Evaluating Waste Management Practices at Zambia Sugar: A Case of Zambia Sugar Plc, Mazabuka

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Abstract

The generation of hazardous waste is a necessary side effect of modern industrial production. Factories must cope daily with large accumulations of unrecyclable chemical by products generated by normal production techniques. Sustainable waste management is a growing global priority, especially in agro industrial sectors where large volumes of waste are generated. This study assesses the waste management practices at Zambia Sugar Plc, one of the largest agro processing companies in Zambia. This study aims to engage the Zambia Sugar Company on the causes, effects and improvement strategies on improper waste management. Data was obtained from respondents by means of interviews, questionnaires and project observation Schedules. The sample consisted of one hundred respondents. Frequency, percentages, tables, graphs and pie charts were used to analyze the qualitative and quantitative data obtained. The study recommended that moving towards and achieving sustainable waste management requires policy advocacy, more community engagements, partnership and collaboration as well as new technology solution and other mitigation measures in waste management.

1. Introduction

This chapter lays the foundation for understanding waste management at Zambia Sugar, one of Zambia's largest agro-industrial operations. It begins by highlighting the global and regional challenges of solid and industrial waste, and how poor waste handling contributes to environmental degradation, public health risks, and unsustainable industrial growth. Effective waste management is a critical element of environmental sustainability and corporate responsibility, particularly in industrial sectors such as sugar production that generate substantial waste streams.

Uncollected or improperly disposed of, leading to environmental contamination and increased health hazards. This situation underscores the urgency for effective industrial waste management systems across the continent.

In Zambia, industrial waste management continues to pose significant challenges despite the existence of environmental policies and regulatory frameworks. The Environmental Management Act No. 12 of 2011 mandates industries to adopt environmentally sound waste management practices under the oversight of the Zambia Environmental Management Agency (ZEMA). However, enforcement remains weak due to limited institutional capacity, inadequate data collection, and insufficient collaboration between industries and regulatory bodies (Chisanga et al., 2023 [9]; ZEMA, 2022). As a result, many industrial operations still face difficulties in achieving compliance with environmental Globally, the approach to waste management has evolved from mere disposal to integrated systems that emphasize waste prevention, reduction, reuse, recycling, and energy recovery (World Bank, 2018). However, in many developing regions, including Africa, such practices remain underdeveloped due to limited infrastructure, inadequate policy enforcement, and low public awareness (Mafongoya, et al., 2019). According to UNEP (2020), Africa generates approximately 125 million tonnes of municipal solid waste annually, with industrial waste forming a significant share of this total. Unfortunately, a large proportion of this waste remain standards, which compromises national sustainability goals.

The sugar industry is one of Zambia's major agroindustrial sectors, contributing significantly to employment, rural development, and export earnings (Illovo Sugar Africa, 2021). Zambia Sugar Plc, a subsidiary of Illovo Sugar (Africa's largest sugar producer), operates one of the largest sugar plantations and processing facilities in sub-Saharan Africa, located in Mazabuka, Southern Province. Its operations involve large-scale cultivation, harvesting, and processing of sugarcane, all of which generate substantial quantities of organic and inorganic waste, including bagasse, molasses, effluent, plastics, and general solid waste (Zambia Sugar Plc, 2021). If inadequately managed, these wastes can cause severe environmental pollution, threaten community health, and lead to non-compliance with ZEMA's environmental guidelines.

1.1 Problem Statement
Despite the growing recognition of sustainable waste management as a critical component of environmental protection and industrial efficiency, many agroindustrial firms in Zambia continue to face significant challenges in managing their waste effectively. Zambia Sugar Plc, one of the country's largest industrial operations, generates substantial quantities of both organic and inorganic waste through its agricultural and processing activities. Although the company has implemented various initiatives such as effluent treatment and composting, persistent inefficiencies in waste segregation, recycling, and stakeholder participation remain evident (Chisanga *et al*., 2023 [9]; (Immaculate, *et al*., 2025). These shortcomings have resulted in environmental pollution risks, potential noncompliance with ZEMA regulations, and threats to community health and sustainability. The persistence of these issues suggests a gap between policy requirements and actual practice in waste management at Zambia Sugar Plc. Furthermore, limited empirical research exists on the effectiveness of the company's current waste management systems and the underlying factors influencing their performance. This study, therefore, seeks to evaluate the effectiveness of waste management practices at Zambia Sugar Plc by identifying the key challenges contributing to inefficiencies, assessing their environmental and operational impacts, and proposing practical strategies to improve waste management for sustainable industrial operations.

1.2 Objectives
1.2.1 General Objective
The general objective of this study is evaluating waste management practices at Zambia sugar plc Mazabuka.
1.2.2 Specific objectives
1. To identify causes of improper waste management practices at Zambia Sugar Plc.
2. To investigate the effects of improper waste management practices at Zambia sugar.
3. To propose measures for improving waste management at Zambia sugar.

1.3 Research Questions
1. What are the causes of improper waste management practices at Zambia Sugar Plc?
2. What are effects of improper waste management at Zambia Sugar Plc?
3. What measures can be implemented to improve waste management practices at Zambia Sugar Plc?

1.4 Significance of the study
This research is significant for multiple stakeholders. For Zambia Sugar Plc, it offers a critical reflection on current practices and suggests pathways for improvement. For environmental regulators and policymakers, the study provides evidence-based insights that can inform policy design and enforcement strategies. For academia and future researchers, the findings add to the limited body of knowledge on industrial waste management in Zambia.
Furthermore, the study has social relevance. Effective waste management has direct implications for community health, environmental conservation, and economic efficiency. By fostering more sustainable practices, Zambia Sugar can strengthen its corporate social responsibility and enhance its reputation both locally and internationally.
This study is timely and relevant given the growing emphasis on sustainability and the increasing scrutiny of industrial environmental practices. By focusing on Zambia Sugar Plc, the research provides insights into the challenges and opportunities within the agroindustrial waste management sector. It also offers a case study for policymakers, environmentalists, and other sugar companies seeking to improve their environmental footprint.
Furthermore, the study seeks to fill a research gap by providing empirical data and analysis on waste management in Zambia's sugar industry. Its findings may contribute to the development of more robust environmental policies and industrial standards, benefiting not only Zambia Sugar but the broader sector and society as a whole.

1.5 Limitations of the Study
Possible limitations include restricted access to sensitive company data, respondent bias, and logistical challenges during fieldwork. However, measures such as triangulation and respondent validation will be used to mitigate these limitations.

2. Literature Review
This chapter presents theoretical framework and a review of existing literature relevant to waste management practices, focusing on Zambia Sugar Plc and other industries across the globe. This literature review synthesizes existing research to identify the underlying causes of improper waste management practices, investigate their effects, and propose measures for improvement, aligning with the study's objectives. The literature is reviewed across three levels: The global context, the African context and the Zambian context, aligning with the three specific research objectives.

2.1 Theoretical Framework
The theoretical framework is the foundation on which the research is based (Booth, *et al*., 1995) [6]. It offers an eye through which the research problem is perceived and understood. In assessing waste management practice at Zambia Sugar, numerous theories shed light on environmental behavior, institutional accountability, and sustainable practice. This section will examine the major theories guiding this study: The Systems Theory, the Environmental Management Theory, and the Stakeholder Theory.
2.1.1 Systems Theory
According to (Miranda, 2014) [23], systems Theory operates on the philosophy that all different components of a system exist as interrelated and interdependent ones. According to

waste management theory, all different actors and steps involved like production, creation of waste, managing waste, and disposal will need to coordinate well with one another in order to achieve optimal results (Yusop, & Nooraini, 2021). Zambia Sugar is in a system that involves internal units (e.g., production, transport, environmental management) and external stakeholders (e.g., regulators, local communities, suppliers). Inefficiency in any component of this system can impact waste management operations (illovosugarafrica.com, 2025) [18]. The use of Systems Theory enables the researcher to view Zambia Sugar's waste management as a system where policy, technology, people, and community involvement must be coordinated for sustainable needs. Failure in any subsystem (e.g., inadequate training of personnel or failure of waste treatment equipment) may lead to an overall environmental risk.

2.1.2 Environmental Management Theory
Environmental Management Theory is concerned with systematic planning, implementation, and monitoring of activities that impact the natural environment (Barrow C.J., 1999) [5]. At its core, the theory is founded on ecological principles and encourages embracing environmentally friendly policies, technology, and practices. Environmental Management Theory can help Zambia Sugar evaluate compliance of the firm with ecological levels, reducing wastage, and adhering to regulations and rules.

2.2 Literature Review
2.2.1 Waste Management Practices
Under the Solid Waste Regulation and Management Act of 2018, Zambia formally recognizes waste as a resource and promotes a hierarchy of waste handling prioritizing prevention, reduction, reuse, recycling, composting before disposal. The Act also calls practice of the waste management hierarchy prevention, minimization, reuse, recycling, energy recovery, and disposal. Understanding how Zambia Sugar positions itself in the hierarchy will help decide the effectiveness of its waste practice.

2.2.2 Stakeholder Theory
Stakeholder Theory holds that companies must consider the interests of all the stakeholders who are affected by their operations (Harrison, *et al*., 2019). For Zambia Sugar, these are employees, communities, regulatory authorities, environmental interest groups, and shareholders. Good waste management must, therefore, consider stakeholder expectations, concerns, and comments. This theory stresses the importance of participatory approaches in planning and executing waste management. For instance, local community participation for recycling campaigns or programs can lead to environmentally sustainable practices. Through stakeholder inputs, Zambia Sugar can enhance transparency, build trust, and promote environmental stewardship.

Table 1: Summary Table: Waste Management in Zambia & Zambia Sugar Plc

Level	Highlights
National	Waste hierarchy law, weak enforcement, limited recycling & landfill infrastructure, rising circular economy initiatives.
Company (Zambia Sugar plc)	Established EMS aligned with AWS; efficient waste segregation (54 bays); ~80% waste diversion to productive use.
Challenges	Resource constraints in enforcement; persistent public attitudes; nonengineered landfill practices.

Source: Field Research (2025)

According to a 2022 study by (Debrah, *et al*., 2022) [13] on barriers to the circular economy in SubSaharan Africa, Zambia faces significant waste management challenges, with annual costs of indiscriminate waste disposal estimated at USD 195 million (approximately 0.9% of GDP) as per the 2012 Water and Sanitation Program report. The projected waste increase to 244 billion tons by 2025 (with a population of 1.50 billion in SSA) underscores the urgency (Debrah, *et al*., 2022) [13]. Efforts by international partners are noted, but political preference for cheaper disposal methods (e.g., open dumps) over engineered landfills persists, raising questions about the effectiveness of current policies (Chanda & Chitondo, 2024) [7].

A study on waste management in Zambia's construction sector highlighted the need for Site Waste Management Plans to address environmental challenges, indicating broader waste management deficiencies applicable across industries. (Muleya & Kamalondo, 2017) [1]. Globally, improper waste management in the sugar industry is driven by inadequate infrastructure, limited technical expertise, high costs of modern treatment technologies, and weak regulatory enforcement, (Dominic, 2022) [15]. Many sugarproducing countries, including Brazil, India, Pakistan, and Indonesia, struggle with financial barriers that hinder adoption of sustainable technologies such as anaerobic digestion and waste-to-energy systems (Nizami, 2018) [26], (Liman, 2018) [22] and (KHATIB, 2019) [21]. Lack of awareness of circular economy opportunities, such as converting bagasse into biofuels or bioplastics, further contributes to inefficiencies. Poor waste handling has severe consequences, including soil and water contamination, reduced agricultural productivity, biodiversity loss, and increased greenhouse gas emissions from burning agricultural residues. Health risks also emerge through exposure to untreated waste, air pollutants, and contaminated water, while failure to valorize waste streams results in lost economic opportunities. Although many countries are transitioning to sustainable waste solutions, institutional weaknesses, cultural attitudes, and high transition costs often delay progress (UNEP, 2020).

Across Africa, waste management challenges are magnified by weak regulatory enforcement, rapid industrialization, limited investment in waste infrastructure, and poor institutional coordination. In many countries such as South Africa, Nigeria, Kenya, and Malawi the sugar industry continues to rely on outdated and inefficient disposal methods due to gaps in technology, funding, and environmental management systems (APRILIA, 2021) [3], (Hassan, *et al*., 2021) [16]. These systemic weaknesses result in severe environmental degradation, including soil erosion, water pollution, loss of biodiversity, and air pollution from open burning (Dladla, *et al*., 2017) [14] and (Debrah, *et al*., 2022) [13]. Public health risks are substantial, as communities near dumpsites face higher incidences of cholera, malaria, respiratory diseases, and chemical exposure. Africa also suffers from illegal dumping and importation of hazardous waste such as electronic waste (Niyobuhungiro & Schenck, 2022) [25]. Despite the existence of international and regional policies, implementation remains weak, prompting many African countries to adopt measures such as plastic bans,

Extended Producer Responsibility schemes, community-based recycling programs, and green financing initiatives aimed at improving waste treatment technologies. However, enforcement remains inconsistent, and most waste continues to leak into the environment (Bandara, *et al*., 2019) [4].

In Zambia, ineffective waste management is influenced by limited institutional capacity, weak enforcement of environmental laws, inadequate funding, insufficient waste infrastructure, and low public awareness (Muleya & Kamalondo, 2017) [1]. Local authorities often lack the autonomy and resources required to manage industrial waste effectively, resulting in over-reliance on central government support (ZEMA, 2020) [32]. Studies show that many agro-processing industries, including Zambia Sugar Plc, face challenges such as poor waste segregation, limited investment in modern treatment technologies, and incomplete compliance with the Environmental Management Act. Financial constraints hinder the establishment and maintenance of proper waste facilities such as incinerators and effluent treatment systems. Social and behavioural tendencies, including low environmental awareness and lack of training among workers, further exacerbate poor practices. The consequences are significant, with risks of soil and water pollution, air contamination from improper handling of by-products like bagasse, and potential health hazards to surrounding communities. Despite these challenges according to (Zondiwe Mbewe Zambia Sugar, 2023) [33] and (illovosugarafrica.com, 2025) [18]. Zambia Sugar Plc has made notable progress by adopting modern technologies such as bagasse valorization, improved waste segregation procedures, enhanced record-keeping, and upgrades in effluent treatment *(Hazemba & Clube, 2024)* [17]. The company has also benefited from ISO 14001 certification, which strengthens environmental compliance and aligns operations with global standards. Further improvements recommended for Zambia include enhanced internal waste tracking systems, improved recycling infrastructure, stronger community engagement, increased training, and adoption of the 3Rs: Reduce, Reuse, recycle to promote a culture of sustainability (Chanda & Chitondo, 2024) [7].

3. Methodology

This chapter presents the research methodology that will be used to evaluate and enhanced waste management practices at Zambia sugar plc with the focus on causes, impacts, and improvement strategies. It includes the research design, population and sampling techniques, data collection methods, instruments, and data analysis techniques. The methodology is designed to ensure that the research questions are addressed effectively and that valid and reliable data are collected.

3.1 Research Design

Research designs differ and only depend on the way different researchers start their studies from the very onset of the study. (Creswell, 2012) [12], has defined research design as a structural framework within which the study is to be conducted.

The study adopted mixed-methods research design, combining both qualitative and quantitative approaches. This design will be selected to provide a comprehensive understanding of waste management practices by collecting numerical data as well as indepth insights from key stakeholders. Quantitative methods help identify patterns and trends, while qualitative methods offer detailed explanations of observed phenomena.

3.2 Study Area

According (Creswell, 2012) [12], a study area refers to the specific geographic location or setting where a research project is conducted. It is the physical or organizational boundary within which the researcher collects data and applies their methods. The research was conducted at Zambia Sugar Plc, located in Mazabuka, Southern Province. The company is one of the largest sugar producers in Zambia and has a significant impact on the local environment due to its scale of operations. Understanding its waste management practices is essential for promoting sustainable industrial operations in the region.

3.3 Target Population

A population refers to the total collection of elements or subjects that share common observable characteristics or patterns which the researcher seeks to investigate and draw inferences from (Saunders, *et al*., 2012). According to (Denscombe, 2010), a population is defined as a universe encompassing all members of a real or hypothetical group of people, events, or objects to which the results of a study are intended to be generalized.

For the purpose of this study, the target population is 100 individuals, including Zambia Sugar Plc employees directly involved in waste management, environmental officers responsible for regulatory compliance, local government officials overseeing environmental health, and community members residing near the factory. These groups were purposively selected because they represent key stakeholders with firsthand knowledge, experiences, and perceptions regarding the effectiveness, challenges, and impacts of current waste management practices at Zambia Sugar Plc. Their input is essential for gaining a comprehensive understanding of the environmental and social implications of the company's waste management systems.

3.4 Sampling Technique/ Sample Size

(Cooper & Schindler, 2014) [10], have described sampling techniques as the methods that takes into account how a sample was selected. According to (Sekaran & Bougie, 2015) [29], sampling techniques include; the probability and the non-probability techniques. They distinguished probability sampling techniques where a sample is chosen based on known probabilities and were given equal chances in order to avoid biasness. a Cochran's formula will be used to determine a sample size because the population is unknown.

A purposive sampling technique will be employed to select respondents who will be directly involved or knowledgeable about waste management at Zambia Sugar.

3.5 Sample Size

A sample size is the number of participants, observations, or data points selected from a larger population for the purpose of a study or analysis. It's a subset of the population that is representative of the whole (Creswell, 2011) [11].

$$n^0 = \frac{Z^2 \cdot P \cdot (1-p)}{E^2}$$

Where:
- $n0n\_0n0$ = sample size
- Z Z-value (1.96 for 95% confidence)
- E= estimated proportion (use 0.5 if unknown, for maximum variability)
- E= margin of error (e.g., 0.1 for ±10%)

$$n^0 = \frac{(1.96)2 \cdot 0.5.0.5 =}{0.1^2} = 96.04 = 100$$

The sample size consists of 100 participants, including 60 company employees, 5 environmental officers, 35 community representatives. This sample is deemed sufficient to provide meaningful insights and facilitate data triangulation.

3.6 Data Collection Instruments

Data Collection instruments are instruments or methods used by researchers to gather information from respondents for the purpose of answering research questions or testing hypotheses (Creswell, 2011) [11].

The research methodology employed a combination of data collection tools, including structured questionnaire with open-ended questions. These questionnaires allowed for the collection of both quantitative and qualitative data, providing a comprehensive understanding of the research topic. Additionally, interview guides were developed for key informants, enabling in-depth, one-onone conversations that gathered valuable insights from experts and individuals with relevant experience. Furthermore, focus group discussion guides were created to facilitate group dynamics and gather diverse perspectives on the research topic, allowing participants to share their thoughts and experiences in a collaborative setting.

3.7 Data Analysis Techniques

Data Analysis techniques are software applications or frameworks designed to facilitate the process of collecting, cleaning, transforming, analysing, and interpreting data (Cooper & Schindler, 2014) [10].

Data will be analysed using descriptive statistical tools such as frequencies, percentages, and means to summarize and interpret the responses obtained from the questionnaire. These statistical measures will help to highlight patterns, trends, and common responses among the participants. The analysis will provide insights into the causes, effects, and potential solutions to improper waste management practices at Zambia Sugar Plc.

3.8 Triangulation Framework

(Cooper & Schindler, 2014) [10], define triangulation as the use of multiple methods, sources, or investigators to increase validity and reliability.

To enhance the validity and reliability of this study, a triangulation approach will be employed, combining multiple methods and sources.
1. Data Triangulation:
   - Surveys and questionnaires
   - Interviews (in-depth, semi-structured)
2. Methodological Triangulation
   - Qualitative method (statistical analysis)
   - Quantitative method (thematic analysis)

This triangulation aimed to increase confidence in findings, reduce bias and enhance.

4. Data Findings and Interpretation
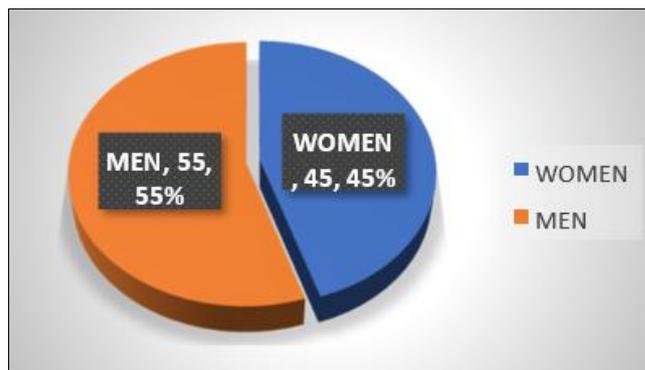
A total of 40 respondents participated, and the analysis integrates their perceptions with observable institutional practices.

The demographic profile of respondents shows a relatively balanced gender distribution, with men constituting 55 percent and women 45 percent. Most participants were within the 31–40 and 41–50 age brackets, each representing 35 percent of the sample, suggesting a predominantly middle-aged workforce with extensive experience in operational roles. Only 20 percent were aged 18–30 years, and 10 percent were above 51 years.
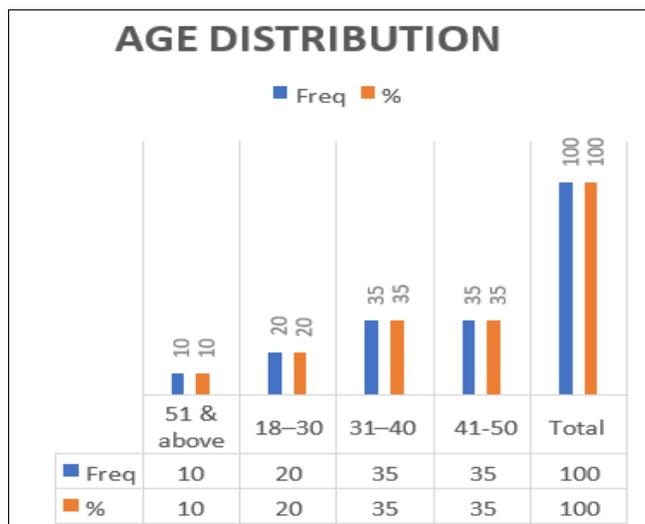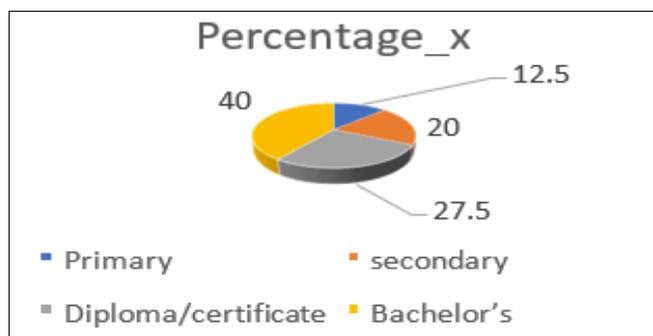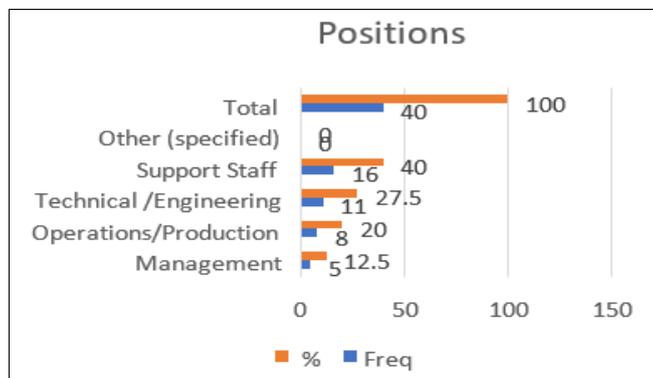

Source: Field work (2025)

Table 2: Gender & Age Summary

This diversity of roles provided a broad perspective on waste management practices across the organization.

Regarding the underlying causes of improper waste management, the findings indicate strong institutional commitment, as 80 percent of respondents rated policy enforcement as very strong and the remaining 20 percent rated it as moderate. All respondents confirmed the existence of a formal waste management policy and reported that waste is consistently sorted at the source, suggesting that policy awareness is high. Similarly, all respondents agreed that resources required for waste handling such as bins, protective equipment and waste stations were adequately provided, indicating sufficient resource allocation within the institution. However, although most respondents were aware of educational background of respondents demonstrated high capacity for technical

engagement, as most had attained tertiary-level qualifications. Specifically, 37.5 percent held diplomas or certificates, while 32.5 percent had bachelor's degrees or higher. Secondary-educated respondents accounted for 27.5 percent, with only 2.5 percent having primary education. Additionally, the roles represented within the company ranged from support staff (40 percent) to technical and engineering personnel (27.5 percent), operations staff (20 percent), and management (12.5 percent).

Source: Field word (2025)

Table 1: Roles & Education Summary

Environmental issues, 95 percent indicated they were not aware of community complaints related to waste disposal, suggesting a communication gap between the company, employees, and the surrounding community. Respondents identified water pollution, soil contamination and air pollution as the primary environmental impacts, demonstrating a heightened awareness of ecological consequences associated with improper waste management.

In terms of the broader effects of improper waste handling, the majority of respondents (55 percent) perceived the environmental impact of the company's waste disposal practices as moderate, while 32.5 percent believed the impact was low. A smaller proportion (12.5 percent) rated the impact as very high, reflecting concerns about water, soil and air pollution. None believed the impact to be negligible.
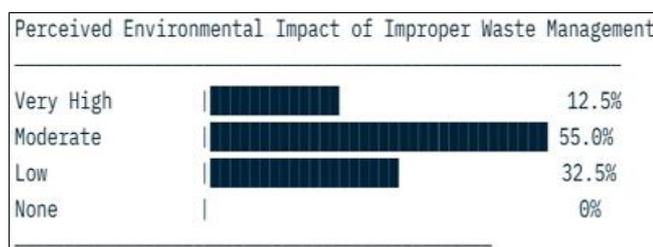

Fig 10: Environmental impact of improper waste management

Employee health impacts were perceived to be low, with 75 percent of respondents stating that waste disposal practices posed no health risk. The remaining respondents acknowledged some health concerns, indicating the need for continuous monitoring and protective measures. Although community complaints were reported to be minimal, the lack of awareness among employees suggests weak information sharing processes regarding external feedback.

The study also identified measures currently implemented to improve waste management. All respondents confirmed that they undergo regular training on waste handling and disposal, demonstrating strong investment in capacity building.

Source: Field data (2025)

Fig 2: Training and waste reduction

This commitment is reinforced by the company's multisystem waste management approach, which includes recycling, composting, landfill disposal and incineration. Respondents emphasized recycling and composting as key sustainable practices. All employees agreed that poor waste management typically arises from multiple interconnected causes rather than isolated issues, indicating a collective understanding of systemic challenges. Waste reduction strategies were strongly supported, with unanimous confirmation that source reduction, process optimization, and recycling initiatives are actively practiced. Furthermore, daily inspections by management were reported across the company, highlighting ongoing monitoring and consistent enforcement. Overall perceptions of the waste management system were highly positive, with 72.5 percent rating it as excellent and the remaining 27.5 percent rating it as good. No respondent rated the system poorly, demonstrating general satisfaction with existing measures.

In conclusion, the findings reveal that Zambia Sugar Plc has strong waste management structures supported by well-defined policies, adequate resources, and comprehensive training initiatives. While the environmental impacts of waste remain the most significant concern, institutional practices reflect strong compliance and commitment to environmental stewardship. Nonetheless, there is a need to strengthen communication with surrounding communities, enhance monitoring processes and continue investing in technologies that promote sustainable and efficient waste management.

5. Discussion and Conclusions

This chapter discusses the findings of the study in relation to the objectives, existing literature, and the conceptual framework guiding the research. The chapter is organized

into three main sections: the discussion of results, the conclusions drawn from the findings, and the recommendations for policy, practice, and further research. The discussion situates the study within the broader context of waste management in Zambia and globally, while conclusions highlight the most critical insights and the recommendations suggest actionable strategies to improve waste management practices at Zambia Sugar Plc and similar industrial settings.

5.1 Discussion of Findings

As objective number one, the study found that Zambia Sugar Plc has a formal waste management policy, rated by employees as either very strong (80%) or moderate (20%) in enforcement. This aligns with literature emphasizing that policies form the backbone of structured waste management practices (UNEP, 2020). However, as also noted in studies across Sub-Saharan Africa, the presence of a policy does not automatically guarantee effectiveness due to gaps in enforcement and monitoring (Chanda & Chitondo, 2024) [7] The unanimous confirmation that waste is always sorted indicates high compliance with best practices. Yet, challenges persist in terms of community feedback and communication gaps. Only 5% of respondents reported awareness of community complaints, while 95% indicated they were not aware. This reflects a broader issue noted in Zambia's Environmental Management Agency (ZEMA, 2021) reports, where weak community company engagement undermines transparency and environmental accountability.

Resource allocation was not perceived as a challenge, with 100% of respondents stating that sufficient budget, staff, and equipment are provided. This finding diverges from much of the African literature, which highlights resource scarcity as a primary barrier (World health, with 75% disagreeing and 12.5% strongly Bank, 2018). disagreeing that it affects them. This confidence in Instead, Zambia Sugar Plc's challenge seems to lie in occupational health and safety may reflect ensuring that available resources are utilized efficiently and strategically, particularly in adopting advanced technologies such as waste-to energy systems, which are gaining traction in South Africa and Kenya (Debrah, *et al*., 2022) [13]. However, looking at objective two, the study revealed that the most visible impacts of improper waste management are environmental, including water pollution, soil contamination, and air pollution. These concerns resonate with findings from studies in Nigeria and Kenya, where sugar processing industries have been linked to effluent discharges that pollute waterways and agricultural land (Bandara, *et al*., 2019) [4]. Interestingly, employees did not perceive waste management to pose a major threat to their emphasizes inclusive stakeholder engagement as key to sustainable waste management (WESS, 2017) [31].

On the other hand, objective number which outlines measures for improving waste management, Zambia Sugar Plc was found to implement a combination of landfill, recycling/composting, and incineration, with a particular emphasis on recycling and composting. This aligns with circular economy principles that stress waste minimization and resource recovery (Dladla, *et al*., 2017) [14]. By adopting such practices, the company demonstrates a commitment to sustainability beyond basic compliance (Muleya & Muyoba, 2010) [24].

Zambia Sugar Plc's investment in training, PPE, and compliance with ZEMA guidelines. However, this perception could also mask latent health risks, such as respiratory issues linked to air pollutants or long-term exposure to chemical waste. Studies in Ghana and Tanzania show that employees often underestimate health risks due to limited monitoring of chronic conditions (Yusop, & Nooraini, 2021). Community complaints were minimal, but the dominant "Not aware" responses suggest weak feedback loops. This points to a potential disconnect between the company and community stakeholders.

International best practice Regular training and employee involvement in planning were unanimously confirmed, reflecting strong internal capacity-building. This finding supports (Bitzer, 2016), which emphasizes knowledge transfer and staff engagement as critical factors in effective industrial waste management. Employees rated the overall waste management system highly, with 72.5% rating it as "Excellent" and 27.5% as "Good." This positive perception indicates strong institutional commitment, but the literature reminds us that self-reported evaluations may not fully capture underlying inefficiencies (ZEMA, 2020) [32] For instance, while employees believe the system is excellent, the environmental impact ratings (55% moderate, 32.5% low, and 12.5% very high) suggest that significant pollution risks remain.

5.2 Conclusions

The study concluded that Zambia Sugar Plc has invested significantly in institutionalizing waste management through policies, daily monitoring, resource allocation, and employee training. Employees generally perceive the system as effective and non-threatening to health, and there is evidence of sustainability-driven practices such as recycling and composting.

6. Acknowledgement

7. References

1. Muleya F, Kamalondo H. An Investigation of Waste Management Practices in the Zambian Construction Industry. Journal of Building Construction and Planning Research. 2017; 5(1):1-13.
2. Ahmad M. Industrial effluent quality, pollution monitoring and environmental management. Environment, Monitoring and Assessment. 2008; 147:297-306.
3. Aprilia A. Waste Management in Indonesia and Jakarta: Challenges and Way Forward, 2021.
4. Bandara N, Patrick J, Hettiaratchi JPA. Environmental impacts with waste disposal practices in a suburban municipality in Sri Lanka. International Journal of Environment and Waste Management. 2019; 12(6).

5. Barrow CJ. Environmental Management | Principles and practice. 1 ed. London and New York: British Library, 1999.
6. Booth WC, Colomb GG, Williams JM. The Craft of Research. 3 ed, s.l.:s.n, 1995.
7. Chanda TC, Chitondo L. Towards Sustainable Waste Management in Zambia: A Comprehensive Review. International Research Journal of Modernization in Engineering Technology and Science. 2024; 6(3):2597-2614.
8. Chavula P, *et al*. An overview of Zambia's Agricultural Extension and Advisory System. Agricultural Economics and Extension. 2022; 6(10):209-214.
9. Chisanga Masebe A, Mulenga E, & S, S. Knowledge, Attitude and Practice Towards COVID-19 Infection Prevention and Control Measures in Mwandi District of Zambia: A Three Year Retrospective Study. International Journal of Infectious Diseases and Therapy, 2023.
10. Cooper D, Schindler S. Business Research Methods. New York: McGraw-Hill Irwin, 2014.
11. Creswell J. Designing and Conduction Mixed Method Research. SAGE Publication, 2011.
12. Creswell JW. Educational Research, Planning, Conducting, and Evaluating Quantitative and Qualitative Research. 4 ed. 501 Boylston Street, Boston, MA 02116. University of Nebraska-Lincoln.: Pearson Education, Inc, 2012.
13. Debrah JK, Teye GK, Dinis MAP. Barriers and Challenges to Waste Management Hindering the Circular Economy in Sub-Saharan Africa. Urban Science. 2022; 6(3).
14. Dladla F, Machete F, Shale K. A review of factors associated with indiscriminate dumping of waste in eleven African countries. African Journal of Science, Technology, Innovation and Development, 2017.
15. Dominic. Solid Waste Management, s.l.: World Bank, 2022.
16. Hassan MT, Dilawar S, Akbar M. Industrial Waste Management in Pakistan: Problems and Prospects. Global Management Sciences Review. 2021; 11(1):39-53.
17. Hazemba M, Clube R. From Waste to Resource: Creating an Enabling Policy. Frontiers in Sustainability, 2024.
18. Illovosugarafrica.com, 2025. Illovosugarafrica.com. [Online] Available at: https://www.illovosugarafrica.com/about-us/zambia [Accessed 3 August 2025].
19. Kalogiannidis S, Syndoukas D. The Impact of Agricultural Extension Services on Farm Output: A Worldwide Viewpoint. World Agricultural Economy. 2024; 5(1).
20. Kaza S, *et al*. Publication: What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development, 2018.
21. Khatib AE. Municipal Solid Waste Generation, Composition and Management: The World Scenario. Environmental Science and Technology. 2019; 42:1509-1630.
22. Liman A. Comparative analysis of municipal solid waste. Engineering, Environmental Science, 2018.
23. Miranda F. Systems Theory: Perspectives, Applications and Developments. s.l.: Nova, 2014.
24. Muleya F, Muyoba R. Minimizing Construction Material Waste through Design: National Council for Construction. Construction News Magazine, Zambia, 2010.
25. Niyobuhungiro RV, Schenck CJ. A global literature review of the drivers of indiscriminate dumping of waste: Guiding future research in South Africa. Development Southern Africa. 2022; 39(3):p. 321337.
26. Nizami DA-S. The Issues of Sustainable Solid Waste Management System in Developing Countries. s.l., s.n, 2018.
27. Okot-Okumu. Solid waste management in African Cities-East Africa. In: Rebellonm LFM. Waste Management-An Integrated Vision, 2019.
28. Ritzer G, R. J. M. The Concise Encyclopedia of M., Lewis, P. & Thornhill, A., 2012. Research Methods for Business Students, 2010.
29. Sekaran U, Bougie R. Research Methods for Business: A Skill Building Approach. 5 ed. New Jersy: John Wiley and Sons, Hoboken, 2015.
30. United Nations Environment Programme (UNEP). Global Waste Management Outlook, 2021.
31. WESS. Sustainable Development Challenges, s.l.: Uinted Nations, 2017.
32. ZEMA. 2020 Anual Report, lusaka: Zema, 2020.
33. Zondiwe Mbewe-Zambia Sugar. Waste to productive use-Zambia Sugar, Lusaka: News Diggers, 2023.