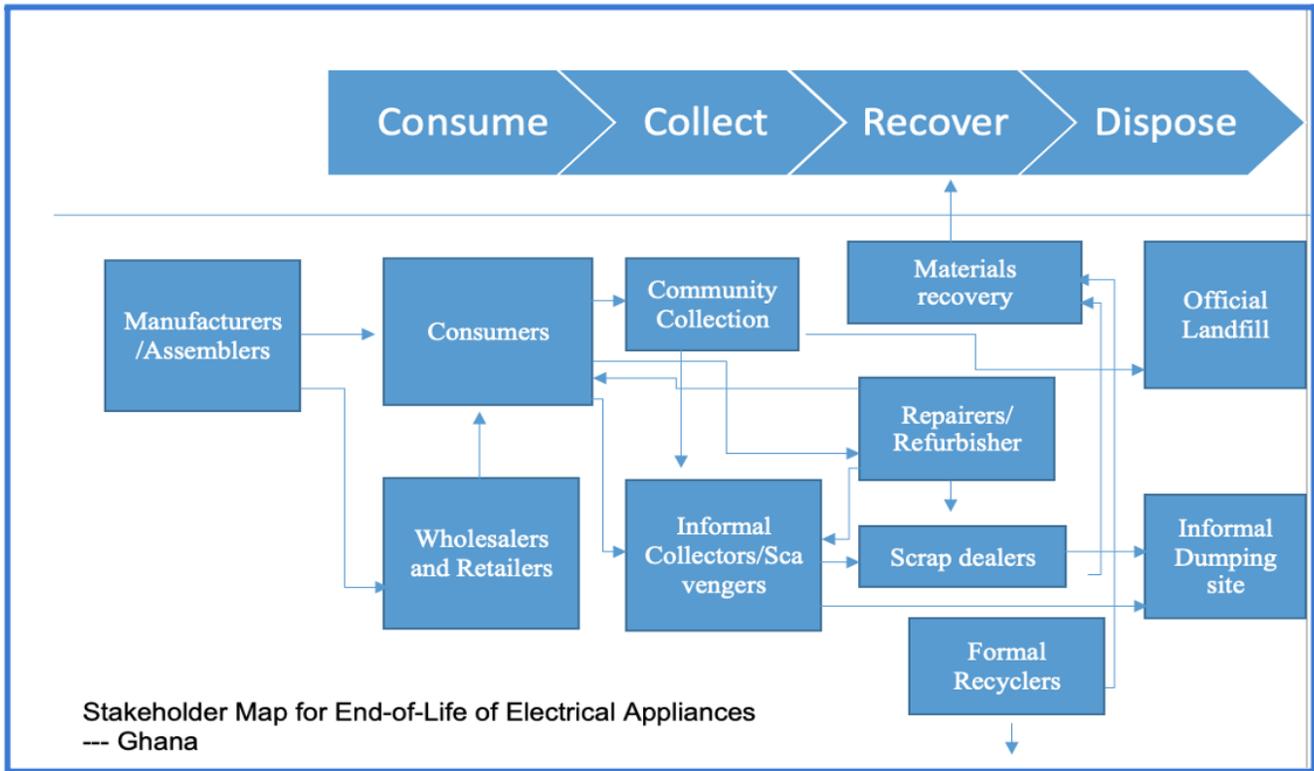
Figure 6: Stakeholder's Mapping

The interaction between stakeholders in the end-of-life ecosystem evolves into two major pathways in Ghana. The formal and informal structures that lead to these pathways are depicted in Figure 7 & 8.
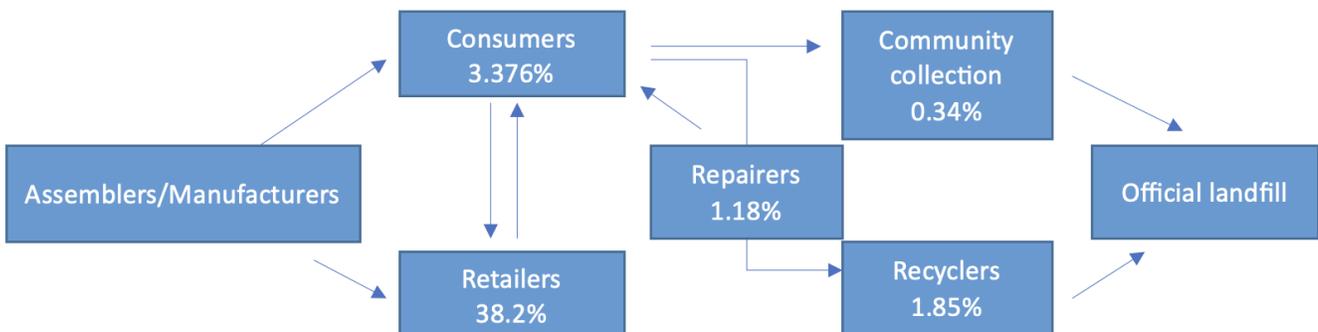
Figure 7: Formal Pathway
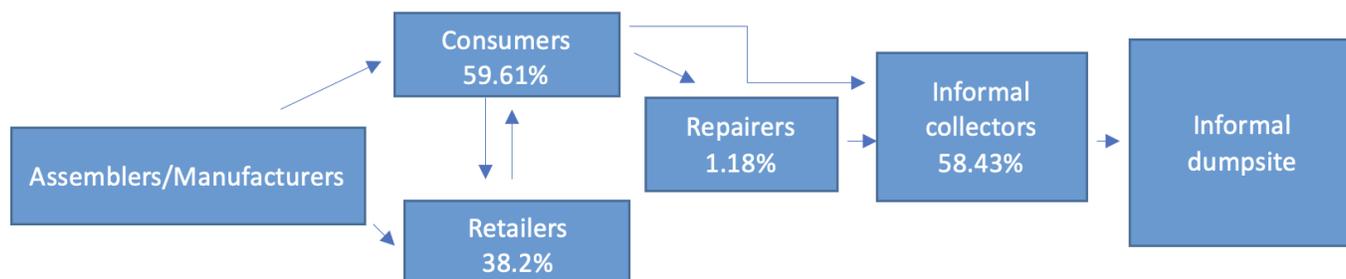
Figure 8: Informal Pathway

The aforementioned pathways unmistakably demonstrate that consumers of e-waste materials dispose of the majority of their e-waste through informal collection (58.43%) as opposed to the formal approach, which is less than 3%.

3.3.3. Stakeholders Analysis

Manufacturers/Assemblers

There is no production of electronics in Ghana, but a very limited assembly of parts. These assemblers are often referred to as 'manufacturers. Although not on a large scale, these 'local' manufacturers assemble electrical and electronic equipment components into fully functional devices by importing parts or obtaining them as scraps from e-waste. The following assemblers were identified:
- Omatek Computers Ghana Limited
- Zepto Ghana Limited
- GN Electronics Ghana
- Innovate labs and engineering consult

Omatek Computers Limited is one of the major assemblers of electrical and electronic equipment in Ghana that locally assembles parts to produce notebooks, computers, servers, casings, speakers, Plasmas, LCD screens, and solar panels with internationally accepted standards of quality[49] to be sold locally and in export markets. It has a production capacity of 350 units of electrical and electronic equipment per day but averages 150 units per day[50]. **Zepto Ghana Limited** is another major assembler that produces televisions, computers, Hi-fi systems, and tablets. It also provides services in Computers & Accessories and Assembled Computer Repair & Services.

Also, in a bid to reduce the country's increasing demand for imported electronic and electrical appliances, **GN Electronics** in 2016, started to locally assemble and produce high quality household appliances such as Television sets and set top (decoders),

Since it began operating in 2019, **Innovate Labs** and Engineering Consults has built a reputation for creating and facilitating access to small scale manufacturing services for diverse stakeholders throughout the product development value chain in Ghana. Most crucially, they collaborate directly

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[49] https://omatek.ng/omatek-computers-limited/

[50]Ghana e-Waste Country Assessment‑SBC E-waste Africa project, March 2011

with customers by providing the required goods and with scrap dealers by marketing the waste generated during the assembly of these appliances.

Figure 9: Manufacturer (Photo credit: Innovate labs and engineering consult)

"… a significant percentage of the things we do are for farmers because they need tools to do their work. so we have the scrap people, agricultural people; small-scale food manufacturers… most of the time we find the use for the waste, we give or sell the waste back to the scrap dealers" - **Innovate labs and engineering consulting.** As a small-scale manufacturing company, they usually source parts from scrap dealers or recyclers for manufacturing or assembling new products: *"We get most of our metal parts from scrap……"* - **Innovate labs and engineering consult**

From the interaction with the manufacturer stakeholders, the company is largely interested in maximizing value from e-waste, not only economic value but also as a means to locally manufacture new products by recycling items from the waste.

"We discovered a while ago that the scrap is not going anywhere, it's either we find a means of reintegrating it back to the ecosystem… making sure that whatever we buy even if we can't recycle the whole of the item, some part of it should be recycled…" - **Innovate labs and engineering consult**

Consumers

Consumers can be categorized as individuals or groups who purchase electrical and electronic appliances for personal or household use. These appliances can be divided into major appliances (e.g., washing machines, dishwashers, refrigerators) and small appliances (e.g., mobile phones, coffee machines, microwaves, ovens, electric kettles, vacuum cleaners, irons). The purchase of these appliances are known to serve different purposes to the individual from entertainment to storing information, to preservation of foods as the needs is endless

"it keeps me busy, whenever I am bored and when I want to sleep, I watch TV…… fridge for keeping food, water…….and laptop to store information and data for my business" - **Consumer**

Figure 10: A customer purchasing household appliance (Photo credit: Sylvameric)

In Ghana, electrical and electronic appliances can be purchased from different platforms, such as online stores (e.g., Jumia, Superprice, Shopbeta), retail shops, roadside, and hand-to-hand. The purchase of these applainces is determined by same factors such as brand name, affordability, durability, etc. Consumers are of the opinion that satisfaction derived from these appliances can be credited to these factors.

"Most of them are from people that've used them before except for the fridge I bought brand new from retailers" - **Consumer**

"So, I will still base my answer on the price, if the price is moderate and affordable, I would go for it. At least I know it's new and I'm the first person using it. If it comes up with any fault, I can easily send it back to where I bought it. So if the price is moderate I would prefer to buy a brand new one" - **Consumer**

Although this element is given top attention when buying household electrical equipment, it does not exclude the possibility of a failure since these appliances are frequently too vulnerable to many types of breakdowns, including electrical failure, falls, etc. When appliances malfunction, repair shops are typically the most trusted source of assistance since the owners of these products are confident in their capacity to bring the damaged or malfunctioning appliances back to full performance. Retail stores also provide warranties on items bought within a certain time frame, giving customers the chance to have any damage to the item rectified.

"… when it breaks down, the first response is to send it to the repairer to see what happened and also we tend to see if there's a way of fixing it., and also the cost of repairing it" - **Consumer**

"They have warranties. Some 10 years, some 5 years warrant. For example, when my air conditioner broke down, the first thing I did was call the dealer or manufacturing company (Hisense), and I was asked to bring my receipt, which I couldn't find. I was told they can't change it if I can't find the receipt. One of their technicians came in and discovered that the part that was spoiled wasn't expensive, so I got it and they fixed it". - **Consumer**

In the advent of failed electrical appliances being irreparable, owners of these items are exposed to different options for disposing such items, which include selling them to scrap dealers, discarding them as waste, giving them away, etc.

"I just pack it somewhere and give it to anyone who wants it… sometimes, I leave it with the repairer… if it can be taken to scrap, if they like it, I can sell it to them but if they don't, I dispose of it" - **Consumer**

"It's difficult to keep these items because they occupy space. For example, when my door machine got spoiled, I sent it to a repairer, but he couldn't find the part, and there are no other brands that produce such parts. So I was forced to buy another one, and the repairer called to ask if I needed the spoiled item. I told him to keep it so that in case the new one gets spoiled and we need a part to fix it, we can get it from the old spoiled one. So I'm keeping it because it is a small item and it wouldn't occupy space". - **Consumer**

Retailers

The retailers (brand new and second-hand) are individuals or groups who scout for the brands in demand to meet consumer needs and prevent capital lockup.

Figure 11: Retail Shop (Photo credit: Facebook)

Since there are several appliances from a brand, consumers are left to make decisions based on their knowledge, past experience with the brand, and, in most cases, recommendations from retailers, friends, and family. Brands commonly sought after including Binatone, Toshiba, Midea, Hisense, Nasco, Brum, Sony, Philips, Panasonic, and Kenwood, just to mention a few, for brand new appliances, while they consider Russell, Philips, and Kenwood for second-hand appliances. In recent times, companies like Hisense, Midea, and Nasco have become household names not only for their affordability and availability but also because their products cut across various household needs. In recent times, due to various affordable and available purchasing processes for these household item brands, most consumers would rather replace broken items past their warranty period than repair them, whereas repairs may be considered for brands such as Philips, and Binatone due to their high cost.

Most retail businesses in Ghana are fully registered and operate as SMEs that sell mainly to customers within the locality or region. These retailers venture into the sales of various household appliances such as ceiling fans, electric cookers, TVs, blender, fryers, mobile phones etc. These items can be purchased by household members either as brand-new products or as imported second-hand appliances. As a member of the EE end-of-life stakeholder group, the retailers are in constant interaction with 3 other stakeholders: consumers, repairers, and scrap dealers. Each of these stakeholders individually forms an open channel to the final destination of e-waste material with regards to the end-of-life pathway for electrical appliances.

In terms of the valuation of electrical appliances, brand new retailers believe that the quality must be top notch in order for customers to have full satisfaction for their money: *"People are after quality products not because of the price, if the quality is good people would not mind the price"* - **Brand new retailer**

For the fairly used (second-hand) retailers, the affordability of electrical products and durability of the items are identified as good value for money: *"They believe that those ones are durable, …who don't have money and those less privileged,"* **- Second hand retailer**

The importation of fairly used appliances is sometimes a drawback for the retailers who buy these products with the "no-testing" policy. As a result, fairly used stores frequently have defective items that are beyond repair, and these are subsequently sold to scrap dealers to make some extra money. Stakeholder interactions indicate that enterprises selling both new and used items frequently are not

aware of the various policies regarding e-waste disposal: *"I don't think there is any policy"* **- Second hand retailer**

Retailers of Brand-New Electrical Appliances

In relation to the manufacturers' policies, retailers of brand-new electronic appliances offer warranties that are mostly between 6 to 12 months after purchase on products from their stores. The availability of warranties on electrical products assures customers of the quality of the product and the brand's credibility. Retailers of brand-new items believe that the establishment of manufacturer's recycling companies in the country would aid in proper disposal of e-wastes:

"What I want is just the recycling-based companies to be around, and the manufacturers or companies that we buy these products from should also do a follow-up on their product" **- Brand new retailer**

Retailers of Second-hand Electrical Appliances

Warranties are not provided to consumers because fairly used stores get their supply from importers based on product trials. But these retailers insist on offering long-lasting, high-quality products to encourage better patronage from customers and potential customers. Fairly used retailers believe that e-waste from defective equipment can be converted into smaller household appliances rather than simply being sold as scrap, given that the cash value they currently receive from selling to scrap merchants is not satisfactory. They opined that more value would be gained from recycling these defective goods into reusable, appliances in the household.

"I think the recycling… because my brother is into this electrical engineer. So when we go to his room, he has heater cups, fan, and he has small parts ones too. So, he takes something from this and takes something from that… and just fix it to make it work" - **Second-hand retailer**

Collectors

Collectors are people or organizations that collect and transport WEEE from consumers to recyclers, disposal sites, or landfills. The three-division seen in this segment are:
- Informal Collectors: mobile and/or sedentary scavengers, scrap dealers.
- Formal Collectors: Caritas foundation and small-scale businesses
- Domestic waste collectors: Zoomlion Limited

Informal Collectors

In Ghana, the collection of e-waste is mostly undertaken by informal collectors. Interactions with this set of stakeholders suggest that they mostly double as scrap dealers and are the mainstay of the disposal system of WEEE in Ghana. These are young men who go from door-to-door to pick up or buy obsolete EEE as they travel long distances. They also sift through waste bins or visit landfills and other dumping grounds for WEEE.

Figure 12: Scrap dealers at the Agbogbloshie scrapyard (Photo credit: Qualiquant services limited)

"We go house to house…., sometimes if we see some of our colleagues, we can still buy from them; if somebody is dismantling, we can still go and ask him if they want to sell or buy, if the person like he can sell…. I normally work with mechanics, also with repairers, churches, schools, mosques, houses sometimes those people that collect scraps from the refuse dump called bowlers they come to sell to me as well" - Informal collector

Given the instant cash exchange, which can be as low as 1 GHC or as high as 200 GHC depending on the amount of e-waste exchanged, the informal collection of e-waste is seen as the most popular method of getting rid of faulty electronics. Other stakeholders that also prefer to sell unused or faulty electronic items for instant cash include retailers (mostly the fairly used retailers), customers, and repairers.

The remaining parts of EEE are disassembled and segregated, with the 'not-so-important' parts broken up into smaller pieces or sold as a whole.

"Sometimes they bring cables and then we burn them to remove the coppers (inside) from it, sometimes they bring computer units, printers, photocopy machines, laptops, fridges, air conditioners, … sometimes the repairer will call me to come and collect the items… I will dismantle it, take the copper and any other metals from it. Then, I throw away the rest which is plastic… sometimes they bring a fridge or washing machine and other things… so that we can separate copper, brass, etc. from it…" - Informal collector

*"1 kilo is 40 cedis…… it depends on how much I was able to get, but in a month, I can get up to 50 kilos of copper, for iron in a month I can get 800 kilos to 1 ton (1000 kilos) or below" - Informal **collector***

*"In the last 3 years I have been able to organise 16 tons which I sold one ton for 850 cedis" - **Informal collector***

Although, practically all other stakeholders are served by these informal collectors at the end of an appliance's life, they are also the ones who take the most risks. As a result of burning e-waste with plastic casings, especially at Agbogbloshie scrap yard, these informal collectors hinted that they are constantly in direct contact with fumes from Lead, Cadmium, and Dioxins. Some informal collectors who double as scrap merchants claim that the nature of their work exposes them to significant risks that could lead to lung illnesses, or nervous system disorders.

"…e-waste is a very complex thing to do, we call it a circular economy because it has its own economic value, and every component is important, that is why we do segregation. You have to segregate the boards, the wires (cables), and then the chips, each component comes with its own economic value, so when you send it there, they weigh it, and they pay the money that helps to build or keep the company running. We have a lot of laptops, and flat TVs, which have different cash values. Batteries are not something to dispose of, anyhow. All of these things have economic, social, and environmental impacts.

We do more of collections and segregation here, then the recyclers are the partners we send it to for the recycling" - Informal Collector (Recycler)

"For me, I am handling the iron, the copper side attracts more money…. from the fridge, we can get iron. Sometimes old roofing sheets can bring in money… Whenever an old house is demolished, we will go there and look for iron rods, copper, and so on…" - Informal Collector

Formal Collectors

The collection of e-waste materials is not limited to the informal sector alone in Ghana. There are private owned/non-governmental organizations who ventured into the daily business of collection of e-waste materials to ensure its proper disposal such organizations include Caritas Foundation, a non-governmental organization, is in the business of collecting e-waste to help curb the improper disposal of e-waste which affects the environment at large. The e-waste collection is mostly from institutions such as hospitals, schools, etc. due to their recognition as licensed entities. However, for door-to-door operations, private organizations like the Caritas Foundation are faced with a number of challenges, which include lack of manpower, and public awareness, and thus are overtaken by the informal collectors (scrap dealers) in this area. . These collectors simply collect these items and dismantle them in an eco-friendly manner, then sell the items to re-cyclers. The formal collectors engage with various government officials and the Environmental Protection Agency (EPA) which issues permits to carry out the collection and dismantling of e-waste materials. Sometimes, they also create awareness via the media about the proper disposal of e-waste.

Domestic Waste Collectors

These waste management solution providers' services are safe for people's homes, places of work, and local communities. These businesses frequently provide comprehensive waste management services in Ghana, including waste collection, hauling, transfer, and sorting, as well as recycling and disposal. They have full operating, waste disposal, and management licenses, unlike the informal collectors.

"We are into waste management, our business cuts across all the sectors in waste management, from collection, transportation, and disposal" - Domestic Waste Collector

Like the formal collectors, the domestic waste collectors work hand in hand with the environmental health officials who monitor their waste collection and disposal activities. The major function of these collectors is to provide metallic containers to communities for the collection of waste. The waste disposed of in these containers is therefore taken and further processed by these collectors. However, they do not independently decide where to place these containers, as they work solely under the directives of the environmental health officers.

"We provide the metallic containers to the various communities, but we are the service company, we do not determine where to place them. It is the environmental health training assemblies that tell us where to place them, like they can say to us to place one in community A or two in community B, they give out the locations….."- Domestic Waste Collector

Unlike the formal collectors, the domestic waste collectors do not do any form of segregation during waste collection and disposal processes. Specifically, they collect this waste and dump it at disposal sites and landfills.

"There is no form of segregation or anything, and there are no plans or something to process them or to remove a particular part….. Once the waste is dumped, we don't really go to pick or even sell any form of it, but the landfill is managed by us" - **Domestic Waste Collector**

Repairers

A repairer renders the service of getting faulty EEE into a functioning state. They are usually located close to offices and residences to make them accessible to consumers of electrical appliances. While they are dependent on consumers to approach them with faulty appliances for repairs, they also rely on scrap dealers for spare parts and the disposal of unrepairable appliances.
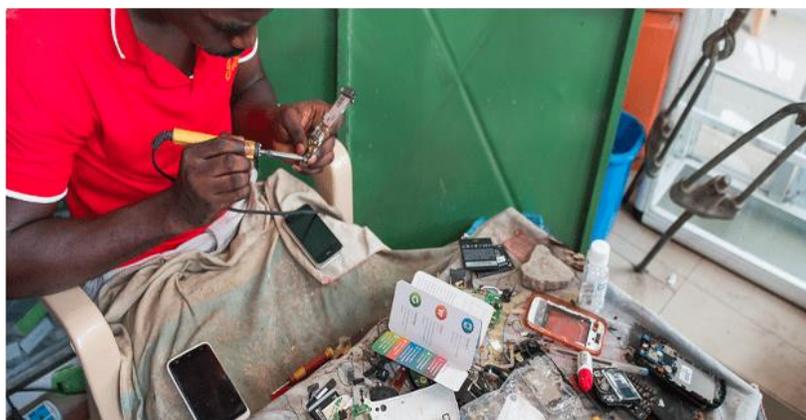
Figure 13: Electrical repairer (Photo credit: Fairphone)

These repairers typically identify with the private sector and conduct business as sole proprietorships. Due to the inconsistent failures of electrical appliances, different household appliances require different levels or types of electrical appliance repairs. These household products' maintenance and repair procedures are unconnected to one another, hence, various electrical spare parts are needed. Most of these spare parts are obtained from local merchants or from malfunctioning electronics within the same model.

"I have a problem with spare parts. Not all the time, but you can look for the spare part and get some of the parts you can't get, so when they just brought you a look and you did not see it you will just call them so that they will just come and pick it up. You can tell them that they should keep it until when you get the part, so you will call them. There is no problem about charge" **- Repairer**

Customers and e-waste collectors are the two main stakeholders' repairers most frequently contact with, in the end-of-life ecosystem. These stakeholders' interactions are thought to be informal and largely transactional in nature. The rare brands of appliances imported into the country are one of the most frequent problems mentioned by repairers. They continually attempt to repair these items by trial and error due to a lack of repair knowledge or spare parts. Also, because there are not enough original parts for faulty appliances, repair workers are forced to use substandard items and parts.

"… let's say if you bring a blender and I went to buy the motor in it, and maybe the motor bends a bit as I want to fix it, I'll have to spend my money to go and buy a new motor before I can fix it… You can't tell the person you have bought the 'motor' before and it spoils again. So, that's the only challenge in this work…. also, people don't pay so much for repairing…." **Repairer**

There are some appliances you've never seen before… something like an ice maker… Seeing it for the first time, I didn't even know how to open it, so I had to go online and learn how to open the appliance, and then I learned how to fix it. You have to go and learn about a new product seen before you are able to fix it" **- Repairer**

Most repairers have a lot of abandoned appliances in their shops since they lack sufficient replacement parts to fix them. This forces customers to buy new appliances rather than try to fix their damaged ones. Hence, in order for them to be skilled in fixing these brands, repairers are appealing to manufacturers to train them.

"I faced challenges like working on something and having the person return it after 2 to 3 days to say that it is not working after I had repaired it. Sometimes this may be due to electrical issues, power outages, or something else, but most customers do not understand this, so they complain a lot. Sometimes the customer might not know how to use the gadget and they come back to complain that it is not working" **- Repairer**

Recyclers

Recyclers are companies or individuals that dismantle, extract, and process valuable items from the waste of electrical and electronic equipment into usable products while taking into consideration the treatment of these hazardous fractions in the environment. Formal recyclers in Ghana include City Waste Management Company Limited, Environwise Waste Systems, Waste Recycling Ghana Limited, and Appcyclers. These companies engage in the business of recycling with the aim of providing innovative solutions to solve e-waste management problems and recover useful materials.

"The main motive is to come up with innovative solutions and solve e-waste management…. we collect electronic waste and we recycle it into useful products mobile phones, television set, laptops, we basically collect only small gadgets because of our capacity we do collect, we do sort, we do dismantle, we off cycle as well" …… **- Appcycler**

Figure 14: Recycler (Photo credit: AP photo)

These recyclers also serve as centers for the collection of faulty electrical devices. This is a way to offer a less dangerous method of disintegrating and extracting valuable components from the e-waste materials. The organization's capacity solely determines how much e-waste is collected, as they typically employ 3-4 people. At Appcyclers, an e-waste recycling business established in 2019, they concentrate on collecting small gadgets, which they then sort, disassemble, and recycle into valuable items like artefacts such as e-waste sculptures, picture frames, circuit board bracelets, etc. Recyclers put the waste they get from electrical and electronic equipment through rigorous processes of segregation and disassembly in order to recover materials that are both useful and valuable, economically.

"We call it a circular economy it has its economic value, and every component is important, that is why we do segregation, you have to segregate the boards, the wires, then the chips, each component comes with its economic value" - ***5 Seconds Connect***

Figure 15: Artefacts made from e-waste materials (photo credit; Appcyclers)

These recyclers are in cognisance of the existing policies and standards on e-waste management and disposal. Their compliance with these policies and standards has improved their ability to mitigate the environmentally hazardous effects of waste.

*"There are both international and national standards. Some of the standards are the segregation aspects because if you know how to segregate waste appropriately then you would know the value, and you would not endanger the environment which would be hazardous to humans" - **5 Seconds Connect***

The recyclers indicated that specific amounts and types of e-waste are to be collected on a monthly basis in order to produce quality products with acceptable standards. These products are processed and resold to companies and individuals. The minimum quantity required is 0.11-0.16 tons of waste.

"We are sceptical as to who we take products from and the number of products we collect. We have a boundary limit on how many products we collect in a month (0.11-0.16 ton), also we sell these products to basically people who are conscious of waste in the environment" - **Appcyclers**

Electronic waste recycling has potential economic benefits, but because of the volatile market, recyclers were unable to provide a precise estimate of the value of the products they sold each year. However, they were able to declare that the lowest sum ever generated was GH₵ 10,000 ($847) per year.

*"The market is not stable, we can't give a specific price range, let's say the least amount we've generated is about the range of 10,000 Ghana cedis ($847)" ....***Appcyclers**

*"My yearly turnover is like 10,500 Ghana cedis ($889)" .... ***5 Seconds Connect**

3.4.   Household Survey

Consumers are members of the general public who purchase and use various kinds of electronics and discard (or store) them as waste once they have outlived their usefulness. For the study, we examined the household's consumers, paying close attention to both urban and rural consumers. While 337 homes were surveyed, 3 in-depth interviews were conducted with 3 consumers to better understand consumer behaviour and sentiments surrounding electronic appliances end of life, the study also included existing data on household income in Ghana's rural and urban areas to offer context for the survey's overall findings.

Household Income

According to the Ghana Living Standards Survey Round Seven (GLSS7) which provides a wealth of information for understanding living conditions and monitoring the welfare system in Ghana, the income of households was culled. Urban households in the country have an estimated total annual income of GH₵ 185,509.35 million[51], representing 76.6 percent of the total national income, whereas rural localities have GH₵ 56,762.16 million, representing 23.4 percent. Furthermore, among the rural localities, the rural forest has the highest annual income of GH₵ 30,497.99 million, followed by rural coastal (GH₵ 15,550.65 million), with rural savannah having the lowest of GH₵ 10,713.52 million (Table 8). However, the annual average per capita income in urban localities is GH₵ 16,373 implying an average income of GH₵ 44.86 per day, while their rural counterparts have an average annual income of GH₵ 5,880, which represents an average income of GH₵ 16.11 per day.

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[51] In 2017, 1USD=4.40GHc (https://freecurrencyrates.com/en/exchange-rate-history/USD-GHS/2019)

Table 8: Mean annual household and per capita income by type of locality (GLSS, 2016)

Locality	Mean annual household income (GH₵)	Mean annual per capita income (GH₵)	Estimated total annual income (Million GH₵)	Percentage share of annual income
Urban	**46,902**	**16,373**	**185,509.35**	**76.6**
Accra	63,027	23,532	31,338.59	12.9
Other Urban	44,583	15,344	154,170.76	63.6
Rural	**17,830**	**5,880**	**56,762.16**	**23.4**
Rural Coastal	27,875	10,199	15,550.65	6.4
Rural Forest	17,110	5,947	30,497.99	12.6
Rural Savannah	12,706	2,882	10,713.52	4.4
Ghana	**33,937**	**11,694**	**242,271.51**	**100.0**

Household Appliances

The study's data revealed that appliances were present in every household studied, whether or not they were functional. The most frequent appliance in a household is the mobile phone (95%), followed by a television (90%), and an electric fan (74%). Table 9 shows that the most sophisticated and heavy appliances, such as refrigerators, electric irons, blenders, microwaves, computers, and washing machines, were mostly found in urban and semi-urban households. This is due to the fact that Accra's electrification rate (SHEP, 2016), way of life, and living conditions are very different from those in the rest of the nation, particularly when compared to rural areas (GLSS, 2016).

Rural areas in Ghana, unlike their urban counterparts, are characterized by agriculture and informal economies with limited access to economic, physical, and human assets and a declining environmental quality because of overdependence on natural resources[52].

It is evident that households in semi-urban areas were more likely to own smaller equipment, including televisions, electric fans, electric irons, blenders, kettles, sound systems, and hair dryers. This may be due to the fact that there are many second-hand stores in these locations, and these

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[52] https://link.springer.com/article/10.1007/s11625-021-00929-8

stores typically prefer to deal in such items. Individuals in semi-urban areas can buy these products in second-hand stores since they have a reasonably high purchasing capacity. Urban households may indeed be able to afford used goods, but because of the social class system, they can feel ashamed to be seen buying second-hand items and might also have restricted access to fairly used or second-hand stores, as several studies have shown that social stigma is often associated with buying second-hand items. A study published in 2013 in the Journal of Consumer Research found that consumers who purchased second-hand products felt a sense of "moral taint," which resulted in feelings of shame and guilt[53].

Table 9: List of Appliances owned by Consumer Households in the Study

Appliances	Rural[54]	Semi-Urban[55]	Urban[56]	Total/Overall
Mobile phone	94%	93%	99%	95%
Television	88%	97%	93%	90%
Electric Fan	65%	93%	85%	74%
Electric Iron	48%	90%	83%	62%
Radio	68%	40%	51%	61%
Refrigerator	43%	79%	81%	58%
Blender	15%	86%	72%	39%
Electric Kettle	20%	66%	64%	37%
Sound System	19%	52%	49%	31%
Electric Cooker	23%	50%	41%	31%
Computer	13%	40%	56%	28%
Microwave	5%	34%	54%	23%
Portable Media Player	8%	7%	31%	15%

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[53] https://www.jstor.org/stable/10.1086/667690

[54] Rural areas are areas having features which are typical of areas that are far away from large towns or cities.

[55] Semi-urban is partly urban, that is between urban and rural; somewhat but not wholly characteristic of urban areas

[56] Urban means belonging to, or relating to, a town or city.

Washing machine		10%	20%	7%
Others	5%	13%	6%	6%
Hair Dryer		17%	13%	5%

Purchase Sources of Household Appliances

In Ghana, electrical household appliances can be found and purchased either from a formal or informal market. Research showed that compared to the male, more females are prone to buy these electronic items from the formal markets. The distribution of these statistics is shown in Figure 16 below.
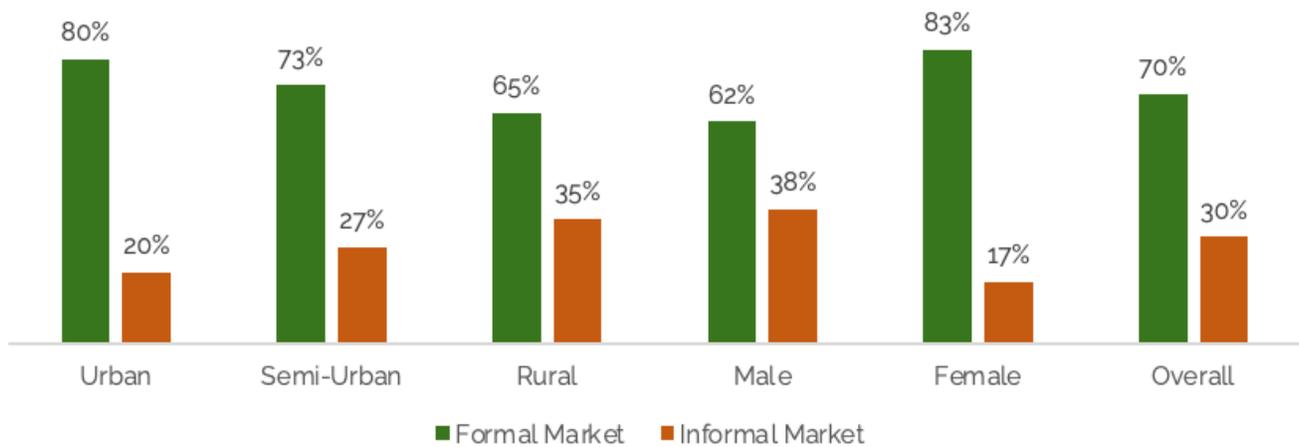

Figure 16: Purchase source for Household Appliances

The formal market

In the formal market, each retailer has a fixed location, i.e., a brick store. To attract consumers, formal retailers post their prices on the products in-store while the opposite is the case at informal markets. In this study, a significant majority of consumers reported purchasing electronic appliances from the formal market rather than the informal. In contrast to rural areas, this is significantly more prevalent in urban areas, possibly reflecting the large spending power of urban households. Research indicates that most consumers who frequently buy from formal markets do so in malls and high-end stores, with a lesser percentage doing so online or at manufacturers' and dealers' outlets. In contrast to consumers in rural and semi-urban areas, urban households generally prefer to purchase household appliances from shopping malls as opposed to other formal markets because the mall has its own name (brand) to protect (refer to Figure 17).

Findings from the qualitative interviews with the consumers also support the findings that the purchase of electronic appliances is usually from retail shops (formal markets): *"I bought it from the mall, If you buy from the mall, they will give you a receipt in case the phone has a problem, You can go back to the same shop to complain, but if you buy from the roadside, before they can move away....*
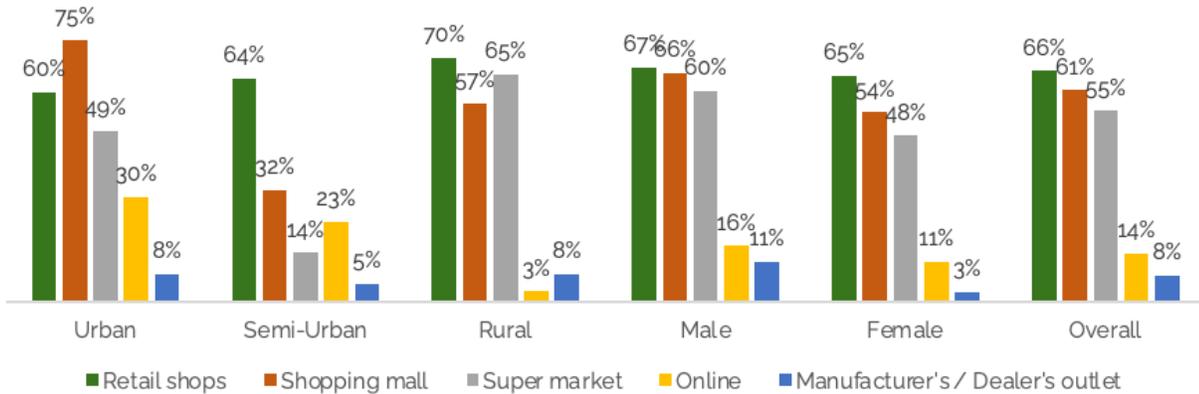
Figure 17: Formal markets for purchasing household appliances

Informal markets

When asked which informal market they prefer to shop for electronic products, 65% of respondents replied the open/local market, while 61% said they prefer the roadside vendors. Others reported purchasing from second hand shops and/or the roadside hawkers. Some people mentioned buying from their neighbours (see Figure 18). Consumers in the rural areas are slightly more likely to visit informal markets than other study strata as seen in the data since they have lower incomes and are closer to open air markets and roadside vendors.
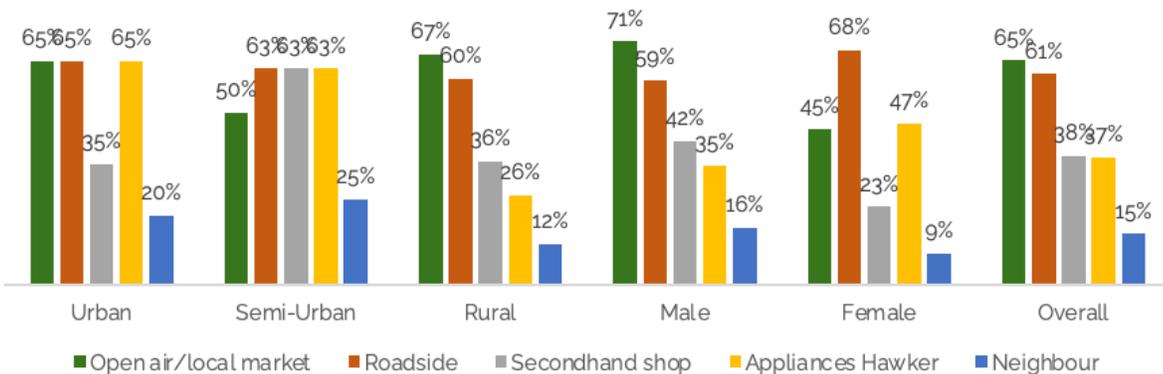
Figure 18: Informal markets for purchasing household appliances

Most Preferred Market for Household Electric appliances

According to a sizable majority of consumers across the settlements, Figure 19 below demonstrates that formal markets tend to be the most preferred source for buying household appliances. It's interesting to note that despite the fact that rural consumers do not often make these purchases at formal marketplaces, as shown in figure 19, their preference for them is more strongly expressed. This can be related to the aspirational purchasing tendencies of lower-class individuals.

Figure 19: Most Preferred Market for Household Electric appliances

Drivers of Purchase Decisions of Household Electric appliances (Formal)

The quality of the product[57], existence of a warranty/guarantee on the product, as well as the product's pricing and accessibility, all played significant roles in consumers' decisions to buy or purchase electronic appliances, especially from the formal market. Table 10 below displays the factors influencing household electronic equipment purchases across different socioeconomic strata in the study. In comparison, urban households were more inclined than respondents from rural areas to purchase these items from formal marketplaces because of all three of the most popular factors: quality (71% vs. 61%), warranty (50% vs. 41%), and affordability (50% vs. 37%). Interviews with the consumers further corroborate the findings from the data: *"At least I know it's new, and I'm the first person using it. If it comes up with any fault, I can easily send it back to where I bought it"* ***- Consumer***
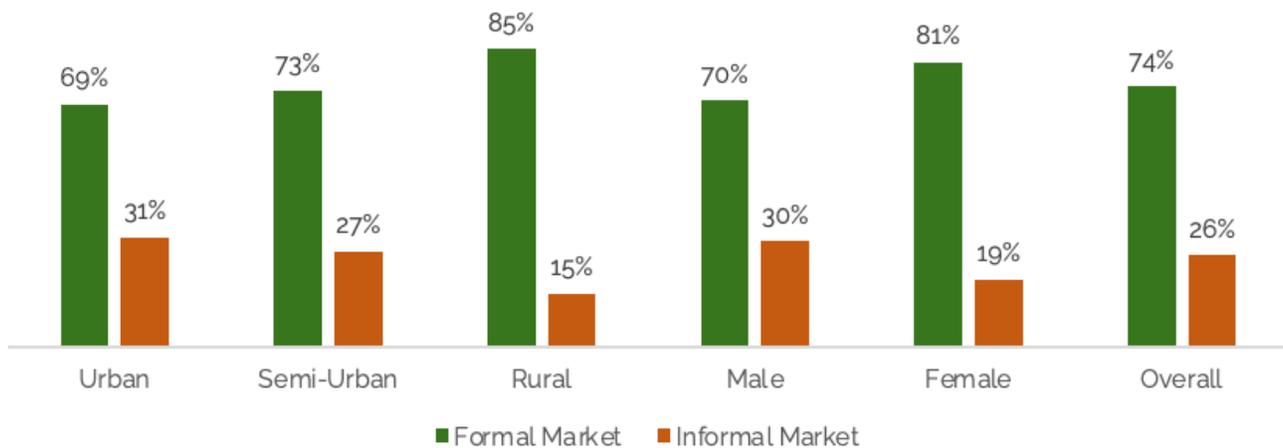
Table 10: Drivers of Purchase Decisions of Household Electric appliances (Formal)

	Urban	Semi-Urban	Rural	Male	Female	Total
Quality (products efficiency and meeting customer's need)	71%	81%	61%	71%	65%	68%
Warranty is sure and given	50%	36%	41%	53%	35%	46%
Affordability- within my financial plans	50%	23%	37%	47%	38%	43%
Accessibility	39%	55%	48%	43%	44%	43%
The appliances last longer / more durable (long life)[58]	57%	18%	19%	42%	38%	41%

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[57] The quality of a product in this study refers the ability of a product to meet consumer's needs, satisfaction and expectation, considering factors such as performance and reliability,

[58] Durability in this study means the ability of a product to remain functional over a long period of time

Trust with retail shop	34%	50%	41%	38%	38%	38%
Ease of repair when it breaks down	48%	23%	20%	34%	39%	36%
Brand of Product	21%	57%	51%	32%	37%	34%
Professional Service Delivery	11%	24%	31%	22%	15%	19%

With regards to affordability, this is subject to the preference of the customer in comparison with the brand of product as such product cost more. It is also established that urban respondents like to buy from malls and part of the reasons for this is the brand of the product. However, findings from this survey shows that respondents from the urban areas have more prioritized drivers such as quality, warranty and affordability before the brand of the product is considered.

Drivers of Purchase Decisions of Household Electric appliances (Informal)

In spite of the fact that informal markets have the tendency to sell appliances at lesser prices in comparison with formal markets, pricing appears to be the first and most common criterion considered by consumers when purchasing household appliances from the informal market, while also considering product accessibility and quality. Table 11 shows that affordability is more of a driver for male consumers compared to female consumers. In-depth interactions with the consumers further buttress this position; *"... my answer is still on the price, if the price is affordable, I would go for it"* - **Consumer**

Table 11: Drivers of Purchase Decisions of Household Electric appliances (Informal)

	Urban	Semi-Urban	Rural	Male	Female	Total
Affordability-within my financial plans	88%	75%	73%	89%	71%	84%
Accessibility[59]	57%	25%	47%	59%	33%	52%
Quality	26%	50%	23%	30%	20%	28%
Trust with retail shop	19%	50%	40%	25%	25%	25%
The appliances last longer / more durable	19%	25%	40%	22%	25%	23%

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[59]Accessibility in this context is the ease with which consumer can obtain these products from the markets

Ease of repair when it breaks down	8%	13%	7%	8%	8%	8%
Brand of Product	9%	0%	0%	7%	5%	7%

Failure Behaviours and Decisions

According to the survey, urban consumers encounter electronic appliance breakdowns more frequently than semi-urban and rural customers, who report roughly comparable rates of experience. Appliance breakdowns happen more frequently for female consumers (96%) than for male users (89%). This might be due to the extended exposure to and access to electricity in urban areas, which is unstable and harms appliances. Access to electricity also correlates with increased usage of the equipment, which promotes deterioration of the electrical components.
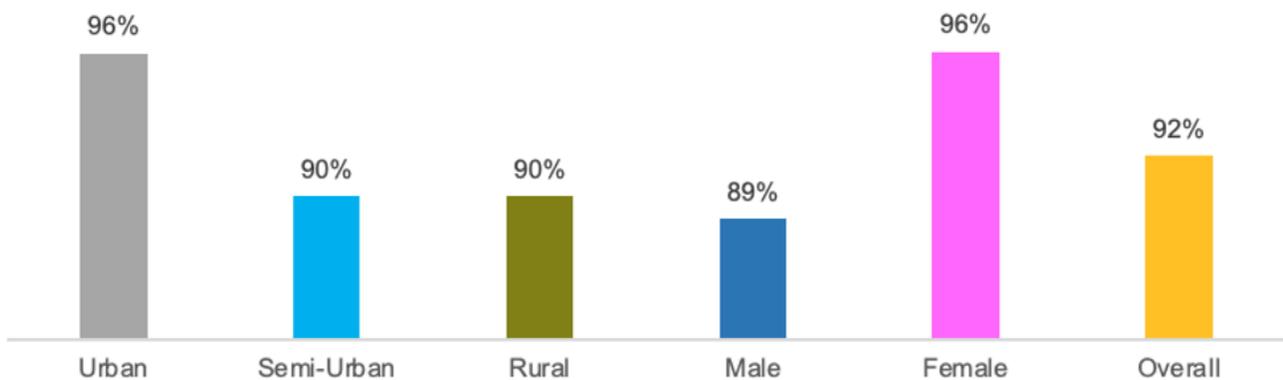
Figure 20: Failure behaviours and Decisions

Household Electronics and Appliances with the Highest Percentage Rate of Failure

From the survey, nine out of every ten households in the study locations have experienced breakdown or failure of their home appliances, indicating that appliance failure is a common occurrence within every household. Electrical equipment may be faulty because of improper or delayed maintenance, subpar manufacturing materials, usage wear and tear, or other external factors (such as mishandling). According to Table 12, owners of these electrical items most frequently reported problems with their televisions (42%) and mobile phones (38%).

Table 12: Household Electronics and Appliances with the Highest percentage rate of Failure

	Urban	Semi-Urban	Rural	Male	Female	Total
Television	35%	34%	47%	45%	38%	42%
Mobile phone	38%	21%	40%	42%	31%	38%
Radio	31%	25%	38%	40%	30%	36%
Electric Fan	9%	4%	38%	27%	20%	24%
Refrigerator	21%	39%	21%	17%	31%	23%
Blender	29%	40%	38%	30%	37%	34%
Electric Iron	24%	11%	19%	19%	22%	20%
Electric Kettle	37%	26%	27%	27%	38%	32%
Electric Cooker	41%	20%	36%	42%	26%	36%
Computer	20%		35%	27%	10%	21%
Microwave	16%	20%	30%	11%	25%	18%
Washing Machine	30%		100%	27%	33%	29%
Portable Media Player	10%		31%	21%	11%	17%
Sound System	11%	13%	6%	11%	7%	9%

Causes of Electronic Appliances Failure

Figure 21 below shows that more than half of consumers cited electric failure[60] as the most frequent reason for electronic appliance failure, with consumers in rural areas more likely to experience it than those in semi-urban and urban areas. This claim is further supported by the inferences made by one of the key informant interviews conducted: *"...when I got a brand-new television for my mom, there was a power outage and after electricity was restored, the television didn't come on.... and that was how the TV became faulty... Mostly, it's power fluctuations that cause the problem with electronic appliances..." -* ***Consumer***

The next best reason for electrical appliance failure is the appliance crashing to the floor (32%), followed by the age or improper maintenance of the appliance. Nonetheless, the household appliances that are most negatively impacted by electrical failure are further examined below for the top two reasons mentioned in figure 21.
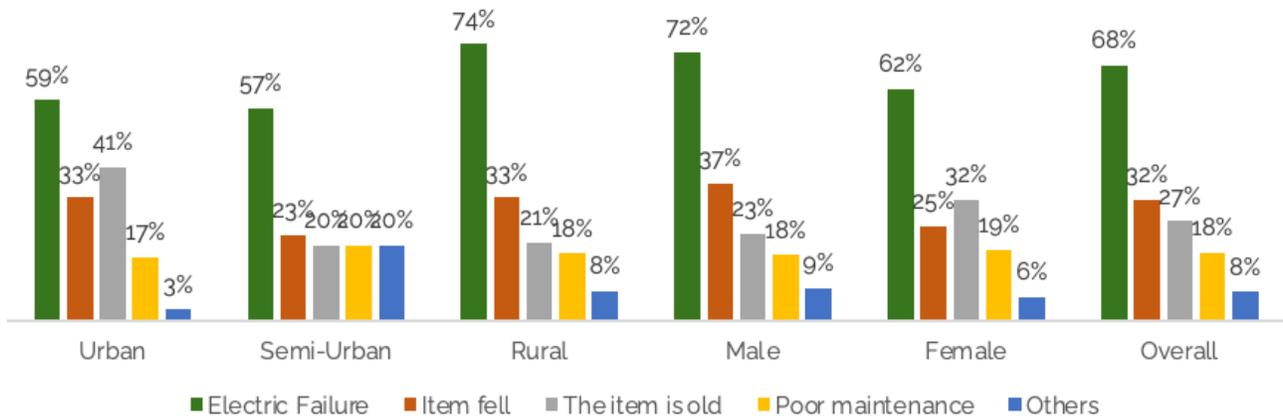
Figure 21: Causes of Electronic and Appliances Failure

(a)   Electric Failure

For this research, consumers in all three settlements who claimed to have faulty electrical products as a result of electrical breakdowns (Table 13). Results indicated that televisions were the most affected by power outages, followed by mobile phones, with more urban customers expressing this opinion. This is hardly surprising considering that television is one of the most popular consumer electronics used by households.

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[60] In this context, electric failure refers to frequent power outage, instability and fluctuations (such as high or low voltage),

Table 13: Electric Failure (Causes of Electronic and Appliances Failure)

	Urban	Semi-Urban	Rural	Male	Female	Total
Television	30%	31%	52%	48%	39%	45%
Mobile phone	46%	38%	37%	44%	30%	39%
Radio	21%	6%	29%	28%	21%	25%
Electric Fan	9%		29%	22%	21%	22%
Electric Kettle	35%	31%	5%	13%	18%	15%
Electric Cooker	25%	19%	12%	17%	12%	15%
Fridge / Refrigerator	16%	38%	10%	10%	21%	14%
Blender	21%	31%	6%	8%	19%	12%
Electric Iron	19%		10%	11%	12%	11%
Computer	16%		6%	10%	4%	8%
Microwave	11%	6%	2%	3%	8%	5%
Sound System	7%	13%	1%	3%	3%	3%
Washing machine	7%		1%	2%	3%	2%
Portable Media Player	4%		1%	2%	1%	2%
Others	4%	6%	1%	2%	3%	2%

* n = 220

(b)   Item Fall

Consumers have also identified electronic failure or malfunction as being caused by the device falling off to the ground. This analysis is based on consumer reports that electrical products they owned had malfunctioned after falling to the ground. Due to portability and convenience, mobile phones (59%) are the most commonly associated with this problem. Following as the top consumer appliance is

television (46%) (refer to table 14).

Table 14: Item Fall (Causes of Electronic and Appliances Failure)*

	Urban	Semi- Urban	Rural	Male	Female	Total
Mobile phone	69%	40%	55%	62%	52%	59%
Television	31%	40%	54%	47%	45%	46%
Radio	13%	20%	40%	34%	23%	31%
Electric Cooker	25%	20%	9%	16%	10%	14%
Blender	25%	20%	4%	11%	13%	12%
Electric Fan	3%		15%	10%	13%	11%
Electric Kettle	19%	40%	3%	8%	13%	10%
Computer	19%		4%	10%	6%	9%
Electric Iron	9%	20%	7%	8%	10%	9%
Fridge / Refrigerator	6%	20%	6%	7%	6%	7%
Portable Media Player	3%		7%	7%	3%	6%
Microwave	9%			1%	6%	3%
Sound System	3%	20%	1%	4%		3%
Washing machine	6%		1%	3%	3%	3%

* n = 104

Frequency of Electronic and Appliance Failure

A one-time failure is the most common frequency for electronic and appliance failure, with the three settlements having proportionately similar amounts. The frequency that came after that was 'once a year', then 'twice a year'. Very few customers reported 'three times a year'. (Refer to figure 22)
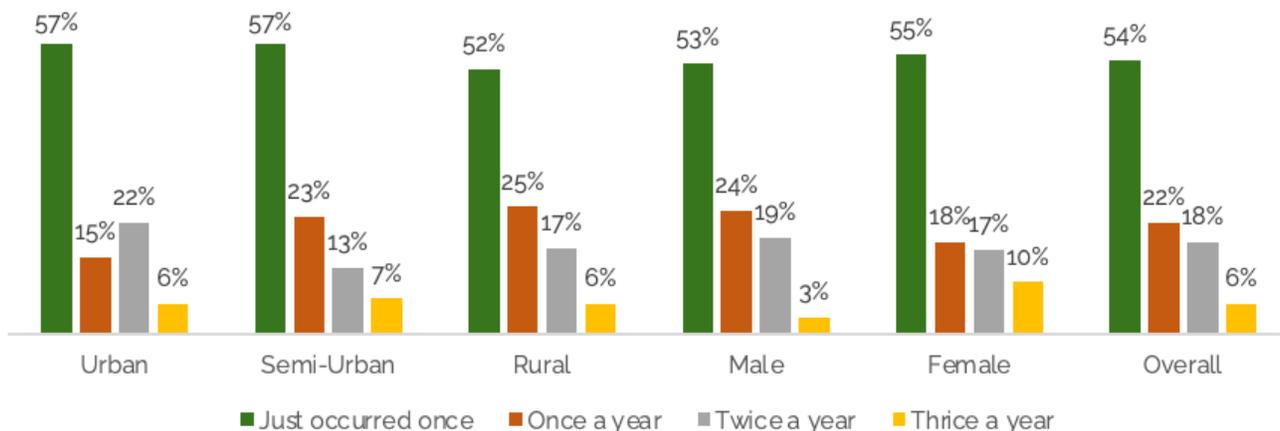
Figure 22: Frequency of Electronic and Appliance Failure

Decision Regarding Failed Household Electronics and Appliances

Table 15 shows that consumers prefer to repair damaged electronic appliances repeatedly. The least desired option is to give away the defective electrical systems and this implies that even after repairs, consumers still prefer to utilise their faulty equipment rather than throw them away. The finding is further supported by in-depth consumer interviews: *"when it breaks down, the first response is to send it to the repairer to see what happened and also we tend to see if there's a way of fixing it" -* **Consumer**

Table 15: Decision regarding Failed Household Electronics and Appliances.

	Urban	Semi-Urban	Rural	Male	Female	Total
Repair it and continue using	76%	63%	89%	85%	80%	83%
Discard the item as waste	4%	7%	4%	4%	5%	4%
I keep it in the house until I have time for it	6%	7%	2%	4%	4%	4%
Give it away	7%	3%	1%	1%	6%	3%
Others	7%	20%	3%	6%	6%	6%

Decision-Maker over Failed Household Electronics and Appliances

A significant majority of the consumers stated that the household head is the decision maker ensures the fixing of the failed appliances/items in the households. More male consumers were found making this household decision compared to the women (85% vs. 74%). (See Figure 23)
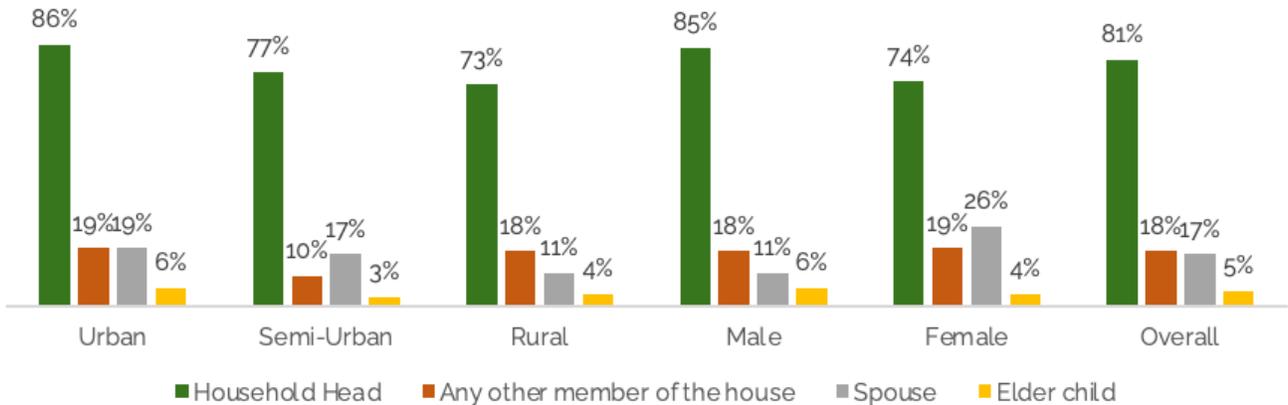

Figure 23: Decision-maker regarding Failed Household Electronics and Appliances

Decision Period to repair failed Household Electronics and Appliances

The majority of consumers said they would rather fix faulty electrical items as soon as they develop a problem. Consumers in urban areas cited this defence for fixing their items more frequently than those in rural areas. This can be due to the fact that urban dwellers can easily afford the cost of fixing the item whenever it fails with more access to repairers. Other considerations for repairs were having the money (16%) and having unsuccessfully tried to fix the problem at home (9%). (See figure 24)
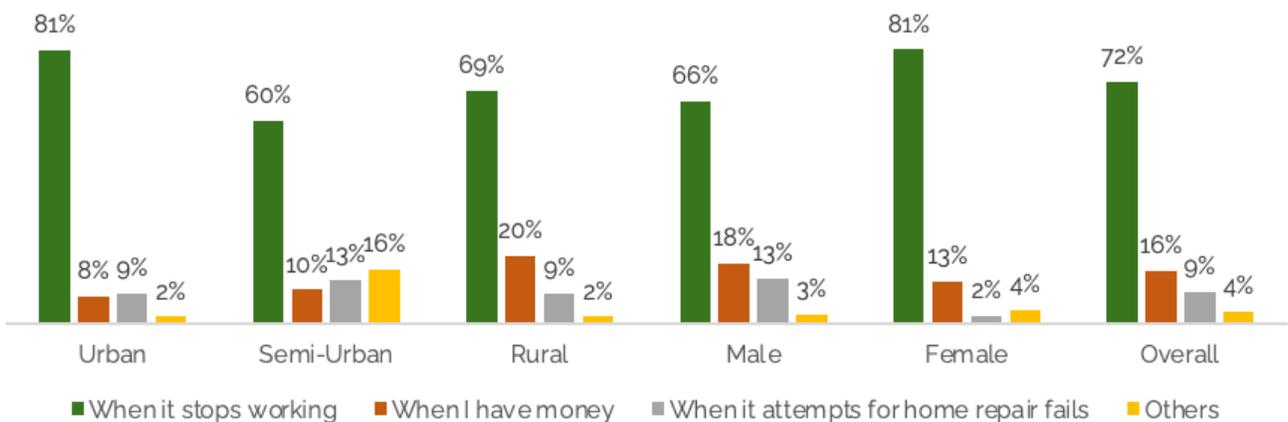

Figure 24: Decision Period to repair failed Household Electronics and Appliances

Preferred Location to Fix Appliances

Findings from the survey shows that a substantial majority of the households across the three settlements prefer repairing failed appliances at a repair shop than any other place as shown in figure 25

Figure 25: Preferred Location for Fixing Appliances

Information source for fixing locations

According to the survey, most consumers sought advice on repairs from people in their neighbourhood. This demonstrates that consumers believe local sources to be more trustworthy than other sources. It is less typical to obtain information from warranty documentation because not all products come with them, and even when they do, they might not clearly identify the fixing locations close to the customer. (See table 16)

Table 16: Information source for fixing locations

	Urban	Semi-Urban	Rural	Male	Female	Total
From a neighbour / Neighbourhood	67%	66%	82%	75%	79%	76%
From the dealer shop	18%	7%	12%	14%	13%	13%
From Warranty document	3%	7%	3%	4%	2%	3%
From the internet	7%		1%	3%	2%	3%
Others	5%	20%	2%	5%	4%	4%

The average cost of fixing failed appliances

According to table 17, to one-third of the consumers surveyed, the typical cost of repairing this equipment depends on the severity of the defect. While more consumers in semi-urban and urban areas believed that 5%–10% of the value determined the typical cost of repairing faulty appliances, consumers in rural areas believed that the severity of defect determined the typical cost of repair.

Table 17: The average cost of fixing failed appliances

	Urban	Semi-Urban	Rural	Male	Female	Total
Depend on the level of breakage	15%	30%	44%	41%	24%	34%
Less than 5% of the value of the item	24%	7%	9%	11%	17%	13%
5-10% of the value of the item	28%	43%	12%	13%	30%	19%
11-20% of the value of the item	12%	3%	11%	11%	9%	10%
21-30% of the value of the item	10%	13%	11%	10%	11%	11%
31-40% of the value of the item	5%		6%	5%	6%	5%
Above 41% of the value of the item	6%	3%	7%	8%	4%	7%

Unrepaired Faulty Electrical Appliances

This section examines the data based on every household that experienced an electrical appliance failure that was beyond repair. Table 18 below shows that televisions and mobile phones are the most popular household items that falls into this category, closely followed by electric kettles, and all other household items included. Compared to consumers in semi-urban and urban areas, closely twice as many consumers from rural areas reported being unable to fix their television. This could be a result of the limited resources (e.g., skilled electrical technicians, electrical spare parts, etc) available to consumers in rural locations for repairing these items.

Table 18: Failed down household items that were never fixed

	Urban	Semi-Urban	Rural	Male	Female	Total
Television	20%	29%	39%	33%	29%	31%
Mobile phone	21%	48%	32%	33%	24%	30%
Electric Kettle	18%	10%	10%	11%	16%	13%
Radio	8%	10%	15%	12%	13%	12%
Blender	9%	25%	11%	7%	21%	12%
Electric Iron	8%	14%	11%	13%	8%	11%
Electric Fan	3%	5%	14%	9%	10%	9%
Refrigerator	14%	15%	5%	7%	12%	9%
Electric Cooker	3%	5%	11%	10%	4%	8%
Computer	6%	5%	6%	7%	3%	6%
Microwave	2%	10%	4%	2%	5%	4%
Sound System	8%	5%	1%	4%	3%	4%
Others	15%		6%	7%	10%	8%

*n = 214

Proportion of Consumers with Non-repairable Faulty Electrical Appliances

As shown in Figure 26, a smaller number of consumers in rural homes claim to have such items, compared to those living in urban and semi-urban households, where a two-thirds majority of consumers claimed possessing such items.
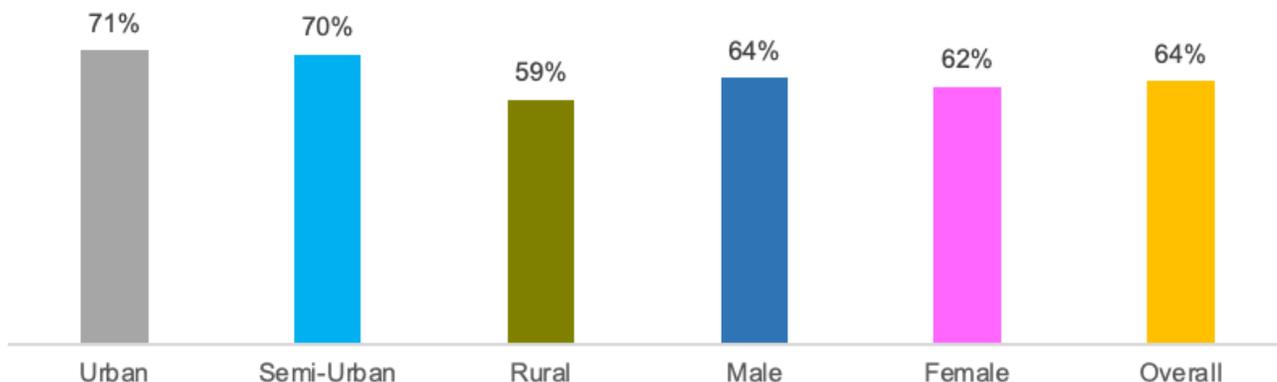
Figure 26: Consumers with non-repairable Faulty Electrical Appliances

Decisions on Non-Repairable Home Electronics and Appliances

Consumers indicated their plans for the non-repairable items in their households that were never fixed when they malfunction which include: keeping it at home or in the store, giving it away, or tossing it away, as depicted in table 19. These findings are supported by interactions with these consumers during one-to-one interviews: *"I wouldn't waste my time; I'll just give it out" -* ***Consumer***

Table 19: Decisions on Non-Repairaable Home Electronics and Appliances

	Urban	Semi-Urban	Rural	Male	Female	Total
Keep in store	20%	14%	38%	26%	35%	29%
Give away	45%	24%	20%	30%	28%	29%
Throw it away	32%	45%	24%	27%	32%	29%
Sell spare parts	17%	14%	32%	26%	24%	25%
Sell to second-hand users	20%	5%	16%	19%	13%	16%
Burn it	8%	5%	7%	8%	5%	7%
Others	1%	33%	2%	4%	5%	5%

Disposal Channels for Failed Electronics and Appliances

Appliances occasionally fail to perform as they should, yet depending on the consumer's preferences, they may not be repaired. In this survey, more than half of the consumers admitted to having defective electrical items to get rid of and offered a range of disposal options. Nearly the same percentage of consumers in semi-urban and rural areas claimed to have tossed the malfunctioning device in the trash, compared to the more than half of urban consumers who acknowledged selling defective equipment to scrap dealers. (See figure 27)

"...if it can be taken to scrap, if they like it, I can sell it to them but if they don't I dispose of it" - **Consumer**
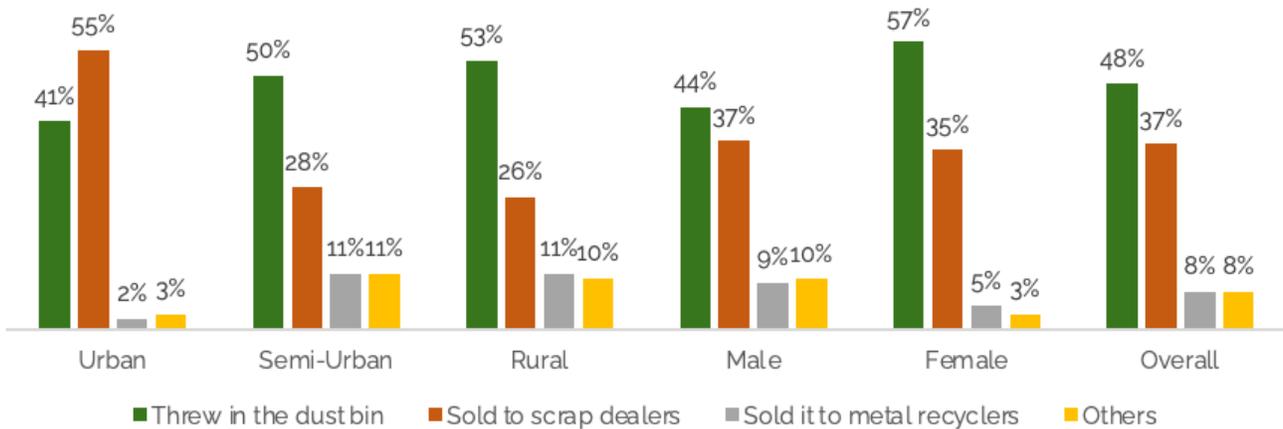

Figure 27: Options to Disposal of Failed Electronics and Appliances

Decision to Replace a Faulty Appliance with a New One

According to the survey, a sizable portion of consumers rely on the repairer's or artisan's discretion regarding when to replace an item that is beyond repair, as depicted in figure 28. According to consumers in urban and rural areas, the lack of the necessary spare parts to repair faulty household appliances is another important factor to consider when deciding when to replace an item. Meanwhile, semi-urban consumers are inclined to replace an electric appliance or product only when it becomes old.
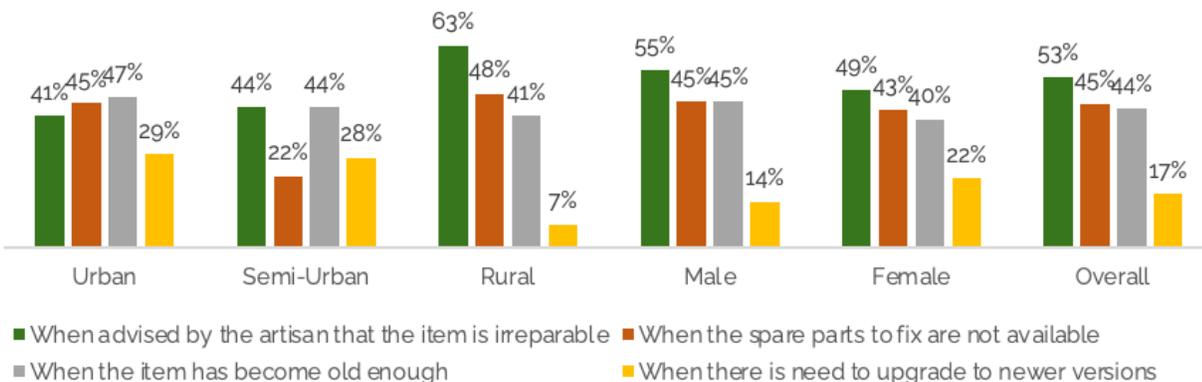

Figure 28: Decision to Replace a Faulty Item with a New One

Purchasing decisions

Reasons for Purchasing Electrical Cooking Appliances

When questioned about the features to take into account when purchasing cooking appliances, 73% of buyers said that price is the most important consideration. It was discovered that a sizable majority of consumers in rural and urban areas gave the appliance's pricing more thought than those in semi-urban areas. Each strata may have distinct motivations for this: urban customers may be maintaining their social hierarchy, whilst rural consumers may have aspirational motivations to belong as rural consumers don't only seek to fulfill their basic needs but also wish to spend their discretionary income on aspirational goods[61]. The quality of a product is another crucial factor in determining whether or not a consumer chooses to buy a cooking appliance, with consumers in rural areas preferring quality over those in urban and semi-urban areas who have access to more high-quality appliances. Consumers in rural locations are also forced to prioritise durability (product life) due to the scarcity of available appliances. (See table 20)

Table 20: Reasons for Purchasing Cooking Appliances

	Urban	Semi-Urban	Rural	Male	Female	Total
Price	81%	60%	71%	72%	74%	73%
Product Quality	65%	53%	67%	67%	62%	65%
Durability (product life)	48%	47%	71%	59%	67%	62%
Recommendations from others	29%	43%	49%	42%	43%	43%
Warranties	30%	20%	33%	36%	23%	31%
Brand name	43%	53%	20%	30%	28%	30%
Type of market (formal/informal)	10%	13%	30%	24%	20%	23%
Other		10%	3%	4%	2%	3%

Purchase Drivers for Electrical Cooking Appliances

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[61] Shruti Gupta & Pratish Srivastav (2016) An exploratory investigation of aspirational consumption at the bottom of the pyramid, Journal of International Consumer Marketing, 28:1, 2-15, DOI: 10.1080/08961530.2015.1055873

When deciding when to make a purchase, the availability of money is more important in rural areas than in urban and semi-urban areas. This suggests that rural consumers do not purchase when there is a dire need and no money to make a purchase. Consumers in urban areas may more easily purchase goods when a need arises than those in rural and semi-urban areas owing to their high purchasing power. (See figure 29)
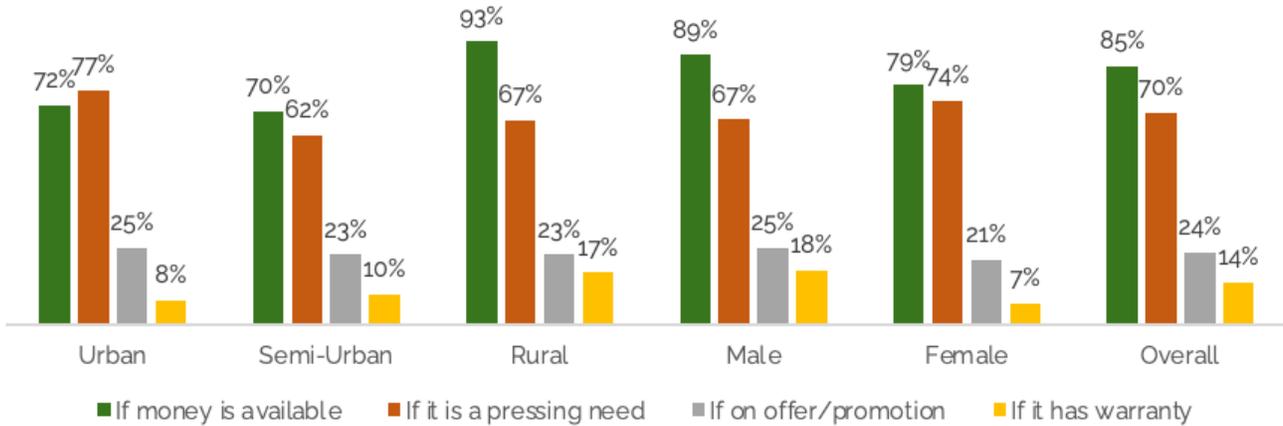

Figure 29: Drivers of purchase for cooking Appliances

Drivers of Non-purchase of Electrical Appliances

Figure 30 shows that the majority of consumers are prevented from buying items that they had previously wanted to acquire. because they lack the needed finances. Comparing the rural area to other settlements, the consumers' low incomes may have contributed to the larger percentage. Poorer specifications and the absence of desired brands are two additional important barriers for consumers, particularly those in rural areas from purchasing electronic goods. The least reason appears to be lack of warranty.
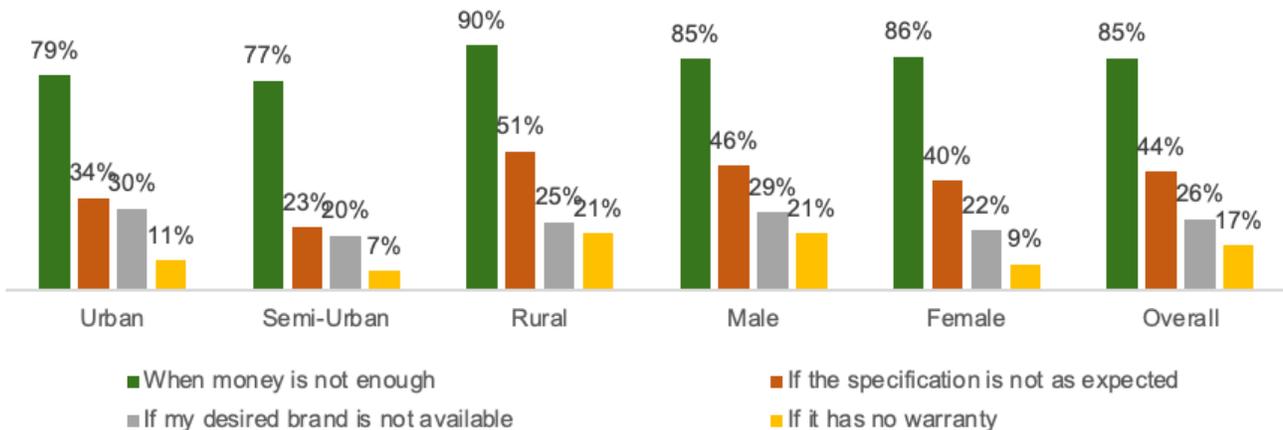

Figure 30: Drivers of Non-purchase of Electrical Appliances

Purchase of Fairly Used Electrical Cooking Appliance

Overall, 43% of respondents reported having previously purchased a second-hand or used cooking appliance. This history of previous purchases of second-hand electrical appliances was less prevalent in the semi-urban areas.
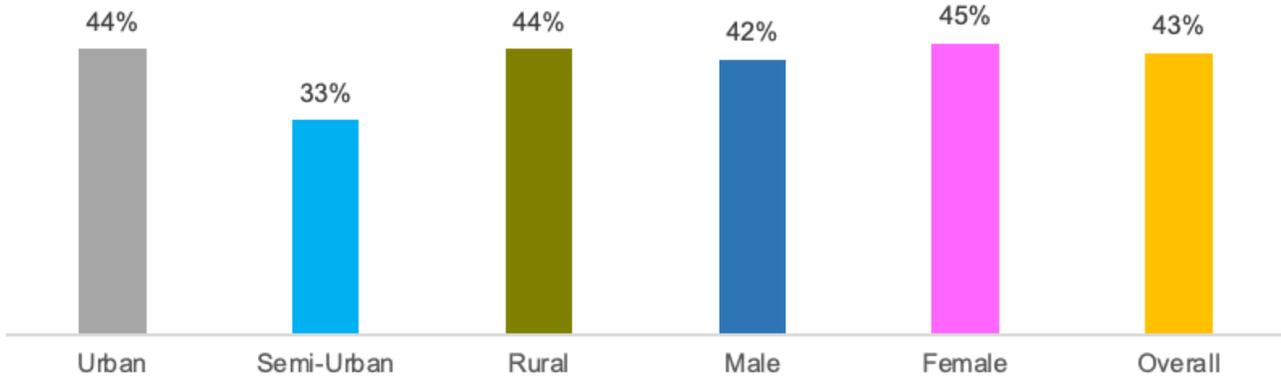

Figure 31: Purchase of used-cooking appliance purchases

Drivers of used-cooking appliance purchases

In contrast to consumers in urban areas, consumers in rural areas typically choose used cooking appliances since they cannot afford to buy new products. For individuals who live in semi-urban areas, this stance is a little different (see figure 32 below), as consumers of these areas prioritise durability over affordability whenever they wish to buy a used item (60% vs. 50%). Contrarily, a significant majority of respondents from rural areas were found preferring used-cooking appliances because of their affordable prices, compared to the durability factor (85% vs. 68%). This further explains findings from figure 28. It is also discovered that men are more likely than women to think affordability is important. Because of this, consumers are able to purchase these goods due to their costs. The data from qualitative studies further supports this:

 "*…the amount i had wasn't enough for the price of the brand new, so i went for the second hand…' -*
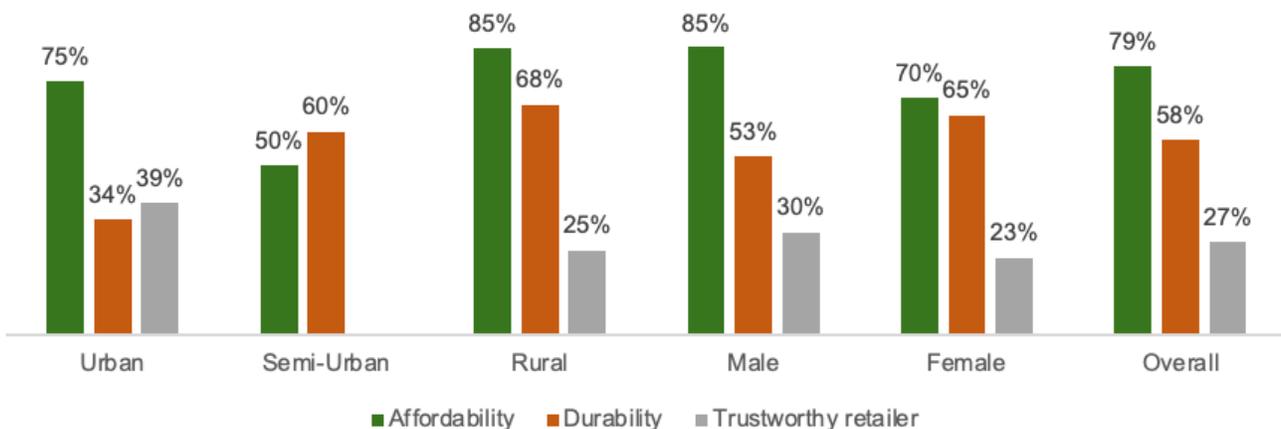***Consumer***

Figure 32: Drivers of used-cooking appliance purchase

Issues regarding Purchasing Second-hand Electrical Cooking Equipment

The main issue identified in this survey with regards to purchasing secondhanded electrical cooking equipment is affordability (price), particularly for consumers in rural areas. Following this is scepticism (purchasing is a risky venture) because consumers cannot test the device or receive a warranty from the seller.
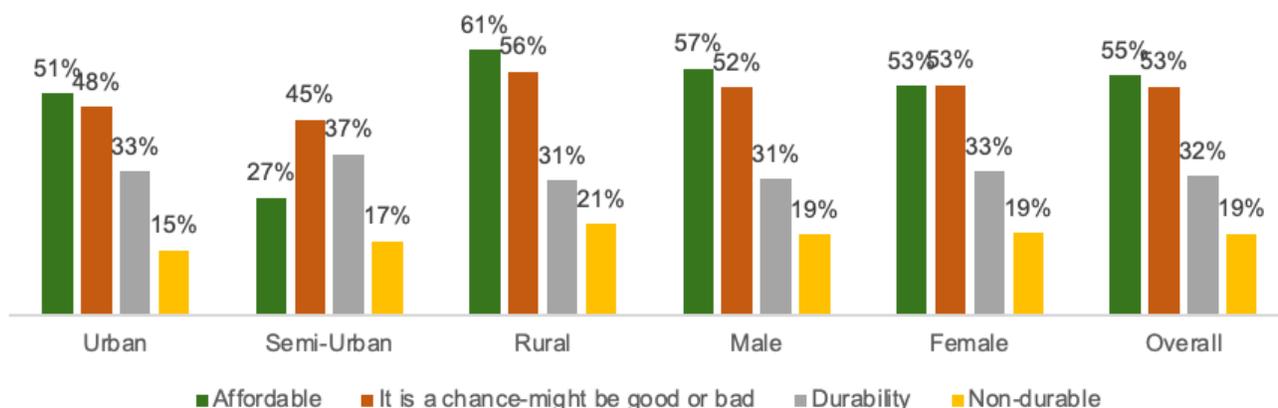

Figure 33: Issues regarding Purchasing Second-hand Electrical Cooking Equipment

Stakeholders in Failed Electrical Appliances

Consumers claim that repair shops and collectors are the primary stakeholders involved in handling faulty products, which may be useful for these stakeholders as they progress through various end-of-life pathways. According to Table 21 below, consumers in rural areas were more interested in bringing these items to repair shops, perhaps due to limited access to electrical appliances retailers when compared to consumers in semi-urban and urban areas.

Table 21: Main stakeholders/dealers in Failed Electrical Appliances

	Urban	Semi-Urban	Rural	Male	Female	Total
Repair shops	48%	37%	71%	64%	55%	61%
Collectors	50%	60%	57%	57%	52%	55%
Second hand retailers	30%	20%	8%	17%	14%	16%
Retailers	24%	23%	3%	11%	11%	11%
Breakers and parts wholesalers	11%	13%	5%	6%	11%	8%
Others	4%	3%	5%	7%	2%	5%

Considered Factors for choosing a repairing place for failed second hand items

The figure 34 below shows that the majority of consumers choose a repairer for their second-hand electrical appliance(s) based on recommendations from others. This is backed up by the long-standing heritage of the repairer in question.
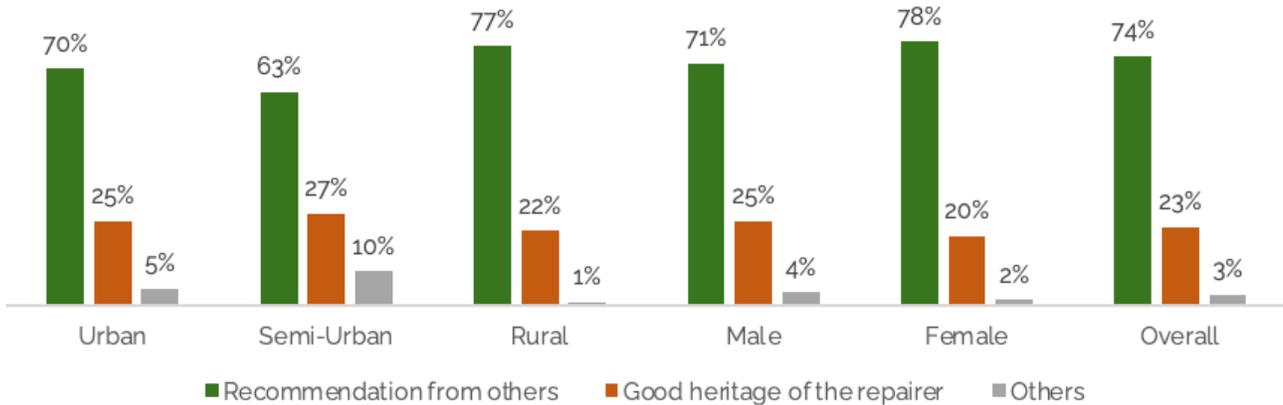

Figure 34: Considered Factors for choosing a repairing place for failed second hand item

Unsuccessful repair of items and Reasons

Data shows that 38% of consumers reported that their faulty items were not successfully fixed. Among consumers that have encountered unsuccessful repairs of faulty electrical appliances, those in rural areas have higher records than those in urban areas (rural=42%, urban=32%). Reasons for this may be due to high repair cost, repairer/artisan skill gap or unavailability of spare parts (see figure 35). Information from one of the key informant interviews reinforces this stance: "*…we have this electricity step down that spoiled my blender and the repairer says it will cost 280 cedis to repair it… it is still there in my house abandoned"* - **Consumer**
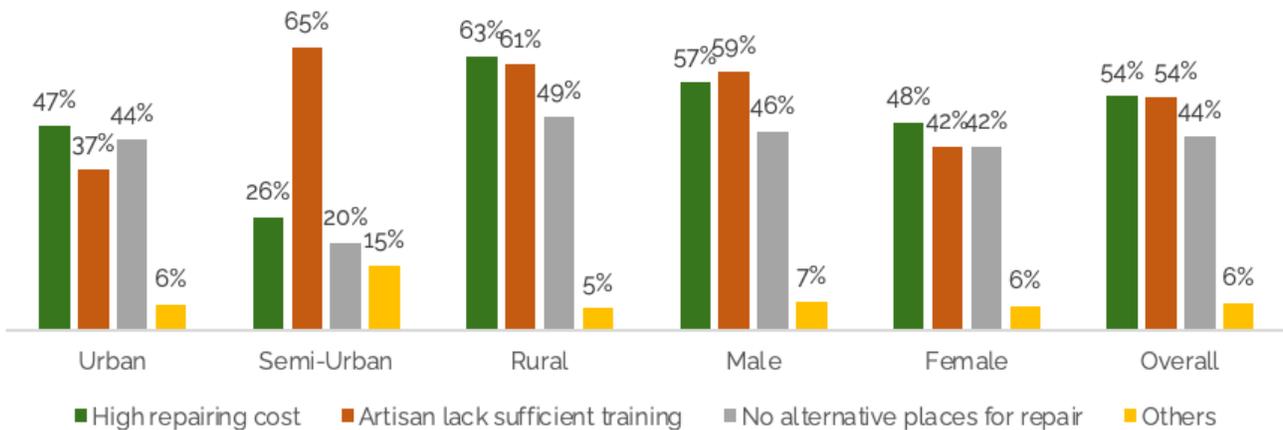

Figure 35: Unsuccessful repair of items and Reasons

Barriers in repair or reuse of items

Two-thirds of the consumers reported repair costs as a main barrier to repair and reuse of the items (64%). The respondents from all geographical settings highlighted this issue, as the most common constraint. Similarly, more consumers from rural areas were unable to get the items repaired because of lack of professional repairers, as compared to the respondents from urban and semi-urban areas (56% rural vs. 38% Semi-Urban vs. 30% urban). Half of the consumers further reported the unavailability of spare parts as the main reason for not getting their products repaired, compared to 41% of the rural and 17% of the semi-urban consumers.

Table 22: Barriers to repair or reuse of failed items

	Urban	Semi-Urban	Rural	Male	Female	Total
Repairing costs	55%	48%	71%	65%	62%	64%
Lack of professional repairers	30%	38%	56%	55%	32%	46%
Unavailability of spare parts	49%	17%	41%	40%	42%	41%
Lack of fund	14%	24%	55%	44%	32%	40%
When it's been in use for so long	21%	21%	36%	33%	26%	30%
Costly spare parts	21%	21%	28%	31%	16%	25%
Doubt in competence of repairer	19%	31%	21%	22%	21%	22%

Attitudes towards Warranties: Effect on purchasing and repair behaviours

More than half of the consumers attested to buying an item with a warranty, specifically those in the semi-urban and urban regions, as compared to the lower percentage in the rural areas.
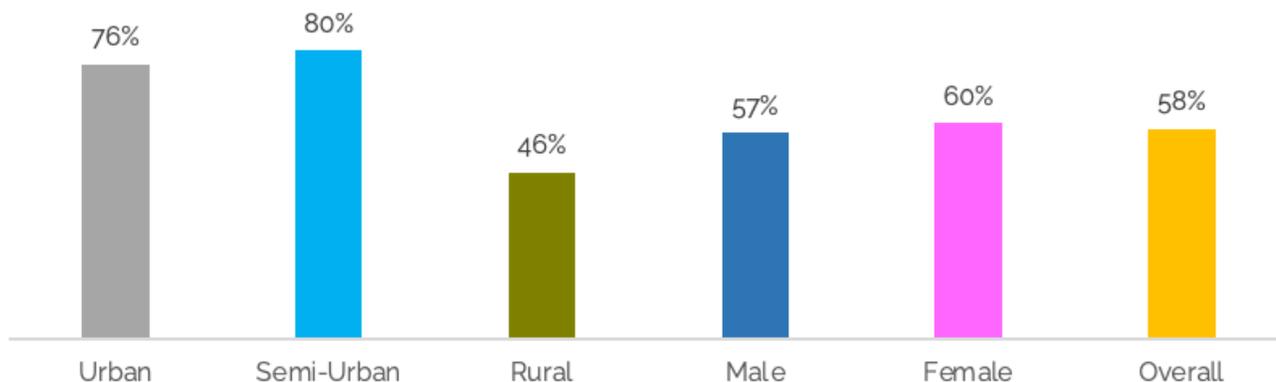

Figure 36: Attitudes towards Warranties: Effect on purchasing and repair behaviours

Warranty Period for Purchased Electrical Appliances

With some of the consumers attesting to the availability of a warranty on the item purchased, the duration of this warranty varies across the product and brand purchased. One to five years, is the most common period of warranty offered by some items. This is followed by less than a year for other items as shown in figure 37
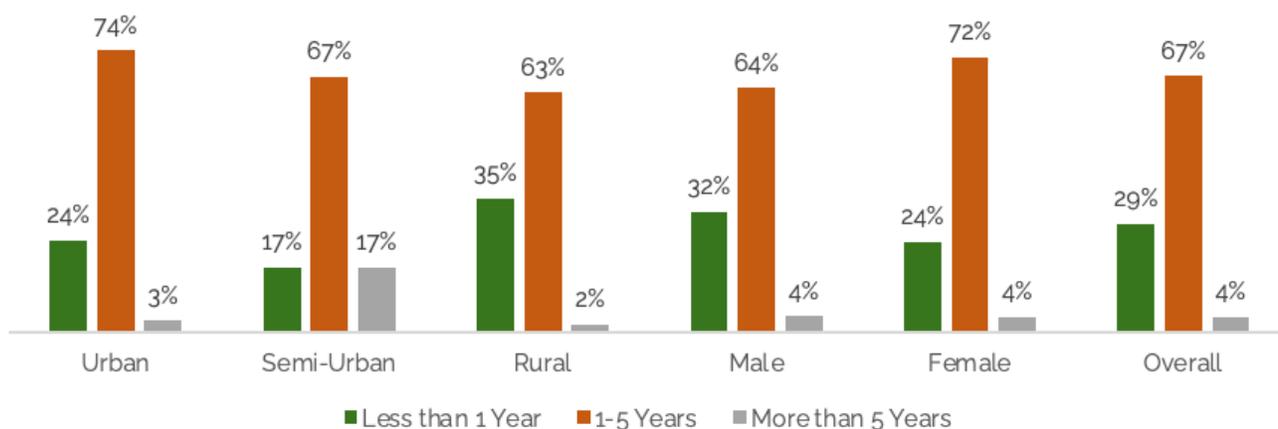

Figure 37: Warranty Period for Purchased Electrical Appliances

Electric Appliances Purchased with a Warranty

Refrigerators (39%) have been identified as one of the most acquired household electronics appliances offered with warranty, compared to other items as seen in table 23 below, with the Male consumers confirming this more than the female consumers.

Table 23: Electric Appliances Purchased with a Warranty

	Urban	Semi-Urban	Rural	Male	Female	Total
Television	39%	38%	34%	39%	30%	36%
Refrigerator	39%	35%	39%	43%	32%	39%
Mobile phone	23%	29%	18%	20%	22%	21%
Electric Iron	4%	7%	11%	7%	9%	8%
Blender	7%	16%	17%	11%	12%	11%
Electric Fan	1%		10%	6%	5%	6%

Computer	16%		19%	16%	13%	15%
Electric Cooker	10%		13%	5%	18%	10%
Washing machine	40%	33%		27%	56%	38%
Electric Kettle	7%	5%	8%	3%	12%	7%
Radio	6%	8%	3%	5%	3%	4%
Sound system	2%		9%	6%		4%
Portable media player		50%		3%		2%
Microwave	8%		30%	3%	17%	10%
Others	83%	0%	0%	29%	17%	25%

Usage of Warranty and Reasons for non-usage

Figure 38 below presents that a substantial majority of the consumers did not use the warranties offered, because the period was not long enough to cover when the repair was needed (item has not broken down yet). Other different reasons established are as also shown in figure 39
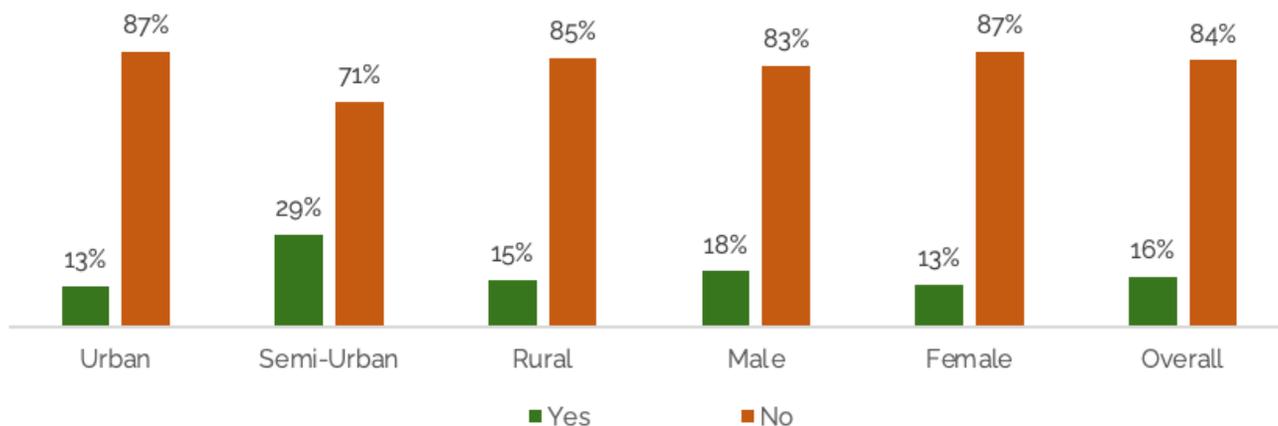
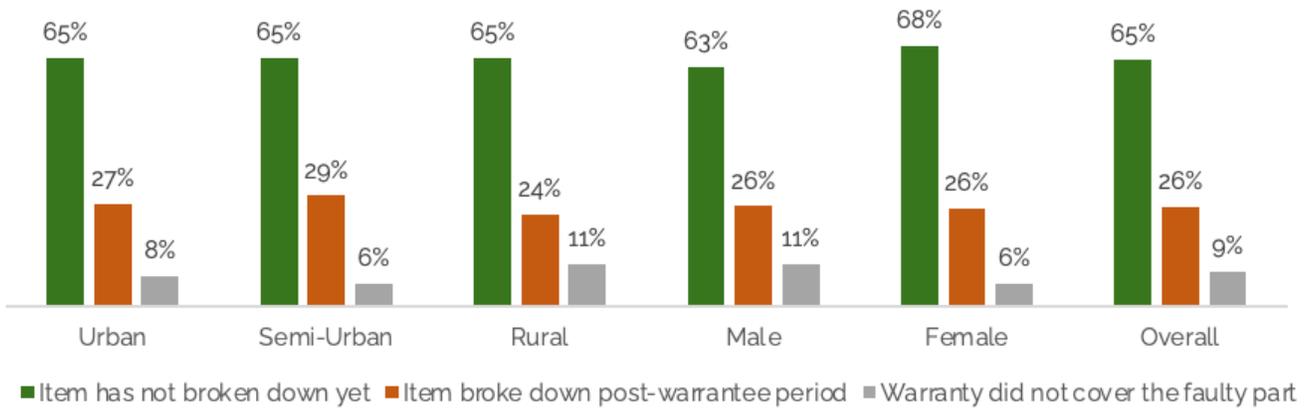

Figure 38: Made Use of Warranty

Fig 39: Reasons for not using Warranty

Purchase decision based on warranty

Overall, slightly more than half of consumers do not base their purchase decisions on the availability of warranty, while the remaining 45%, base their purchase decisions on warranty.
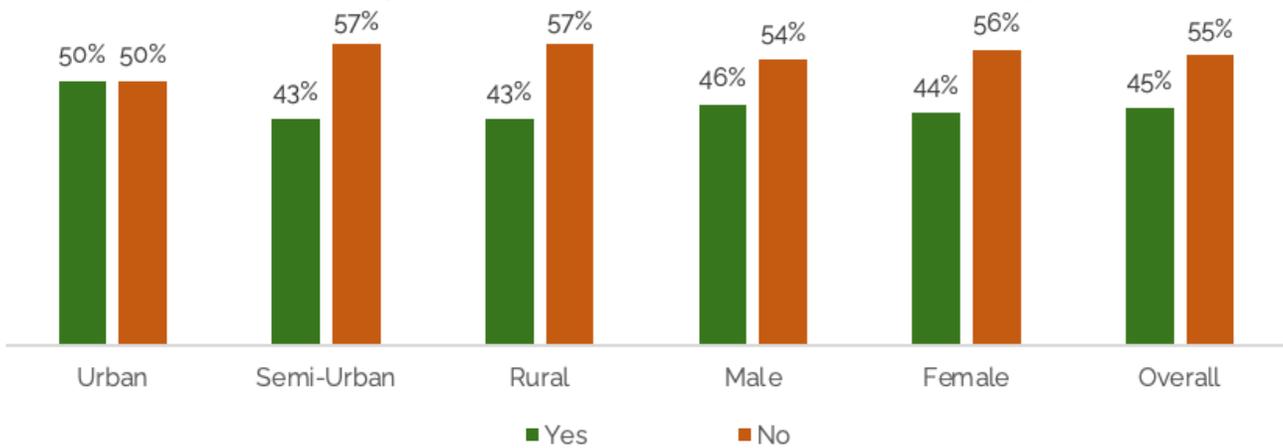

Figure 40: Purchase decision based on warranty

More than half of consumers who base their purchase on warranty feel that doing so will spare them the expense of having to pay extra money to have the item repaired should a problem arise during the warranty period. This is further outlined in Table 24 below.

Table 24: Reasons why Warranty is Utilized

	Urban	Semi-Urban	Rural	Male	Female	Total
It can be repaired or replace without extra money	53%	67%	59%	63%	50%	58%
It assures quality and safety of product	47%	33%	57%	55%	46%	51%
Easy repair or replacement of item	45%	83%	43%	45%	50%	47%
It shows the item is durable	19%	25%	65%	49%	40%	46%
It indicates less financial risk	21%	33%	44%	31%	42%	36%

Consumers who base their purchases on a brand's reputation rather than the product's warranty consider the warranty irrelevant and hold the brand in high regard. (See table 25.)

Table 25: Reasons why Warranty is not Utilized

	Urban	Semi-Urban	Rural	Male	Female	Total
Warranty does not really matter	68%	59%	66%	62%	72%	66%
I buy brands that I trust	45%	41%	47%	53%	34%	46%
Some second-hand items are more durable	19%	6%	40%	36%	23%	31%
Some items cannot be returned when broken	21%	18%	19%	19%	20%	19%

Consumer Perception on Warranties

According to consumers in rural areas, warranties exist only to promote sales. Consumers encounter this in the same way in urban and semi-urban areas. 53% of those surveyed said they normally do not experience appliance problems within the warranty period. (See fig.41)
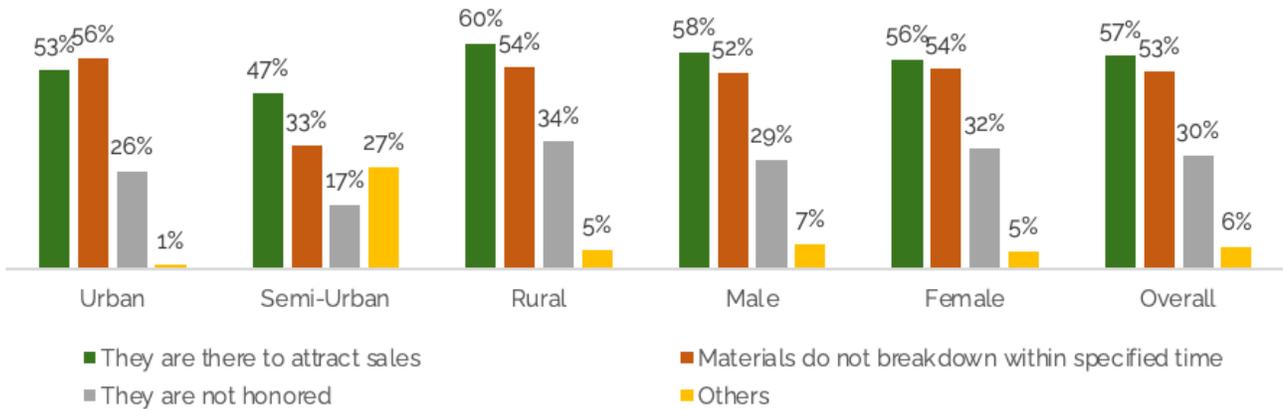
Figure 41: Consumer Perception on Warranties

Attitudes towards e-waste disposal and recycling of energy using appliances.

In terms of the most effective methods for consumer disposal of e-waste, this survey shows that consumers in rural areas are more likely than consumers in other settlements to give their e-waste to collectors or metal/scrap dealers. Also, consumers, particularly in urban and semi-urban settings, prefer to sell their e-waste to other stakeholders who are ready to buy it. Few people choose to dump it in the trash can. The consumer interviews provided more information about how customers dispose of their electronic waste.

"I just pack it somewhere and give it to anyone who wants it …. sometimes, I leave it with the repairer… if it can be taken to scrap, if they like it, I can sell it to them but if they don't I dispose of it" **Consumer**

Figure 42: Consumer Perception on e-waste disposal and recycling

Consumer awareness on standards guiding the disposal of e-waste

Almost all consumers in the survey were unaware of any standards guiding the disposal of e-waste (100%).
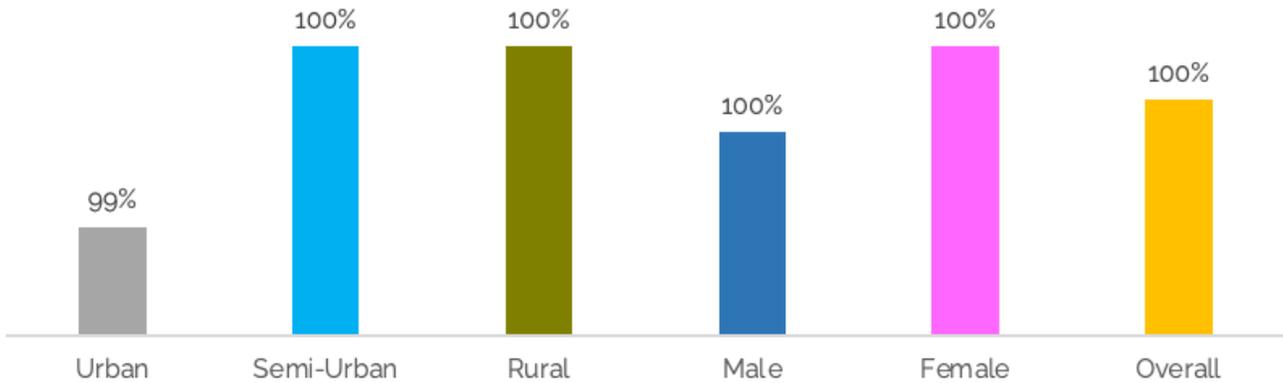
Figure 43: Consumer awareness on standards guiding the disposal of e-waste

E-waste influence measures offered by the local authorities

Figure 44 shows that one-half of consumers are unaware of any e-waste-related influence that local authorities have. While 38% of consumers cited awareness campaigns as influencing tools, 34% cited legal restrictions. When compared to respondents from urban and rural areas, a sizable majority of semi-urban customers were found to be uninfluenced.

Figure 44: E-waste influence measures offered by the local authorities

Barriers to sustainable actions towards e-waste disposal

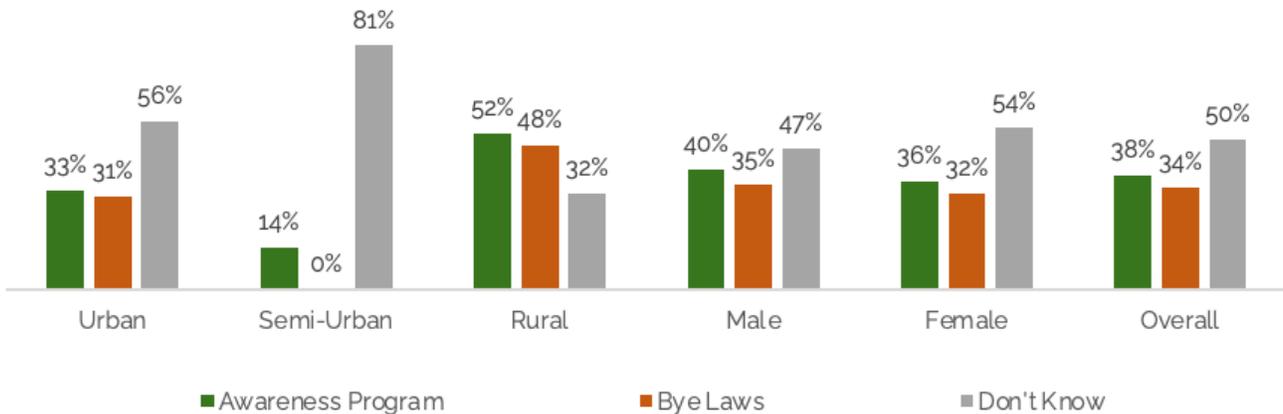Lack of knowledge about e-waste disposal, followed by a lack of e-waste centres in their locations, was shown to be the main barrier preventing many customers or other members of their communities from taking more sustainable measures toward e-waste disposal (see fig. 45).
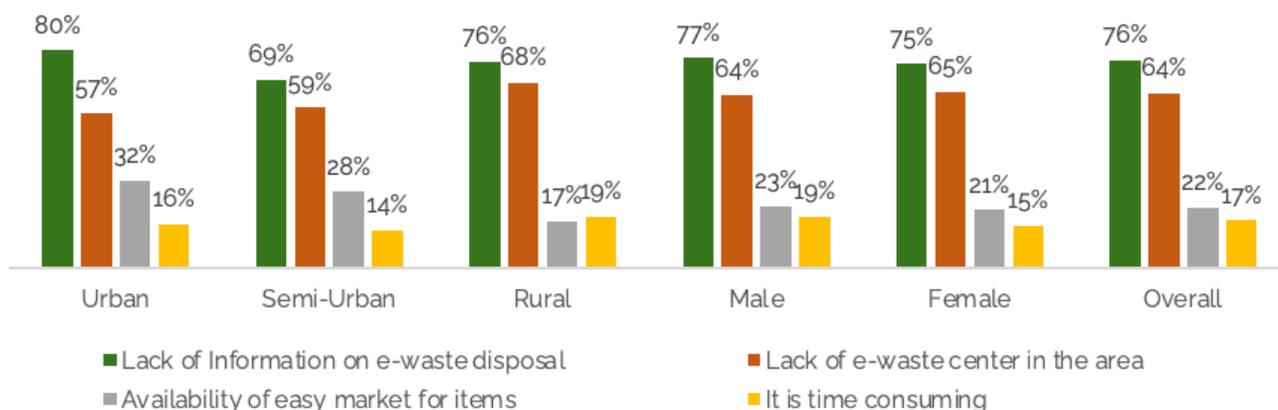

Figure 45: Barriers to sustainable actions towards e-waste disposal

3.5. Stakeholder Structures and Barrie

In relation to the diversity of stakeholders, there are also obstacles preventing their ability to manage the ecosystem of EE waste effectively as well as mechanisms for their extension and growth. These barriers are displayed and discussed in Table 26.

Table 26: Stakeholder structures and barriers

Stakeholder	Structure of industry	Source of material	Barriers
Manufacturers/ Assemblers	These include well-known foreign brands as well as locally assembled ones. **Foreign brands** - Distributed through the wholesaler/retailer - Comes in both brand new and second hand **Locally manufactured** - Gets distributed by the same manufacturers - Very small market available	Materials are sourced from within and outside the country - Due to additional taxes on the importation charges, directly imported materials are expensive. - Within the country, materials are either brand new or second hand. It is believed that some brand-new spare parts or materials are costly but not always durable.	Imported brands; - Sometimes they are very expensive due to exorbitant importation taxes, freight charges, etc. - Get damaged quickly as a result of electrical power fluctuations. - Due to local considerations, such as voltage, it could occasionally not be usable. **Locally manufactured** - May not have the appealing appearance that customers want.

			● No readily available markets for these appliances ● perceived to be of lower quality and durability due to its local manufacture and in comparison, to brands from abroad. ● There are no specific policies that are known to exist that might help local manufacturers.
Retailers (brand new and second hand)	They market reputable, long-lasting brands based on customer preferences. ● operates in both formal and informal settings and depends primarily on their financial resources ● Formal markets sell primarily new items. ● The informal market sells both brand new and second-hand electronic appliances which serve all classes of households.	**Retailers of brand-new appliances** ● Source for appliances from wholesalers or directly from manufacturers or assemblers ● Return policy (warranty) is available for faulty appliances back to the manufacturer for repairs/ replacement. ● In terms of faulty appliances, they replace faulty parts with brand new ones **Retailer of second-hand items** ● Source for both brand new and second-hand appliances. ● Also, source for spare parts to replace faulty parts of second-hand electrical appliances purchased.	● Delays in item replacement; Retailers are requested to follow the procedure of returning the appliance to the manufacturer's approved repairer only whenever a malfunction is experienced. ● Some second-hand appliances are challenging to fix due to a lack of expertise and spare parts. ● High taxation in the existing electronics market serves as a major hindrance to potential investors.
Consumers	Electrical appliances are chosen by consumers based on the brand's reputation, personal or collective user experience, and affordability. These	Consumers source for these products from ● Formal Markets: These are registered businesses fully incorporated	● Some consumers dispose of electrical appliances since there aren't enough authorised facilities or

	elements determine whether to buy an item brand-new or used. ● Affordability ● Need of the appliance ● Quality ● Access to repair ● Durability ● Accessibility ● Experience with such brands	according to Ghanaian laws and in alliance with other regulatory bodies. E.g. retail shops, shopping malls, supermarket, etc ● Informal Markets: Purchases done in such markets are mostly unofficial and items could be traded without proof of purchase. This can be done in the local market, on the roadside, with neighbours etc.	skilled repairers to fix the faulty appliances.
Collectors (Formal & Informal)	Although some of the collectors are formal in structure, the majority of them work informally and are frequently unregistered businesses.	● Formal and Informal collectors get their materials from homes, companies, and dump sites either at a fee or for free. ● These old appliances are sold to scrap dealers. ● Scrap dealers on the other hand gather these old appliances from scavengers and sell them to recyclers or material recovery experts or even local manufacturers	● Constraint in the enforcement of policies regulating the activities of the collectors, especially the informal ones expose them to hazardous conditions ● Limited recycling centres
Recyclers	These are professional companies that remove e-waste from damaged electrical appliances with the intention of replicating or selling the materials to other large-scale manufacturing firms.	The raw materials for these are sourced from collected electrical appliances through the scrap dealers, individual consumers, and repairers. Upon collection, these items are sorted into various components; screens, chips (with gold plates or copper), motherboards, etc.	● Most recyclers have little or no support from donors to compete with other stakeholders in the collection of e-waste materials. ● Policies are in place to efficiently collect e-waste and recycle them in a less crude manner. However, the enforcement of these acts prevents formal

			recycling companies from challenging other unlicensed stakeholders.
Repairers	These are mostly informal businesses and sometimes with or without registration Sole proprietorship for those who have taken the step to register their business. Operates from smaller structures such as a kiosk or 'containers or their homes.	Repairers as the name suggests fixes appliances, not in working condition. They mostly depend on spare part dealers, scrap dealers, and scavengers for appliances for parts that are necessary to fix broken appliances. They are also able to sometimes repair these so-called spoiled appliances and sell them out.	● Not enough capital for expansion. ● Consumers unable to pay for repairs ● High cost of electronic parts

4. Material Flow Analysis

4.1. Current Mass flow
4.2.

All of the EEE and WEEE flow paths among all pertinent stakeholders in Ghana were taken into account during the material flow study. The key stakeholders and the flows between them are shown in the mass flow system chart in Figure 46. The flows and stocks of the EEE were considered in tons for the year 2022. The figures for the mass flow assessment were acquired through key interviews and observations from stakeholders during the study.
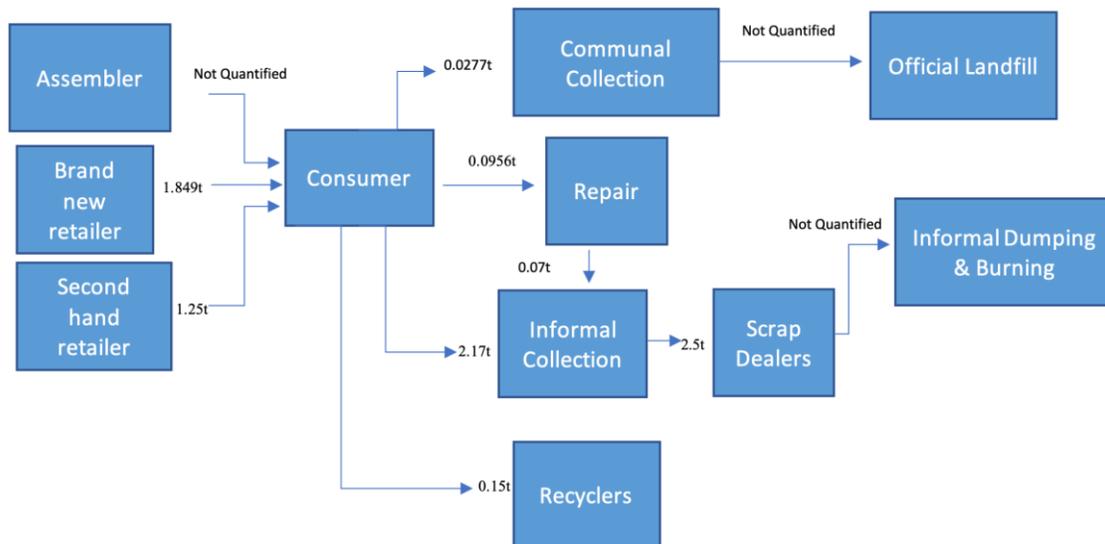

Figure 46: Material flow analysis for Stakeholders (in tonnes)

The materials flow analysis for this research was not appliance specific and is derived from the estimated values given by each stakeholder that was interviewed and observed. Hence, they were

based on the average figures as per each stakeholder represented in the flow. The quantity of flow was measured in tons per year.

From our analysis, it was observed that the amount of e-waste entering both the landfill (formal site) and the informal dumping site was unquantified. The communal collectors and the scrap dealers informed that they rarely weigh the amount of e-waste they dispose of because it has no financial value for them. In 2022, it was observed that more materials were flowing from brand new retailers to consumers when compared to from second-hand retailers. In addition, it can be seen that the majority of materials flow from the consumer through the informal pathways (informal collectors) rather than the formal pathways (recyclers and communal collection), emphasizing the reliance on the informal sector for e-waste disposal.

4.1.2. Future Mass Flow Trend

The EEE sector in Ghana is declining as far as importation is concerned. This is due to recent policies that are aimed at discouraging the importation of electric and electronic equipment, especially of second-hand products[62]. Policies such as Energy Commission Act 541 regulations on the importation of used electronic appliances (2022) and energy efficiency standards and labeling regulations on imported electronics, stagnate the growth of EEE imports. These policies have also led to a corresponding increase in the number of local manufacturers or assemblers, in the country. Not long ago, Omatek Computers was the only assembler, however, there are many others now. Notable among them are Zepto, GN Electronics and Topical Business Solutions. This situation will also add to the number of EEE produced locally and thus expand the local economy.

Ghana imports of electrical and electronic equipment were worth US$ 685.02 million during 2019[63], according to the United Nations COMTRADE database on international trade. The current WEEE flows from this research were calculated based on the information from the key informant interviews conducted in Ghana in 2022, as it was difficult to calculate future WEEE flows based on extrapolated import data. Nevertheless, it could be deduced that future WEEE flows will decrease according to decreases in imports, and that until 2025, WEEE flows will decrease at least by a factor of 2.

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[62] https://www.graphic.com.gh/news/general-news/ghana-bans-importation-of-some-substandard-used-appliances-list.html

[63] https://tradingeconomics.com/ghana/imports/electrical-electronic-equipment #:~:text=Ghana Imports of Electrical electronic equipment was US 24685.02 Million,updated in March of 2023.
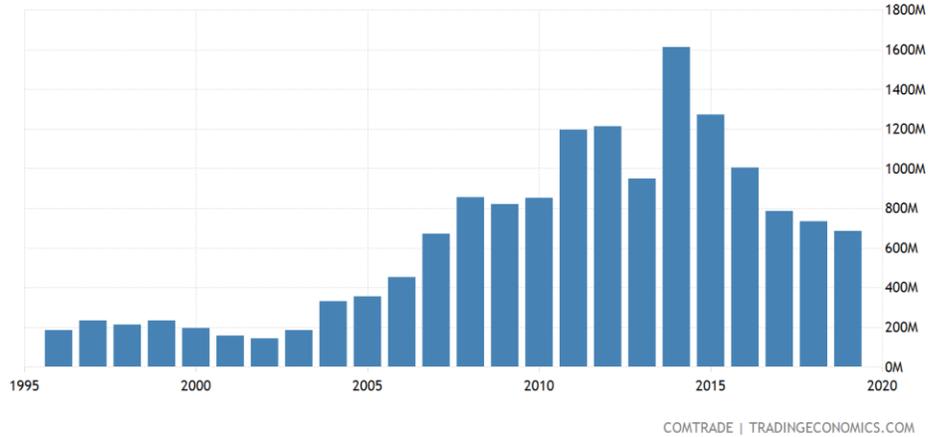
Figure 47: Ghana Imports of Electrical, electronic equipment

4.1.3. Impacts

The great majority of e-waste in Ghana is handled in harmful, unsafe, and unfavourable environmental conditions. Open burning of cables and manual lead-acid battery disassembly are still common activities that seriously harm the environment and human health. Based on the flow within the Ghanaian WEEE sector as indicated by this research, a variety of impacts; social, economic, and environmental have been identified.

Social and Economic Impacts

Sorting through used electronics is a livelihood for many in Ghana especially within the Agbogbloshie area which houses the largest dumpsite. Not only have these activities created employment opportunities for some, economically, e-waste activities generate US$105-268 million annually and represent the livelihood of at least 200,000 out of 29.12 million people nationwide[64]. However, the toxic e-waste poses serious health risks. These workers frequently suffer from respiratory issues, chronic nausea, excruciating migraines, burns, back difficulties, infected wounds, and other illnesses brought on by their hazardous working conditions and the poisonous air pollution.

This report has earlier established that the Ghanaian e-waste sector is largely informal and as a result, locals frequently scour the pits of abandoned electronics in an effort to harvest lucrative metals like copper and gold from them. The damaging inappropriate recovery techniques, like acid baths and burning electronics, are frequently carried out even by local women and children.

The government implemented a regulation in November 2022[65] to prevent the importation of second-hand electronics that are of poor quality from developing countries. It is predicted that the negative socio-economic impact will reduce, should the Ghanaian government have the political will to follow this policy through.

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[64] Oteng-Ababio M., Amankwaa E.F., Chama M.A. The local contours of scavenging for e-waste and higher-valued constituent parts in Accra, Ghana. Habitat Int. 2014; 43:163–171. doi: 10.1016/j.habitatint.2014.03.003.

[65] https://www.graphic.com.gh/news/general-news/ghana-bans-importation-of-some-substandard-used-appliances-list.html

In addition, improper management of e-waste is resulting in a significant loss of scarce and valuable raw materials, such as gold, platinum, cobalt, and rare earth elements. As much as 7% of the world's Gold may currently be contained in e-waste, with 100 times more gold in a tonne of e-waste than in a tonne of gold ore[66].

Environmental and Health Impacts

Figure 48: Burning fumes from the Agbogbloshie (Photo credit: Qualiqaunt Services Limited)

A major impact on the environment results from the numerous processes of disintegrating e-waste materials, such as dismantling, material recovery, and final disposal. During the process of extracting metals from printed wiring boards (PWBs), e-waste materials are first dismantled and then subjected to various ill-mannered processes for extraction, one of which is open burning. Open burning of WEEE has a direct harmful substances into the air. The decomposition of contaminants in soil, sediments, or water has an indirect impact on the environment.

In Accra, approximately 3,000 premature deaths (roughly 11% of the total) were attributable to air pollution in 2019. This exceeds the number of premature deaths caused by the 10.4% resulting from malaria, the 4.9% from tuberculosis, and the 7.5% from HIV/AIDS. Air pollution can be considered a direct impact due to the transportation of hazardous contaminants during open burnings. During this process, dense fumes are produced, affecting the breathing of informal workers and residents close to the site. Currently, in the 'Agbogbloshie' neighbourhood, the situation is quite extreme as there is an incessant rate of burning wires and cables, which results in thick black smoke in the environs, and this has taken longer to clear off despite the closure of the Agbogbloshie scrapyard. The annual nationwide cost to Ghana of air pollution is estimated at $2.5 Billion or approximately 4.2% of GDP[67].

Another major concern is the pressure on the ecosystem. The piles of e-waste materials that are not properly disposed of are often washed down or flooded by rainfall into lakes and rivers, making them unfit for drinking, swimming, fishing, and supporting wildlife. Also, with the annual increase of disposable e-waste, the release of various toxic chemical substances such as lead, mercury and Cadmium added to the soil and water surfaces leads to increase pressure on habitats in the ecosystem and the disappearance of vegetation within the environs.

The food chain is also being exposed to these health dangers. One of Accra's biggest food markets can be found in the Agbogbloshie neighbourhood, where scrawny animals also roam free and graze on the waste. Agbogbloshie was discovered to have some of the most dangerous substances on earth, according to a recent analysis by the environmental organizations Ipen and the Basel Action Network. An egg laid by a free-range chicken in Agbogbloshie contained 220 times more chlorine dioxins than allowed by the European Food Safety Authority. Chlorinated dioxins can harm the

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[66] https://www.unep.org/news-and-stories/press-release/un-report-time-seize-opportunity-tackle-challenge-e-waste

[67] https://documents1.worldbank.org/curated/en/419871588578973802/pdf/Ghana-Country-Environmental-Analysis.pdf

immune system and cause cancer[68]. Ghana has therefore begun to recognize the danger posed by e-waste.

Following the Paris Agreement on Climate Change in 2015, Ghana has recently developed an action plan to transition to net zero carbon emissions by the year 2070, and the ban on the importation and use of these used and inefficient appliances will contribute hugely in attaining net zero emissions within the stipulated period. Ghana has acknowledged the strategic value of addressing climate change and air pollution simultaneously. In its National Greenhouse Gas Inventory that it submitted to the UNFCCC in 2020, it made history by becoming the first nation in the world to include air pollution in the form of black carbon. Furthermore, Ghana released a National Action Plan to Mitigate Short-Lived Climate Pollutants (SLCPs) in 2018 that outlines actions that both enhance air quality and aid in climate change mitigation.

Implementing the identified indicative clean air policies to reduce air pollution could unlock more than $28m for Accra – around 16% of its financial costs under the business-as-usual scenario in 2040 alone. More importantly, in that year, more than 11% of lives could be saved (over 363), and GHG emissions reduced by 32% (2 Mt of CO_2 equivalent). The cumulative impact of the levers on air pollution in Accra from 2023 - 2040 could unlock around $250m, over 3,000 lives, and abate GHG emissions by 29 Mt of CO_2 equivalent[69].

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[68] https://www.theguardian.com/global-development/2019/apr/24/rotten-chicken-eggs-e-waste-from-europe-poisons-ghana-food-chain-agbogbloshie-accra

[69] https://www.cleanairfund.org/clean-air-africas-cities/accra/

Case Studies

Case study 1: Retailer in Brand New Electrical Appliances

Prince Nuhu is a 32-year-old retailer who lives in the sub-urban part of Tamale in the northern region of Ghana. He is married with a child and operates a family business that has been around for over 20 years. The business, '**Central Music'** which started with the sale of musical electronics has diversified into the sales of other electrical electronic appliances such as ceiling fans, standing fans, blenders, electric cookers, stabilisers, etc. As an EE salesperson, his main cash cow is the sales of electric fans, with the overall sales of electronic appliances at 10,000 cedis a year.

'Central Music" is known for the sales of brand-new electronic devices, this is backed by the choice of selling premium and durable products only. The business ensures that customers get optimum satisfaction from purchasing any electrical appliances from them by offering unique after sale services such as free assembling and installation of electrical appliances, and repair support on damaged items: *"…… .as a retailer, if a customer brings an item back, I have to repair it and bear the cost, but I can't replace the item".*

Prince added that: "I care a lot about my customers, and that is why the business has been in operation for more than 2 decades. We deal in quality products because If people buy fake items from me, then they will go and inform others not to buy from me… and that is not good for business.".

As a brand-new retailer, Prince ensures products sold are warranty inclusive. In terms of experience with e-waste, Central Music does not have any experience with handling unrepairable items but damaged items are often repaired for customers rather than being thrown away as scraps. However, Prince claimed he has not had a good experience with items returned during the warranty periods.

He disclosed this experience during a 'return' encounter: *"I don't believe in warranties because as a retailer if a customer brings an item back, I have to repair it at my own cost… manufacturer don't change items for us instead they also want to repair it and send them back to us…. we can't sell a repaired product, at all"*

However, Prince believes the Ghanaian government and the manufacturers have a major role to play in ensuring e-waste is properly managed and recycled: *"The best option is for the government to remove the taxes on the companies that are coming in to settle in Ghana, so we can return products to them to recycle, and maybe they can give money in exchange for the spoilt item. This will be better instead of giving it to scrap dealer who would pay 1 cedi for an item worth like 10 cedis in value … which would encourage us, the retailers… the companies should follow up with the retailers too. They know that people are buying our products and are having issues with them, they need to ask themselves*

that what can we do as a company to bring back these products…, they can recycle it into something else instead even of repairing it……they should build recycling companies worldwide.

Case study 2: Retailer in Second-Hand Electrical Appliances

In the suburban region of Tamale lives Samsudeen Abdulsalem. Samsudeen is a 26-year-old man who is currently a part-time teacher, a student, and a business owner of Mushamadeen enterprise. The business deals with the sales of electrical appliances such as microwaves, television sets, irons, electric cookers, etc.

The sales of electrical appliances at Mushamadeen enterprise are a mix of both brand-new and second-hand products: *"We do brand new at times, but comparing both I would say we are more into the second hand than brand new, the reason being that we have studied our customers and we've found that they have taste in second-hand items more than brand new."*

The business was established over 20 years in Accra, the capital city of Ghana, however, Samsudeen set out to establish a branch in Tamale. Operating for over 4 years, the business has experienced a huge amount of success in terms of sales within the city:

"it is doing well aside from the Covid-19 issues that affected it at some point"

The business majorly sorts for its product from Accra and Kumasi and most times gets based on referrals from dealers. As a second-hand business retailer, he disclosed that customers tend to favour second-hand products in purchase compared to new products: *"People prefer second-hand products, they believe that second-hand products are more durable and also people's mentality believe that second-hand products are the best".*

The second-hand appliances business thrives in this region because a large number of the population within Tamale are middle-income earners. Although there is a mix of sales of new and second-hand products, customers within this region tend to purchase more second-hand products: *"Yes, one thing about this business is that even if I mix the new and second-hand products together, they would still identify and pick the second-hand products, people believe that it is durable and lasts longer."*

Case study 3: Repairer

In the suburban city of Lamashegu lives Abass Saleem, who is 38 years old. A repairer with over 10 years' experience after obtaining his apprenticeship from his master, who lives and operates the same type of business nearby.

"I started this work when I was 9 to 10 years that time, I was in primary school, was when I started it with my father who send me to one of the biggest men in this tamale, he knows a lot about these things electric, electronics especially TV side and he told me that I should learn it and now am also my own boss"

One major reason he is easily sought after is due to his excellence in his delivery, and the pricing for the services rendered is affordable: *"I am honest and I deliver a good job for my customers, these are the reviews I usually get from them."* His business 'Abass Saleem Enterprise', although informal, is popularly known in the area due to his ability to fix different types of electrical appliances such as televisions, electric cookers, electric kettles, etc. The workshop, though small, is partitioned around the front walls of the residential apartment and has two additional staff members who assist him - purchase spare parts or deliver appliances at customer's home. There is a huge turnout in the repairs of electrical appliances and Abass revealed that the most frequent household appliance attended to for repairs is televisions. This is as a result of consistent shortage of electric current. These appliances are brought in with motor bikes from consumers within his vicinity: *"I repair Television the most…… I can repair about 100 TVs a month"*

Abass makes an average of 2000 cedis ($183.4) from repairs of various electrical products, with charges of repair ranging from 60 to 200 cedis (($5.50 to $18.34). This pricing excludes the cost of spare parts which is easily purchased within parts of the town.: *"I buy the spare parts from the Igbos (a Nigerian ethnic group) in Town"*

As a repairer, there are certain difficulties operating such business within the city, and Abass recounts facing such challenges. This involves the purchase of spare parts, modernized working tools to ease and make repairs much more effective.

"I face challenges in terms of buying spare parts, machines, or tools I need and use for my business. The unavailability of some of the parts I need. sometimes I don't get to see some parts to buy, the cost of the tools,"

With the major influx of appliances for repair, Abass shares that he doesn't have the capability to fix these appliances, and as a result, these items are dumped as scraps by his customers in his workshop. These items are then finally sold to scrap dealers: *"It depends on how the things that they want inside the TV they want this thing the copper mostly…..you can sell it and give it to the scrap dealer like for 46 to 50 cedis"*

Having disclosed some of the policies with Abass, he disclosed that he is not aware of these policies and hence does not adhere to it.

Case study 4: Informal Collector

E-waste collection is a regular day-to-day activity in Ghana's northern region. Abdullahi Isaku popularly known as 'Cheerboy' is the vice chairman of the northern region scrap dealer's association. Married with 3 wives and nine children, Abdullahi owns a scrap collection business named Royal Abdullahi Isaku Cheerboy enterprise, with just 1 support employee. This business has been involved in the buying and selling of electronic scraps, batteries, copper, and aluminum to other dealers of e-waste materials in Accra for the past 20 years. As the vice president of the scrap dealer's association, Cheerboy finds it quite easy to gather e-waste materials from different sources: *"I get them from churches, mosques, houses, hotels, restaurants, mechanics, factories, schools, and institutions.*

As a collection enterprise, Cheerboy, after collection and gathering electronic waste, dismantles the damaged electrical appliances and extracts valuable parts from the failed appliances, - Copper, Aluminum, Brass, etc, - and sells them.

"I lose them with tools like a star to remove them so it doesn't burst. I have been trained to remove them gently because when you hit them, it makes lots of noise and disturbs people, but this method I use doesn't cause noise. I lose it, remove the items I want, and throw the rest away. People quarrel with me a lot because of how much I dump things around, they want me to send their trash somewhere else, and they do not want me to burn it, but I need money to be able to do what they are requesting, which if I try to do, I would end up using the whole of my profit for it, which is not advisable. So, I go ahead and burn them here regardless of what they say."

Afterward: *"I sell to people in Accra, I don't go there to sell them, instead, I send them to my friends, and they sell and send the money to me."*

Venturing into the scrap business in search of a better life, Abdullahi recounts that the business had brought good fortunes by making profits from the business: *"I make like 50 kilos of Coppers in a month…. 1 kilo is 40 cedis ($3.67), 30 kilos in a month for brass…. 1 kilo is 20 cedis ($1.83), for aluminium I can get 100 kilos in a month…. 1 kilo is 5 cedis (46 cents)"*

Case study 5: Scrap Dealer

Ibrahim was born and raised in the city of Tamale. A 28-year-old scrap dealer who relocated to Accra in 2017 in search of a living, After many years of seeking a way to make ends meet, he joined the business of collecting and dismantling e-waste items for financial gains: *".... because of the money..."*

Ibrahim occupies a poorly constructed shop around the demolished Agbobolishe scrapyard, where he gathers scraps from e-waste materials, dismantles them, and burns some parts to reveal other vital parts. According to him, the items are obtained from collectors who go from house to house, while he focuses on dismantling them to get the necessary materials for resell: *"So we have boys who go from house to house to ask if there's someone who has an appliance that they are not using again or a spoiled item, then they bring it down here and we dismantle them to get the useful items we need."*

These collected items are brought in either via small bags or via minitrucks. Ibrahim weighs the items and then makes payments to the collectors. These payments vary as it depends on the current exchange rate with the USD: *"1 kilo is 2 cedis (18 cents) to 3 cedis (28 cents) ....it depends on dollars, if the dollar increases the price increases and if it goes down the price also goes down"*

The valuable items are sold in large quantities to various companies through agents who come to the scrapyard to make contact with him or other scrap dealers. These items are available in different sizes depending on how much is available at the time of purchase.
"It depends on the tons, we sell like 20 tons or more, It depends on the load type, some 27 tons, some 43 tons"
The current market for buying and selling e-waste materials and extracted items is lucrative, as scrap dealers gain more with investment in the business.

I make like 200 ($18.34) to 2500 cedis ($229) in a month. It depends on how much you put into the business, if you put 4 to 5 million into the business, you can make about 10,000 cedis ($917) a month.

5.   Conclusion and Recommendation

Every electric device eventually reaches the end of its useful life. The rate, frequency, and activities necessary when an appliance reaches the end of its useful life differ as a result. This research highlighted the various stakeholders involved, what happened with regard to electrical and electronic equipment as it travelled down the pathway, and what was done at each point along the way. The quality of the appliance and whether it was purchased brand-new or used both play a significant role in how quickly it reaches the end of its useful life. The frequency largely depends on structural factors like electrical power as well as the availability and capacity of experienced workers (repairers) to reassemble the equipment when it breaks down. What is most alarming, though, is what happens to the appliances if they prove to be beyond repair or just refuse to work correctly after purchase, leading to an increase in e-waste.

This study demonstrated that there are significant variances and changes between urban and rural locations in terms of the energy used for cooking, the choice of home appliances, the methods used for repairs, and the stages at which appliances reach the end of their lives. While it is evident that high income, exposure, and affluence, influence people's preferences for household appliances and behaviours toward their usage in urban regions, this is not the case for people in rural areas, whose tastes and attitudes are constrained by these characteristics.

This study also revealed that the informal sector plays a key role in Ghana's poor handling of e-waste disposal and management. Poor results in terms of social, economic, and environmental aspects have resulted from this. On paper, however, Ghana appears to be waking up to the change by instituting excellent regulations to stop the spread of subpar electrical appliances, which is the main driver of rising e-waste, as well as strengthening the official e-waste sector to improve e-waste disposal and management. The only thing left is to ensure that these regulations are adhered to strictly.

This welcome development can shape the investment landscape for recycling and waste disposal in Ghana. There is the potential for the electronic and electrical appliance market to develop with the local assembly of appliances being encouraged, enabling new but relatively less expensive products to become available to consumers. This speaks directly to the electrical cooking appliances as well.

In addition, this study shows that repairers play a major role with regard to how fast a product reaches the end of its useful life. Repair increases the longevity of the goods we purchase. In two ways, this helps us save money. First, we save money by replacing our purchases less frequently. Second, repair ensures that outdated equipment still has some residual value on the used market when it is eventually replaced. How much material flows from the consumer to the repairer is revealed by the flow analysis in this report. Thus, it is recommended that repairers participate in brand- and appliance-specific skill-upgrading programs designed and offered by both the public and private sectors.

Having established that the informal sector dominates e-waste disposal and management in Ghana, including them in the quest for change is not unrealistic. In order to address climate change sustainably, our recommendation calls for a considerably stronger and more coordinated focus on recycling and e-waste disposal. By making investments in the unregulated e-waste

industry, local authorities, national governments, and international funders can all more successfully attain current policy aims. Together, across portfolios and other silos, is how this task should be done.

The private sector also has a significant role to play in curbing the challenges associated with e-waste management. There is a need for the government to work in partnership with the private recycling sector by providing mini-recycling facilities. Availability and accessibility to recycling facilities were cited as major obstacles by other stakeholders involved in the end-of-life ecosystem. Hence, there should be a hands-on training program organized by the government and development agencies for recyclers to adopting the best e-waste management practices.

Finally, as can be seen from the report, Ghana is making progress in developing laws and regulations that are aimed at effective e-waste management and disposal. All that is needed now is the political will to see that these laws and regulations are put into practice. How successful this will be in the end will only be determined over time.

Appendix

Questionnaire link
https://docs.google.com/document/d/1uzwh8P1m3Q2ERNUgRXRNoqlcnNOPdoT9

Discussion guides link
https://docs.google.com/document/d/1FAqP2S1pj1yatB4Jc1l0gBm891Jkdq_y

Key informant interview participants

Name	Category
Prince Nuhu	Brand New Retailer
The Makers Electronics	Brand New Retailer
Musamadeen Enterprise	Second Hand Retailer
ELBL Enterprises	Second Hand Retailer
AM Electricals (Saleem Co. Enterprise)	Repairer
King Nass Electricals Shop	Repairer
JK Nyame Ventures	Repairer
Abraham Sackey	Repairer
Caritas Foundation	Formal collector
Ibrahim	Informal collector
Edmund Chigozie	Scrap dealer
Abdullah Isaku Cheerboy	Scrap dealer
Appcycler	Recycler
Fedex Akpogun	Recycler
Innovate labs & engineering Consult	Assembler
Aziz	Consumer
Edem	Consumer
Muhammad Tanko	Consumer
Savannah Waste Management	Waste disposal management
Muhammed Isa	Collector

| Harriet Agbavitor | Academia |

Data Review Dates

Methodology	Start Date	End Date
Stakeholders workshop	1/12/2022	1/12/2022
Household Survey	19/11/2022	24/11/2022
In-depth interviews	20/1/2023	26/1/2023
Vignette	23/3/2023	26/1/2023