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## **Assess the Effectiveness of Current Waste Management and Recycling Practices in Urban Areas: A Case Study of Household, Recycling Companies and the Municipal Strategies**

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### **Abstract**

Ineffective waste management in urban areas presents serious challenges to environmental sustainability and public health, particularly in rapidly expanding cities such as Lusaka. This study investigates the effectiveness of current waste management and recycling practices, with a specific focus on the role of households, recycling companies, and municipal authorities. A mixed-methods approach was employed, combining quantitative data from municipal waste statistics with qualitative data from household surveys and interviews with key stakeholders. Results indicate that recycling participation improves significantly when supported by educational outreach, adequate infrastructure, and clear municipal policies. Government incentives and public-private partnerships were also found to enhance the

capacity of recycling companies. However, barriers such as limited funding, weak enforcement of regulations, and low public awareness continue to hinder overall system performance. The findings underscore the importance of an integrated approach to urban waste management that combines education, policy support, infrastructure development, and community engagement. This research contributes to sustainable urban planning by providing a framework for evaluating and improving recycling and waste reduction initiatives in developing cities. It also highlights gaps in the current literature, particularly regarding the long-term sustainability of recycling programs and the role of technology in enhancing waste systems.

**Keywords:** Waste Management, Recycling Practices, Urban Waste, Lusaka, Household Participation, Municipal Strategies, Recycling Companies

### **1. Introduction**

Lusaka has experienced rapid population growth over the past decades, resulting in increased solid-waste generation and pressure on the city's already strained waste-management systems. Recent studies show that waste generation in Lusaka has risen faster than the capacity of formal collection services, leaving many communities with irregular or no collection at all (University of Lusaka, 2021). The inadequacy of collection systems — including limited coverage, insufficient equipment, and operational constraints — has contributed to widespread improper waste disposal across the city (Simwambi *et al.*, 2020).

The Lusaka City Council (LCC), through its Waste Management Unit, is mandated to oversee municipal solid-waste collection and disposal. However, despite these institutional responsibilities, the council still struggles to manage the city's daily waste output, and only a fraction of the generated waste reaches the official disposal site (UNZA, 2020). As a result, uncollected waste often accumulates in drains, open spaces, and informal dumping points, posing major environmental and public-health risks (Lusaka City Council, 2022).

Recycling practices in Lusaka also remain limited. Although awareness of recycling and waste segregation is relatively high in some commercial areas, actual participation levels are low. For example, a study at Soweto Market found that while most traders were aware of segregation practices, only a small proportion consistently used recycling bins, indicating a clear gap between awareness and practice (IJECC, 2023). Recycling companies and informal waste pickers play a significant role in recovering recyclable materials, but their operations are hindered by inconsistent waste supply, weak coordination with municipal authorities, and inadequate policy support (Simwambi *et al.*, 2020).

### 1.1 Statement of the Problem

Cities around the world are growing quickly, with more people moving in and more businesses being set up. As a result, the amount of waste being produced is also increasing. If this waste is not managed properly, it can lead to serious problems for the environment, public health, and the economy. This makes it very important to have strong waste management and recycling systems in place. However, many cities, especially in developing countries like Zambia, face big challenges in managing waste. These include poor infrastructure, not enough funding, and a lack of public awareness about how to handle waste correctly. Because of these issues, waste is often collected poorly, dumped in the wrong places, and not recycled. This leads to pollution, spreads diseases, and adds to climate change by increasing greenhouse gas emissions. In Lusaka, the capital city of Zambia, most of the waste is dumped at the Chunga Landfill without sorting or recycling. Although the city council and some private companies are trying to improve the system, progress has been slow. Many households do not separate their waste, recycling companies face difficulties, and the government's strategies are not always effective. There is a clear need to study how waste is currently being managed in Lusaka. By looking at what is working and what is not, we can find better ways to reduce waste, improve recycling, and protect both the people and the environment.

### 1.2 General objective

Assess the effectiveness of current waste management and recycling practices in urban areas, a case study of household, recycling companies and the municipal strategies.

#### 1.2.1 Specific Objectives

1. To evaluate the participation of households and recycling companies in waste separation and recycling activities in Lusaka.
2. To assess the current waste management infrastructure in Lusaka, including facilities, technologies, and processes for waste collection, transportation, and disposal.
3. To analyze institutional capacity, policy enforcement and community awareness levels in relation to waste management in Lusaka.

### 1.3 Research Question

1. To what extent do households and recycling companies participate in waste separation and recycling activities in Lusaka?
2. What is the current state of waste management infrastructure in Lusaka, including the facilities, technologies, and processes used for waste collection, transportation, and disposal?
3. How do institutional capacity, policy enforcement, and community awareness levels influence waste management practices in Lusaka?

### 1.4 Significance of the study

The purpose of this study is to examine the effectiveness of current waste management and recycling practices in Lusaka by assessing the roles of households, recycling companies, and municipal strategies. By identifying the strengths and weaknesses within these systems, the study provides valuable insights into how recycling participation can be improved, how private sector actors can be better supported,

and how municipal policies can be strengthened to reduce waste generation and reliance on landfills.

The research is significant because it highlights the need for integrated and sustainable waste management practices in Lusaka, where poor disposal methods continue to threaten environmental quality, public health, and urban development. Findings from this study will serve as a reference point for policymakers, local authorities, recycling firms, and environmental organizations seeking to implement more effective and inclusive waste management strategies. Ultimately, the study aims to contribute to the long-term improvement of solid waste management practices in Zambia.

## 2. Literature Review

### 2.1 Introduction

Solid waste management has become one of the most pressing environmental and public health challenges facing cities in Sub-Saharan Africa. In Lusaka, Zambia's capital, rapid population growth, urbanization, and changing consumption patterns have exacerbated the generation of waste while overwhelming municipal collection and disposal systems. The effectiveness of waste management in this context depends on three key actors: households, who generate waste and determine levels of participation in recycling and separation; waste recycling companies, who provide collection, processing, and market services; and municipal authorities, who design strategies, enforce regulations, and provide infrastructure.

Globally, best practices emphasize integrated solid waste management (ISWM), stakeholder participation, and sustainable financing mechanisms (World Bank, 2018) <sup>[33]</sup>. However, in Lusaka, studies show persistent gaps such as weak household compliance, capacity constraints among recycling companies, and limited municipal oversight (Chanda, 2021 <sup>[9]</sup>; Zulu, 2022). This review examines existing literature on the roles and effectiveness of these three actors in Lusaka's waste management system and identifies challenges and opportunities for improved practices.

### 2.2 Waste management in Kenya

In Kenya, waste management practices remain constrained by rapid urbanisation, limited municipal capacity and inconsistent waste collection services. Studies show that only a portion of urban waste is collected regularly, with low-income and informal settlements experiencing the least coverage, leading to widespread illegal dumping and open burning (Envaco, 2023). Research further highlights the significant role of the informal sector, which handles most primary collection, sorting and recovery of recyclables, yet remains largely unrecognized in policy and under-supported despite its contribution to resource recovery and employment (ACEN Foundation, 2020). Although Kenya has made progress toward more sustainable approaches—including recycling initiatives, composting and emerging waste-to-energy projects—implementation is slowed by inadequate infrastructure, weak enforcement, and fragmented institutional coordination (Envaco, 2022). Overall, Kenya's waste management system operates as a hybrid model combining formal municipal services, informal networks and unmanaged waste flows, underscoring the need for strengthened governance, integrated planning and investment in sustainable waste

systems (Kryptone Consulting, 2021).

### 2.3 Waste Management Practices in Brazil

Brazil's waste management system is characterized by a strong legal framework but uneven implementation. The country adopted the **National Solid Waste Policy (PNRS)** in 2010, which promotes recycling, selective collection, extended producer responsibility, and the gradual closure of open dumps (*da Silva et al., 2019*)<sup>[37]</sup>. Despite these policies, many municipalities still rely on landfilling, and only about 3% of waste is recycled due to challenges such as insufficient sorting infrastructure and low public participation (*IBGE, 2022*)<sup>[39]</sup>. The informal sector plays a crucial role, with waste pickers ("catadores") responsible for a significant proportion of recovered recyclables (*Gomes & Pereira, 2020*)<sup>[38]</sup>. Overall, Brazil demonstrates progress in policy development but faces practical constraints typical of developing urban contexts.

### 2.4 Current Waste Management Practices

Waste management practices today are shaped by the increasing complexity of waste generation, urbanization, and the growing awareness of environmental sustainability. Effective waste management includes a range of practices, from waste collection and sorting to recycling, treatment, and disposal. The shift toward sustainable practices such as recycling, composting, and waste-to-energy (WTE) technologies is reshaping how urban areas manage waste. However, challenges remain, especially in developing regions, where waste management systems are less formalized (*Safi et al., 2021*). Waste management encompasses a series of activities aimed at handling waste materials from their inception to their final disposal. The primary objective is to mitigate the negative impact of waste on human health and the environment. According to *McFarlane and Ortiz (2019)*, waste management involves several key strategies:

#### 2.4.1 Collection

The initial phase of waste management involves the collection of waste from various sources, including residential, commercial, and industrial areas. Effective waste collection is essential for ensuring that waste is managed efficiently and in a timely manner (*Miller, 2020*). Proper collection systems reduce the likelihood of illegal dumping and ensure that waste can be transported to appropriate facilities. In urban areas, collection strategies need to be optimized for population density and the types of waste generated (*Singh et al., 2018*).

#### 2.4.2 Transportation

Once waste is collected, it must be transported to treatment or disposal facilities. This phase requires careful planning to minimize environmental impact and ensure the safety of workers and the public (*Koo et al., 2021*)<sup>[21]</sup>. Efficient transportation routes are crucial to reducing fuel consumption and emissions while maintaining operational efficiency. Transportation logistics must account for varying waste volumes, facility locations, and potential traffic disruptions in urban areas (*Wang et al., 2019*).

#### 2.4.3 Treatment

Waste treatment processes aim to reduce the volume and toxicity of waste materials. Common treatment methods include incineration, composting, and anaerobic digestion (*Zhou et al., 2020*)<sup>[35]</sup>. Incineration reduces waste volume through controlled burning, while composting and anaerobic

digestion help break down organic waste into valuable byproducts like compost and biogas. These methods not only minimize waste but can also produce useful energy or fertilizers, contributing to sustainable waste management (*Maharjan & Ang, 2021*).

#### 2.4.4 Disposal

The final stage of waste management is the safe disposal of remaining waste materials, typically through landfilling or incineration. Proper disposal methods are essential to preventing environmental contamination and health hazards, such as groundwater pollution or the release of toxic gases (*Bong et al., 2020*)<sup>[6]</sup>. Landfills must be carefully managed to minimize their impact on surrounding ecosystems, and alternatives such as waste-to-energy incineration need to be utilized responsibly to avoid air pollution (*Barton & Webb, 2019*)<sup>[3]</sup>.

#### 2.4.5 Concept of Recycling

Recycling is a crucial element of modern waste management, focusing on the recovery and reprocessing of waste materials into new products. This practice conserves natural resources, reduces energy consumption, and lowers pollution levels (*Geissdoerfer et al., 2017*)<sup>[17]</sup>. Recycling is a key strategy in the transition toward a circular economy, which aims to keep materials in use for as long as possible, reducing the need for virgin resources and minimizing waste (*Cohen & Heap, 2020*)<sup>[13]</sup>.

#### 2.4.6 Collection and Sorting

The first step in recycling involves gathering recyclable materials and sorting them by type, such as paper, plastic, and metal. Efficient sorting is vital for the success of the recycling process, as it ensures that materials are appropriately processed (*Tantawi & Amini, 2021*). Poor sorting can lead to contamination, reducing the quality of recycled materials and making them more difficult to reuse. Effective sorting technologies, such as automated systems or manual sorting stations, are often employed to streamline this process (*Sundaram & Gollakota, 2020*).

#### 2.4.7 Processing

Once sorted, recyclable materials are cleaned and transformed into raw materials. This step often involves mechanical or chemical processes that prepare the materials for manufacturing new products. For example, plastic may be shredded and melted down, while metals are melted and purified (*Bocken et al., 2016*)<sup>[5]</sup>. Processing aims to return materials to a usable state, reducing the need for new raw materials and conserving energy. This phase is critical for ensuring that recycled products meet the standards required for manufacturing.

#### 2.4.8 Manufacturing

The processed raw materials are used to produce new products. These can range from everyday consumer goods to construction materials or packaging products (*Miller, 2020*). The manufacturing stage represents the circular nature of recycling, as it closes the loop between waste generation and new product creation. The use of recycled materials in manufacturing not only conserves natural resources but also reduces the environmental footprint of production (*Gartner et al., 2020*)<sup>[16]</sup>.

#### 2.4.9 Purchasing

Consumers play a critical role in completing the recycling cycle by purchasing products made from recycled materials. This step is essential to creating demand for recycled goods, which in turn encourages more recycling and resource conservation (*Koo et al., 2021*)<sup>[21]</sup>. Increased consumer

awareness and demand for sustainable products can drive the market for recycled materials, ensuring the economic viability of recycling systems (Maharjan & Ang, 2021).

#### 2.4.10 Recycling Programs

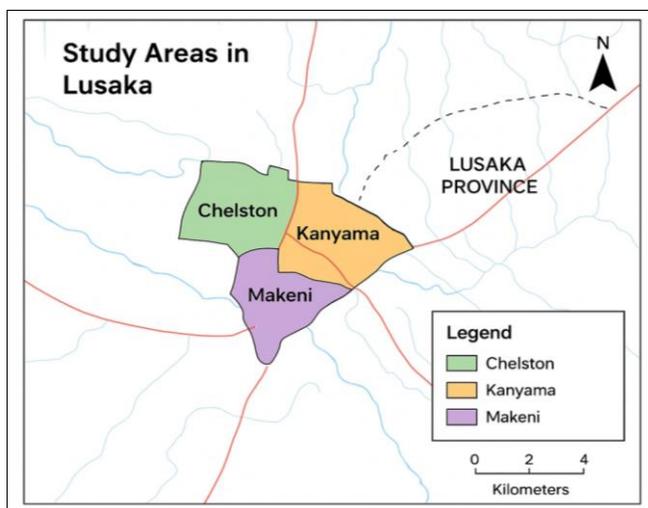
Various recycling programs have been implemented worldwide, yielding varying degrees of success. According to Hage *et al.* (2009), community-based recycling programs that engage local residents in sorting and collecting recyclables tend to be more effective. Additionally, a study by Hassan and Marzouk (2018) found that financial incentives, such as deposit-return schemes, significantly increase recycling rates.

### 3. Materials and Methods

#### 3.1 Study Area

The study was carried out in Lusaka, the capital city of Zambia, with an estimated population of 3.3 million (Zambia Statistics Agency, 2022). This location was selected because it faces significant solid waste management challenges, generating approximately 1,200–1,500 tons of solid waste daily, of which only about 40–45% is collected formally (World Bank, 2020). The rationale and context for selecting Lusaka is that recycling activities in the city remain underdeveloped and are largely dominated by informal actors with limited integration into municipal waste management systems. Moreover, Lusaka is one of the most urbanised cities in the country, with rapid population growth and increased economic activity contributing to high waste generation. The researcher also selected this location due to its accessibility and familiarity, which supports effective engagement with respondents. In line with Berg (2004), an ideal study site is one that the researcher has interest in, can easily access, and where they can obtain immediate support. To ensure that the researcher's familiarity with the study area does not influence the findings, established data collection methods were used to minimize potential bias.

Lusaka was chosen as the study area because it is easily accessible to the researcher and provides a relevant context for examining waste management and recycling practices. The researcher lives in the city, which made it easier to interact with households, municipal authorities, and recycling companies. According to Berg (2004), an ideal study area is one where the researcher has interest, access, and support from respondents. To avoid bias, the study used established methods of data collection to ensure accuracy and reliability of the findings.



#### 3.2 Research Design

This study employed a mixed-methods research design incorporating both quantitative and qualitative approaches. The use of mixed methods was justified by the complexity of waste management systems, which require not only numerical analysis of household participation but also qualitative exploration of municipal policies and private-sector engagement. The case study strategy was adopted with Lusaka as the focal unit, enabling an in-depth understanding of waste management practices and recycling dynamics within a real-life urban context (Yin, 2018).

#### 3.3 Research Approach

A convergent parallel design was used, where quantitative and qualitative data were collected simultaneously and analyzed independently before being integrated during interpretation. This allowed the study to provide a comprehensive understanding of the effectiveness of waste management and recycling practices in Lusaka by comparing household-level behaviors with institutional and company-level practices.

#### 3.4 study Population

The study population comprised three main groups involved in waste management and recycling within Lusaka. These included households, waste recycling companies, and municipal authorities. Households were selected from high-, medium-, and low-density residential areas across the city to capture differences in socioeconomic conditions and waste generation patterns. Waste recycling companies comprised both formal firms, such as Recycle Limited, and informal recyclers operating within Lusaka, providing valuable insights into the structure, challenges, and interactions within the recycling value chain. Municipal authorities, represented by the Lusaka City Council (LCC) through its Department of Solid Waste Management, were included to offer perspectives on institutional frameworks, policy implementation, and coordination mechanisms governing waste collection and recycling in the city.

#### 3.5 Sampling Strategy and Sample Size

A multi-stage sampling technique was used. Lusaka was stratified into high-density (e.g., Kanyama), medium-density (e.g., chelston), and low-density areas (e.g., makeni). Households were randomly selected within each stratum. Purposive sampling was applied for recycling companies and municipal officials.

Households: A sample size of 60 households was determined using Cochran's formula (95% confidence level, 5% margin of error), consistent with studies in similar urban contexts (Mwaanga & Banda, 2021). Sample size computation.

#### 3.6 Data Collection Methods

Household Survey: Structured questionnaires were used to collect quantitative data on waste generation rates, segregation practices, recycling awareness, and satisfaction with municipal services. Key Informant Interviews (KIIs): Conducted with recycling company managers and municipal officials to gather insights into recycling processes, policy frameworks, and challenges. Document Review: Policy documents, municipal reports, and prior academic research on waste management in Lusaka were reviewed to contextualize primary data.

### 3.7 Data Analysis

**Quantitative Analysis:** Data from household surveys were analyzed using SPSS. Descriptive statistics (frequencies, percentages, means) were used to profile household recycling practices. Inferential statistics, including chi-square tests and logistic regression, were applied to examine relationships between socio-demographic factors (e.g., income, education) and recycling behavior.

**Qualitative Analysis:** Interview transcripts were analyzed using thematic analysis. Data were coded inductively and grouped into themes such as “policy gaps,” “community participation,” and “infrastructure challenges.” Triangulation was used to integrate findings from different data sources.

## 4. Presentation of Findings

### 4.1 Introduction

The purpose of the study was to evaluate the effectiveness of current waste management and recycling practices in urban areas. The study was guided by the research questions namely:

1. To what extent do households and recycling companies participate in waste separation and recycling activities in Lusaka?
2. What is the current state of waste management infrastructure in Lusaka, including the facilities, technologies, and processes used for waste collection, transportation, and disposal?
3. How do institutional capacity, policy enforcement, and community awareness levels influence waste management practices in Lusaka?

### 4.2 Demographic Profile of Respondents (Households)

In most cases, a sample profile evaluates the qualities of the intended respondents. Gender, and age group are all factors that are significant to this study. Frequency distributions for personal data were derived using this data.

#### 4.2.1 Gender of respondents

This finding shows that 62% of respondents were female, while 38% were male. This means that women represented nearly two-thirds of the surveyed population. This aligns with the fact that women in many households are primarily responsible for managing domestic waste, which can influence both waste disposal and recycling behavior. Their higher participation rate may also shape awareness levels and decision-making regarding household waste management.

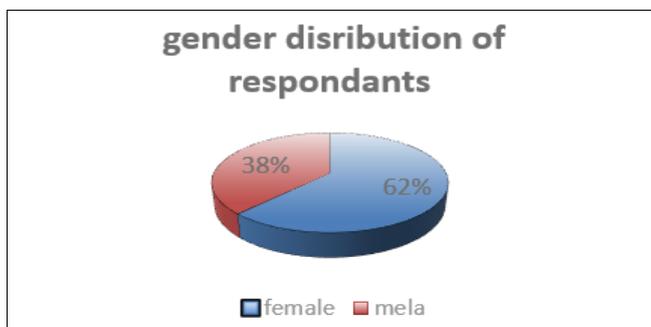


Fig 4.1: Shows gender distribution for respondent

### 4.2.2 Age group distribution

A Chi-square test was performed to examine the relationship between age group and recycling participation among 60 households.

Table 4.1

Age group	Participates in recycling	Does not participate	Total
18-24	4 (11.1%)	8 (22.2%)	12 (20.0%)
25-45	15 (24.2%)	13 (21.6%)	28 (46.7%)
46 and above	10 (16.7%)	10 (16.7%)	20 (33.3%)
Total(n=60)	29 (48.3%)	31 (51.7%)	60 (100%)

Source: Field Data (2025)

Table 4.2

Test	value	df	Asymp
Pearson chi-square	4.720	2	0.094
likelihood	4.881	2	0.087
Lear-by-linear association	2.911	1	0.088
total	60		

Source: Field data (2025)

The results of the analysis,  $\chi^2 (2, N = 60) = 4.72, p = 0.094$ , indicate that there was no statistically significant association between age and recycling participation at the 0.05 significance level.

However, descriptive findings show that respondents aged 25–45 years had the highest participation rate (24.2%), followed by those aged 46 years and above (16.7%). The youngest group (18–24 years) recorded the lowest participation (11.1%). This trend aligns with the earlier finding that women (62% of respondents) were more engaged in waste management, indicating that demographic and social factors jointly shape recycling behavior. This age group is typically more active in household decision-making, including waste disposal and recycling activities. Their involvement is crucial because they represent the most economically and socially active segment of the population, which may positively influence the adoption of improved waste management practices.

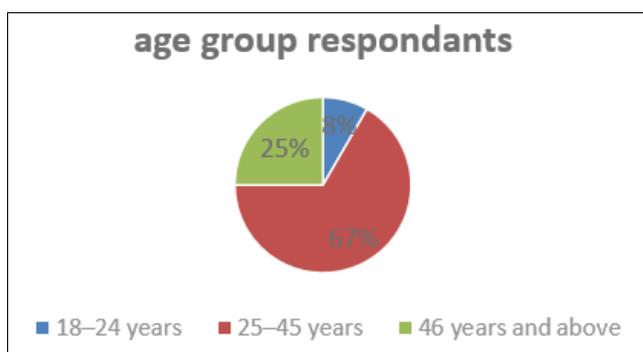


Fig 4.2: Age group distribution

### 4.2.3 Respondents highest Level of education

Education level: 70% had at least secondary education, 20% tertiary, 10% primary or none. The findings reveal that 70% of respondents had attained at least secondary education, 20% had tertiary qualifications, and 10% had only primary education or none at all. This means that a total of 90% of

the surveyed households had at least some formal education, which may contribute to better understanding and awareness of proper waste management practices. Higher education levels often correlate with greater willingness to participate in activities such as recycling, segregation, and proper disposal of waste.

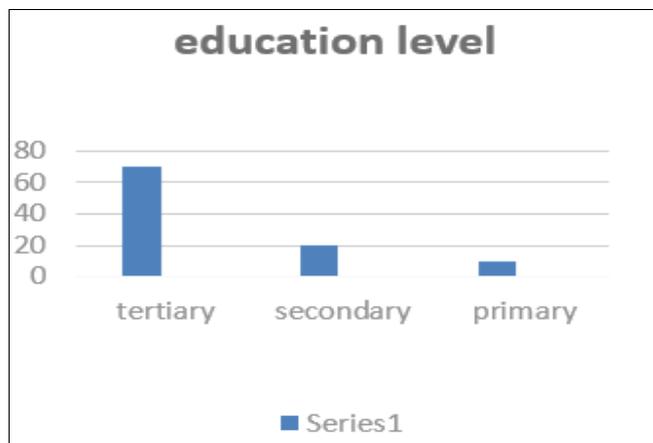


Fig 4.3: Shows education levels of respondents

households may have better access to waste bins and collection services, while low-income households may face challenges that lead to informal disposal methods such as open dumping or burning.

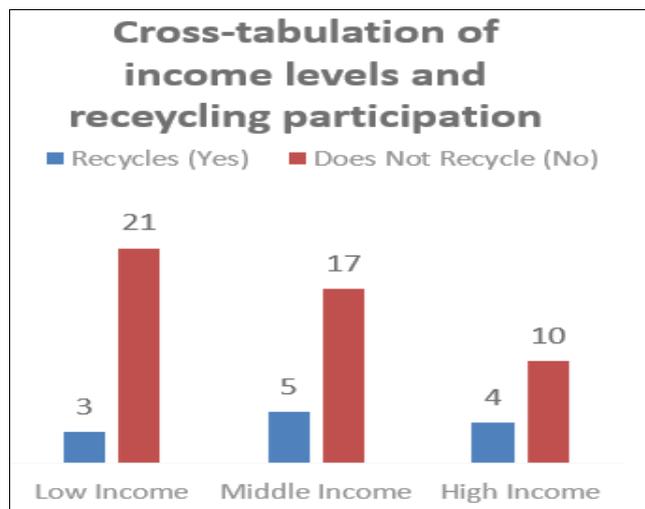


Fig 4.4: Shows household income levels

#### 4.2.4 Household income levels vs recycling participation

Table 4.3

Income Level	Recycles (Yes)	Does Not Recycle (No)	Total	% Recycling within Group
Low Income	3	21	24	12.5%
Middle Income	5	17	22	22.7%
High Income	4	10	14	28.6%
<b>Total</b>	<b>12</b>	<b>48</b>	<b>60</b>	<b>20.0%</b>

H0: There is no relationship between income level and recycling participation.

H1: There is a relationship between them.

Table 4.4

Test	value	df	Asynpsig (2.sided)
Pearson chi-square	6.87	2	0.032
Liklyhood ratio	7.01	2	0.03
Linear-by-Linear Association	4.02	1	0.045
N of valid cases	60		

A Chi-square test was conducted to determine whether household income level was associated with participation in recycling activities. The results,  $\chi^2 (2, N = 60) = 6.87, p = 0.032 (< 0.05)$ , indicate a statistically significant relationship. This suggests that income level influences household engagement in recycling practices.

As shown in Table 4.3, higher-income households had the highest proportion of recycling participation (29%), while low-income households recorded the lowest (12.5%). These findings imply that economic capacity may positively affect the ability and motivation to recycle.

Since  $p = 0.032 < 0.05$ , we **reject the null hypothesis**. And conclude that There is a statistically significant relationship between household income level and participation in recycling. Higher-income households are more likely to participate in recycling activities than low-income ones. Income levels often influence access to waste collection services and ability to participate in organized recycling programs. For example, middle- and high-income

#### 4.2.5 Household Waste Generation and Management Practices

Average waste produced per household: 1.8–2.2 kg per day. Segregation practices: Only 20% of households reported separating recyclable waste (plastic, paper, metals).

Disposal methods: 55% rely on municipal collection points, 30% dispose through informal collectors (often private truckers or “carts”). 15% resort to open dumping or burning. Only 20% of surveyed households reported **actively separating recyclable waste** such as plastics, paper, and metals. The remaining 80% disposed of waste without separation. This low level of segregation is a major barrier to effective recycling because mixed waste is more difficult and costly to process. It reflects gaps in both public awareness and availability of segregation infrastructure such as labeled bins or collection points for different waste streams. More than half of the respondents (55%) rely on **municipal collection points** for waste disposal. Another **30%** use **informal collectors**, often due to irregular municipal collection schedules or better accessibility. However, **15% of households resort to open dumping or burning**, practices that pose serious environmental and health risks, including soil contamination, air pollution, and disease spread. This shows the **gap between service availability and household disposal behavior**.

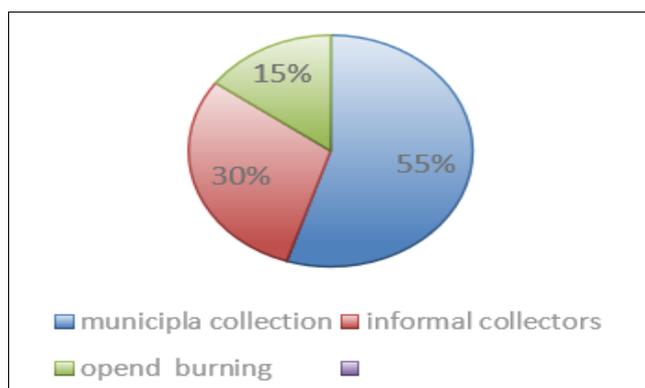


Fig 4.5: Household waste disposal method

### 4.2.6 Household Participation in Recycling

Recycling awareness: 65% of households had heard of recycling, but only 25% actively participated. Materials most recycled: plastics (18%), metals (12%), paper (9%).

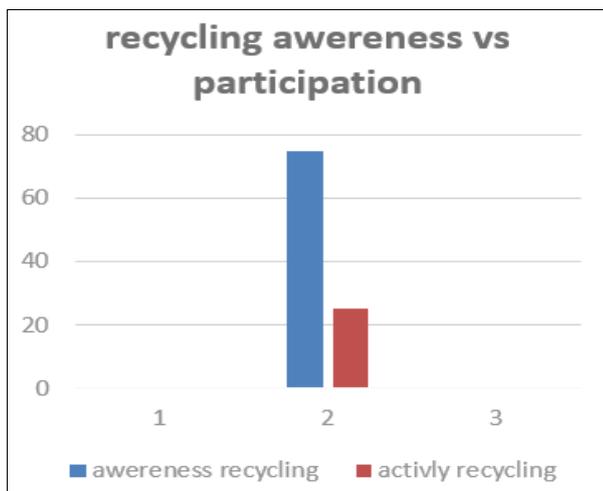
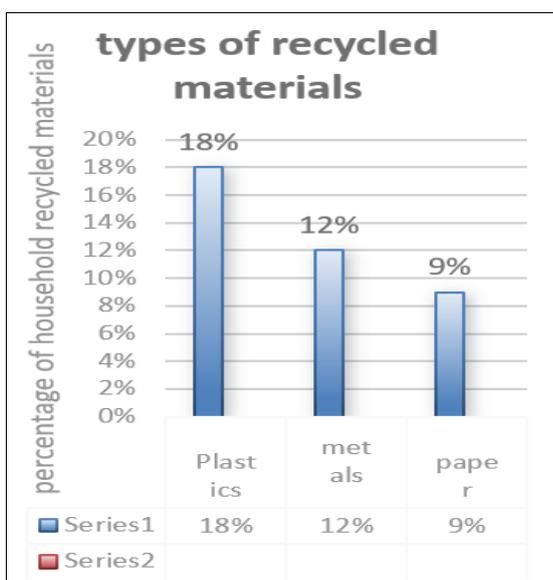


Fig 4.6: Recycling awareness vs participation

This indicates a significant gap between knowledge and action, suggesting that awareness alone isn't enough to drive participation. Barriers could include lack of access While 65% of households are aware of recycling, only 25% actively to recycling facilities, inconvenience, or low motivation.

### 4.2.7 Types of materials recycled

Plastics (18%) are the most commonly recycled material, followed by metals (12%) and paper (9%). This shows that households are more likely to recycle materials that are easy to separate, have visible value, or are commonly collected by recycling programs. The low recycling percentages overall suggest inefficient recycling practices or limited infrastructure/support for certain materials. Barriers to recycling: Lack of municipal-provided bins (70%). Limited awareness of collection points (55%). Perceived inconvenience (40%).



Interpretation: Despite moderate awareness, actual participation is low, hindered by infrastructure and convenience gaps.

### 4.2.8 Waste Recycling Companies' Participation

Interviews with 10 recycling companies revealed: Types of waste processed: plastics (90%), paper/cardboard (70%), metals (60%).

The findings show that plastics are the most commonly processed material, with 90% of recycling companies involved in plastic recycling. Paper and cardboard account for 70%, while metals make up 60%. This indicates a strong market demand for these materials, which are relatively easier to collect, sort, and process compared to other waste streams such as glass or organics.

Operational Challenges Faced by Recycling Companies The lack of a reliable and consistent supply of segregated waste from households affects the operational capacity of recycling companies. High transportation costs further reduce profitability, while weak coordination with municipal authorities limits opportunities for scaling up recycling activities. These structural challenges create dependency on informal waste collectors to fill the supply gap.

Role of the Informal Sector Informal waste pickers supply 50–70% of recyclable materials to companies. The results indicate that the informal sector plays a critical role in Lusaka's recycling ecosystem. Informal waste pickers provide the majority of recyclable materials to recycling companies, compensating for weak formal collection and segregation systems. However, their contribution remains largely unrecognized and unregulated, leading to inefficiencies and lack of integration with formal waste management structures. This reflects the need for formal inclusion of the informal sector in municipal recycling strategies.

### 4.2.9 Municipal Strategies and Perspectives Insights from municipal officials

Current strategies: periodic waste collection, contracting private operators in some areas, and public awareness campaigns. Challenges identified: Limited funding and logistical resources. Poor enforcement of waste management by-laws, Insufficient community participation.

Policy gaps: Absence of a clear municipal recycling framework and weak integration of informal actors.

Interpretation: While strategies exist, they remain fragmented and underfunded, with little focus on structured recycling.

Common concerns: lack of bins, poor enforcement of collection schedules, and minimal municipal engagement.

### 4.3 Current State of Waste Management Infrastructure in Lusaka

The study revealed that Lusaka's waste management infrastructure is functional but limited in capacity, technology, and coordination (Banda and Mufalo, 2022) [36]. On average, households in the city produce between 1.8 and 2.2 kilograms of solid waste per day, which puts pressure on the existing collection system. Most households (55%) rely on municipal collection points, while 30% depend on informal collectors such as private truckers and push-cart operators, and the remaining 15% resort to open dumping or burning, especially in high-density areas where formal collection is irregular. Waste collection in Lusaka is managed by the Lusaka City Council through periodic rounds and private contractors in some areas; however, irregular collection schedules and limited coverage remain major concerns, particularly in low-income communities.

Waste transportation is mainly done by road using municipal and private trucks, supplemented by informal transporters in densely populated neighborhoods. Both recycling companies and municipal officials identified high transportation costs and inadequate vehicles as key operational challenges. The study further found that recycling companies mainly process plastics (90%), paper and cardboard (70%), and metals (60%). Most facilities operate on a small scale, using manual or semi-mechanized sorting and baling technologies, with no large material recovery or composting plants in operation. The informal sector plays a major role in the recycling chain, supplying between 50–70% of recyclable materials to companies, yet these waste pickers remain unrecognized in municipal systems and lack protective equipment and stable income. Respondents also highlighted several infrastructure gaps, including a shortage of municipal-provided waste separation bins (70%) and limited access to recycling collection points (55%). Municipal officials cited poor funding, weak law enforcement, and logistical constraints as the main barriers to improving the city's waste management system. Overall, the study found that Lusaka's waste management approach focuses more on collection and disposal than recycling, with minimal coordination among the municipal authority, private firms, and informal collectors. This situation underscores the need for stronger policy integration, improved infrastructure, and a more inclusive framework to enhance the sustainability of waste management in Lusaka.

#### 4.4 Analysis of Institutional Capacity, Policy Enforcement, and Community Awareness in Relation to Waste Management

The study found that institutional capacity, policy enforcement, and community awareness are key factors influencing waste management in Lusaka. The results revealed that the municipal authorities face limited funding, inadequate logistical resources, and weak coordination with recycling companies, which reduces the effectiveness of waste management operations. The absence of a clear municipal recycling framework further demonstrates low institutional capacity to support structured recycling initiatives. Policy enforcement was also found to be weak, with poor implementation of existing waste management by-laws and minimal integration of informal waste collectors into formal municipal systems. Although 65% of households indicated awareness of recycling, only 25% actively participated, showing that community awareness does not necessarily translate into action due to lack of bins, irregular waste collection, and limited municipal engagement. Overall, these findings suggest that Lusaka's waste management system suffers from institutional and policy weaknesses, while public participation remains low despite growing awareness, highlighting the need for stronger coordination, enforcement, and community involvement.

#### 4.5 Integration of Quantitative and Qualitative Findings

The integration of survey, and interview, results revealed three major patterns that summarize the overall situation of waste management in Lusaka. **First**, household participation in recycling remains low despite moderate awareness levels. Although most respondents understood the importance of recycling, only a small proportion actively practiced it, mainly due to lack of bins, irregular waste collection, and limited incentives. **Second**, the study found a strong

dependence on the informal sector, as recycling companies rely heavily on informal waste pickers who supply between 50–70% of recyclable materials. However, these actors are not formally recognized in municipal waste management strategies, leading to inefficiencies and poor coordination between formal and informal systems. **Third**, the findings indicate significant municipal gaps, with current strategies focusing more on waste collection than recycling. This lack of a structured recycling framework and weak enforcement of by-laws limits progress towards sustainable waste management. Overall, the integration of quantitative and qualitative data shows that Lusaka's waste management system faces interconnected challenges of low public participation, informal sector dependence, and weak institutional support, which collectively undermine sustainability efforts.

#### 5. Discussion

The findings of this study highlight the features of waste management and recycling practices in Lusaka, underscoring the interdependence of households, recycling companies, and municipal authorities in shaping outcomes. The results reveal both progress and gaps, with socio-economic factors, infrastructural limitations, and weak institutional integration emerging as critical influences.

The study found that Lusaka's waste management infrastructure is functional but limited in scope. Most collection relies on periodic municipal rounds and informal collectors, resulting in irregular coverage in high-density areas. The lack of large processing facilities, such as material recovery plants and composting centers, limits the city's capacity to manage increasing waste volumes. These findings agree with Mwansa (2022) [28], who noted that Lusaka's waste system faces major logistical and financial constraints.

The demographic profile of respondents showed that most participants were relatively well-educated, with 70% having attained at least secondary education. This suggests that knowledge and awareness alone may not guarantee effective waste management or recycling participation, since structural barriers such as access to bins and facilities still persist. Similar studies in urban African contexts (Moqsud *et al.*, 2020; Katusiimeh, 2012) [26, 20] argue that education can enhance environmental awareness but does not automatically translate into behavior without supportive infrastructure and incentives.

Despite moderate awareness of recycling (65%), actual household participation was only 25%. The majority of households disposed of waste through municipal points (55%), while 15% continued unsafe practices such as open dumping or burning. This finding reflects broader challenges common in many African cities, where municipal waste systems remain under-resourced and residents resort to informal methods (World Bank, 2018) [33]. The reliance on burning and open dumping also raises environmental and health concerns, suggesting that household participation is constrained not by willingness alone but also by systemic gaps.

Interviews with recycling companies revealed an active but fragmented recycling industry, with plastics being the most commonly processed material. However, companies reported irregular supply of segregated waste and heavy reliance (50–70%) on informal collectors. This aligns with findings by Wilson *et al.* (2012) [32], who emphasize the

central role of informal waste pickers in bridging gaps between households and the formal recycling sector in developing countries.

The dependence on informal actors indicates both an opportunity and a weakness: while the informal sector is effective in mobilizing recyclable waste, the lack of formal recognition and integration limits scalability and sustainability. Without municipal support or policy frameworks, companies face supply chain instability and high operational costs.

Municipal authorities identified funding shortages, weak enforcement, and limited community engagement as major constraints. The absence of a formal recycling framework further exacerbates coordination challenges. These results mirror regional findings that municipalities often prioritize collection and disposal over recycling (UN-Habitat, 2010) [31].

The current strategies, such as contracting private operators and running periodic awareness campaigns, demonstrate some commitment but fall short of addressing structural inefficiencies. The lack of bins, poor monitoring of collection schedules, and limited stakeholder coordination point to systemic fragmentation.

Similar challenges observed in Lusaka—such as low recycling participation and dependence on informal waste pickers—are also evident in Brazil, where recycling remains at about 3% and informal cooperatives dominate material recovery (IBGE, 2022; Gomes & Pereira, 2020) [39, 38]. Likewise, Kenya faces persistent issues with open dumping and limited municipal capacity, reflecting patterns of inadequate enforcement comparable to the Zambian context (UNEP, 2018; NEMA, 2022) [42, 41]. These parallels highlight how developing countries share structural barriers in waste management despite progressive legal frameworks.”

### 5.1 Integrated Findings

The findings of this study reveal that waste management in Lusaka is influenced by three interrelated factors: low household participation in recycling, dependence on the informal sector, and weak municipal capacity. Together, these factors reflect a system that operates with limited coordination, inadequate infrastructure, and weak policy enforcement. The discussion below interprets these results in relation to existing literature and the study’s objectives.

The study established that household recycling participation remains very low despite moderate awareness levels, with only about one-quarter of households reporting active involvement in recycling. This outcome suggests that awareness alone does not guarantee behavioral change, particularly in contexts where infrastructure and incentives are lacking. These results are consistent with findings by Chisanga *et al.* (2024) [12], who noted that households in high-density Lusaka neighborhoods often understand the importance of recycling but lack the means to practice it effectively. Similarly, Wilson *et al.* (2012) [32] observed that public recycling participation in developing countries is often constrained by weak collection systems and minimal institutional support. The findings imply that for Lusaka to improve household recycling rates, community engagement must be combined with practical interventions such as provision of waste segregation bins, predictable collection schedules, and accessible recycling facilities.

The study also revealed a strong dependence on the informal sector, with waste pickers supplying between 50–70% of

recyclable materials to recycling companies. This aligns with Medina (2010) [23] and Mwansa (2022) [28], who emphasized that informal waste collectors play a vital role in urban recycling networks across Africa but often operate without legal recognition or support. In Lusaka, this dependency shows that the informal sector fills critical gaps left by municipal inefficiencies, yet their contributions remain undervalued. Integrating informal actors into formal waste management structures could improve efficiency, increase material recovery rates, and promote inclusive economic opportunities. Formal partnerships, registration, and training programs could help enhance both safety and productivity among informal waste workers.

Weak municipal capacity and policy enforcement further emerged as major constraints to effective waste management in Lusaka. The absence of a clear recycling framework, inadequate funding, and poor coordination between the Lusaka City Council (LCC), private recyclers, and communities reflect systemic institutional weaknesses. These findings support Banda (2022) and Ngwira (2025) [29], who highlighted that Zambian municipalities face persistent budget limitations and weak enforcement of waste management by-laws. Consequently, most municipal strategies remain focused on collection and disposal rather than waste reduction or recycling. Strengthening policy enforcement, improving funding allocation, and developing an integrated recycling policy would therefore be key to achieving sustainable waste management in the city.

Overall, the integration of quantitative and qualitative findings demonstrates that waste management challenges in Lusaka are multidimensional, rooted in both structural and behavioral factors. The system’s dependence on informal actors, coupled with limited municipal support and low public participation, reflects the need for a coordinated approach that balances institutional reform with community empowerment. This study concludes that sustainable waste management in Lusaka requires improved municipal capacity, stronger policy enforcement, and active inclusion of both formal and informal stakeholders.

### 5.2 Conclusion

The purpose of the study was to examine the effectiveness of waste management and recycling practices in Lusaka, with a specific focus on household participation, recycling company engagement, and municipal strategies. The study sought to understand how these three components interact to shape the overall waste management system in the city and identify the key challenges and opportunities for sustainable waste handling.

The study adopted a mixed-methods approach, combining both quantitative and qualitative data from households, recycling companies, and municipal officers. Data were collected from 60 households across different communities in Lusaka and 10 recycling companies that actively engage in waste processing. Additional information was obtained from the Lusaka City Council to provide insights into existing waste management strategies.

The main findings revealed that household participation in recycling remains low despite relatively high awareness levels. Only about one-quarter of the households reported active participation in recycling. The main barriers identified included inadequate municipal infrastructure, lack of waste separation bins, and limited accessibility to collection points. These findings indicate that knowledge

alone does not guarantee behavioral change; rather, structural and logistical support are essential to transform awareness into consistent recycling practices.

The study further revealed that recycling companies play a vital role in the city's waste management chain, but they depend heavily on informal waste collectors, who supply up to 70% of recyclable materials. This situation highlights the significance of the informal sector, yet its exclusion from official municipal plans creates inefficiencies and limits the sustainability of recycling operations. Additionally, recycling companies face several operational challenges, such as irregular waste supply, high transportation costs, and inadequate coordination with municipal authorities.

Municipal strategies for waste management were found to be fragmented and underfunded. While efforts such as contracting private waste collectors and conducting awareness campaigns were evident, there was no comprehensive recycling framework or formal recognition of informal actors within the system. Weak enforcement of waste management by-laws and limited community engagement further constrained the effectiveness of municipal interventions.

In general, the study concludes that waste management in Lusaka is characterized by limited household participation in recycling, strong dependence on informal collectors, and insufficient municipal coordination. The findings suggest that an integrated and inclusive approach is essential for improving waste management outcomes. Such an approach should strengthen partnerships between the municipality and private recycling firms, formally incorporate informal collectors into the waste management framework, and provide households with practical infrastructure and incentives to encourage active recycling participation.

### 5.3 Recommendations

This section of Chapter 5 presents the recommendations arising from the study, based on the key findings on waste management and recycling practices in Lusaka. The recommendations are directed toward the major stakeholders involved in improving waste management outcomes.

The study revealed that for effective household participation in recycling, there is a need to improve access to appropriate waste management infrastructure. Municipal authorities and private recycling firms should ensure the provision of clearly labeled, segregated bins for different categories of waste—such as plastics, paper, glass, and organic waste—at both household and community levels. The availability of such facilities would make recycling more practical and encourage residents to separate waste at the source. Furthermore, local collection points or mobile collection services should be introduced in densely populated areas to facilitate regular and efficient collection of recyclable materials. The study also established that public awareness remains a critical factor in promoting sustainable waste management practices. Targeted sensitization campaigns should be implemented through schools, churches, community centers, and local media platforms to raise awareness of the environmental benefits of recycling, such as pollution reduction and resource conservation, as well as its economic potential through income generation and job creation. Continuous engagement through education and community demonstration activities would help transform public attitudes and foster a culture of environmental

responsibility among residents. In addition, the introduction of incentive-based programs could significantly enhance household participation in recycling initiatives. Local councils and private recycling firms should consider implementing reward systems that provide discounts on waste collection fees, redeemable points, or small financial incentives for consistent recycling behavior. These initiatives can be supported through digital tracking or community-based monitoring systems to ensure transparency and accountability. By recognizing and rewarding positive waste management practices, such programs would motivate households to take active responsibility in waste reduction and segregation.

**Strengthen Collaboration with Municipalities:** Recycling companies should build formal and structured partnerships with the Lusaka City Council (LCC) and other relevant municipal departments. Such collaboration can ensure a more consistent and predictable supply of recyclable materials through coordinated waste collection and segregation efforts. Joint planning with municipal authorities can also help establish designated collection zones, improve waste sorting at source, and reduce contamination of recyclables. In return, municipalities can benefit from improved recycling rates and reduced landfill volumes, fostering a more sustainable urban waste management system.

**Formal Integration of Informal Collectors:** The informal waste sector plays a crucial role in Zambia's recycling chain, often supplying the majority of recyclable materials collected from households and dumpsites. Recycling companies should formally recognize, organize, and train these informal waste pickers to enhance their efficiency, safety, and income security. Training can cover occupational health, material sorting techniques, and environmental awareness. By providing protective gear, fair compensation, and structured working relationships, companies can ensure better quality control of materials, reduce exploitation, and promote social inclusion within the waste value chain.

**Investment in Logistics and Infrastructure:** Transport and logistics costs are among the major operational challenges facing recycling firms in Lusaka. To address this, companies should consider resource-sharing strategies such as pooling transportation fleets, jointly operating transfer stations, or establishing local collection depots in different parts of the city. Such cooperative investments can help reduce costs associated with long-distance collection, improve material flow efficiency, and enhance profitability. Additionally, the adoption of modern waste sorting technologies and digital tracking systems could further optimize logistics operations and strengthen overall competitiveness in the recycling industry.

Municipal authorities should establish a formal recycling policy that integrates all stages of waste management—collection, segregation, transportation, and recycling. This framework should explicitly recognize the contribution of informal waste collectors, ensuring their inclusion through registration, training, and protective measures. By formalizing their participation, municipalities can enhance efficiency, improve data tracking on waste flows, and reduce environmental and public health risks associated with informal and unsafe handling of waste furthermore Local authorities should allocate adequate financial and technical resources to strengthen waste management systems. This includes investing in waste collection vehicles, recycling

centers, transfer stations, and proper landfill facilities. Priority should be given to high-density residential areas, which often face the most severe waste accumulation and service delivery challenges. Partnerships with private investors and development partners can also be pursued to bridge funding gaps.

Focus on the consistent and transparent enforcement of existing waste management regulations is essential. Municipal councils should ensure that residents, businesses, and institutions comply with by-laws regarding waste separation, storage, and disposal. Penalties for illegal dumping, open burning, or littering should be strictly applied. Additionally, enforcement officers should be adequately trained and supported to carry out inspections and implement corrective measures fairly and effectively.

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