

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF ENVIRONMENTAL SCIENCE

**INVESTIGATING THE CHALLENGES FACED BY BRICKMAKING, TILE
MANUFACTURING, AND CLAY PRODUCTS INDUSTRY ON SOLID WASTE
MANAGEMENT.A CASE STUDY OF ZIMTILE PVT LTD, HARARE.**



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OF (BACHELOR OF SCIENCE DEGREE IN SAFETY, HEALTH, AND
ENVIRONMENTAL MANAGEMENT).***

JUNE 2025

DECLARATION

I, Acqueline Mutezo, declare that this dissertation is a result of my original work and has not been submitted for any academic award in any other educational institution. Any resources that were referred to in this research project have been duly acknowledged through in-text citations and a properly formatted reference list.

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This dissertation is suitable for submission to the faculty and has been checked for conformity with faculty guidelines.

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Date 13 October 2025

DEDICATION

I dedicate this dissertation to my beloved family, mentors, lecturers, and everyone who believed in me, even when I doubted myself. This achievement is as much yours as it is mine. With gratitude and hope, I dedicate this work.

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ABSTRACT

This study investigates the challenges faced by the brickmaking, tile manufacturing, and clay products industry in managing solid waste, using Zimtile Pvt Ltd in Sotherton, Harare, as a case study. As industrial waste generation increases in Zimbabwe, there is growing concern over its environmental and social impacts, particularly in densely populated urban industrial areas. Three main objectives guided the study, and the first one was to examine the existing waste management practices used by Zimtile, followed by assessing the challenges and environmental impacts arising from improper waste management, and lastly, to explore potential strategies and solutions for improvement.

A mixed methods approach was adopted, combining quantitative data from structured questionnaires and qualitative insights from interviews, observations, and document review. The study was framed using the Environmental Kuznets Curve (EKC), Systems Theory, and Stakeholder Theory and Stakeholder Theory to analyze institutional behavior, industrial dynamics, and environmental accountability.

Findings revealed that Zimtile primarily disposes of waste through burning and on-site dumping, with minimal recycling or reuse. Challenges identified include inadequate infrastructure, limited funding, weak enforcement of policy, and strained community relations due to pollution. Despite these issues, respondents expressed support for interventions such as employee training, technological upgrades, recycling programs, and stakeholder engagement.

The study concludes that Zimtile's waste management practices remain largely unsustainable, but with proper investment, policy enforcement, and collaboration, the company can transition toward environmentally responsible operations. The research contributes to national priorities outlined in Vision 2030, NDS1, and Education 5.0, while aligning with global goals under Sustainable Development Goals (SDGs). Recommendations include developing a formal waste management policy, improving infrastructure, engaging communities, and fostering partnerships with regulators and recyclers.

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LIST OF ACRONYMS AND ABBREVIATIONS

CBO	Community-Based Organization
CSR	Corporate Social Responsibility
EMA	Environmental Management Agency
EKC	Environmental Kuznets Curve
GWP	Global Warming Potential
ISO	International Standardization Organization
MDGs:	Millennium Development Goals
MSW	Municipal Solid Waste
NDS1	National Development Strategy 1
NEC	National Employment Council
NGO	Non-Governmental Organization
QMS	Quality Management System
SDGs	Sustainable Development Goals
SHE	Safety, Health, and Environment
SSPS	Statistical Package for the Social Sciences
SWM	Solid Waste Management
UNEP	United Nations Environment Programme
ZELA	Zimbabwe Environmental Law
Zimtile	Zimtile Pvt Ltd

CHAPTER 1

1.0 INTRODUCTION

Solid waste management has become an increasingly important issue in the context of industrial development and environmental sustainability. As industries expand to meet growing urbanization and infrastructure demands, the volume and complexity of waste they produce also increase. (ZELA, 2023). In Zimbabwe, the brick-making, tile manufacturing, and clay products industry is a key contributor to economic activity, yet it remains largely underregulated and under-researched concerning its environmental footprint. Poor waste handling practices not only threaten ecological systems but also impact public health and surrounding communities. This research emphasizes investigating the challenges of managing solid waste faced by Zimtile Pvt Ltd, a major manufacturer in Harare's Southerton industrial area, to understand current practices, identify institutional and environmental barriers, and explore viable strategies for sustainable waste handling in line with national and global goals.

1.7 STUDY BACKGROUND

Solid waste management is all activities related to managing waste from its generation to its final disposal, including collection, sorting, recycling, treatment, and disposal. Construction waste is one of the largest solid waste streams in the world, contributing 30 - 40% of total solid waste to landfills in many economies. (Islam, et al., 2019).

Worldwide research has been conducted due to the importance and urgency of this issue, and studies on solid waste management have focused heavily on developing sustainable strategies to address the growing problem of waste generation. These studies have included investigations into waste reduction, recycling, composting, waste-to-energy technologies, and proper disposal methods. The economic and environmental impacts of different waste management practices, particularly in the context of rapidly urbanizing areas and increasing global waste production, with

a significant focus on identifying innovative solutions to minimize the environmental footprint of solid waste disposal while maximizing resource recovery, were also focused on (Bank, 2018)

The global generation of industrial solid waste has been on an upward trajectory, driven by industrialization and economic growth. In 2024, the industrial solid waste management market was valued at over USD 1 trillion and is projected to expand at a compound annual growth rate (CAGR) exceeding 2% from 2025 to 2034 (Gupta & Sharma, 2024). This expansion demonstrates the growing demand for efficient waste management techniques. Waste generation has significantly increased in Asia over the last 50 years, mostly due to industrialization and population growth. Approximately 45-50% of all waste produced, especially kitchen waste, is organic waste. However, recent data shows that waste generation is trending downward in nations like South Korea and Japan, which can be attributed to successful public awareness campaigns and campaigns and waste management policies. (Priyashantha, et al., 2022).

According to a survey on the development of municipal solid waste management in North America, there is ongoing inefficiency in drainage maintenance and portable water distribution, which increases the risk of waterborne illness and poses major health risks to the general public. These issues are made worse by deficiencies in solid waste management, where irregular collection services result in environmental contamination and a risk to public health. (Ross & Law, 2023).

The majority of businesses produced waste in the form of plastics (59-79%), cardboard (31-61%) and food scraps (21-37%), according to a study that looked into the waste management practices of small businesses in a selection of townships in the Gauteng province of South Africa. Office paper, glass, metals, food items, and other waste materials were among the waste types that the survey found to be significantly correlated with the formality of businesses. Suggestions were made to maximize waste reduction initiatives in the townships and enhance current waste management procedures. (Kwenda, et al., 2024).

A comprehensive study published in the African Journal of Environmental Science and Technology highlighted the pressing issues in solid waste management across East African countries. The research identified key challenges, including insufficient waste collection services, reliance on unsanitary landfills, and limited recycling initiatives. These factors contribute to environmental degradation and pose health risks to local communities. (Yu, et al., 2021). A study conducted in Aba, South East Nigeria, assessed the approaches of industries toward waste

management. The findings revealed that industrial solid waste poses serious health concerns, and existing management strategies are often inadequate. The study emphasized the need for comprehensive waste management practices to mitigate health risks and environmental degradation. (Ajero & Chigbo, 2012)

In Ghana, the Agbogbloshie area has become notorious for improper electronic waste disposal and recycling practices. The informal processing of e-waste in this area has led to severe environmental pollution, including soil and water contamination with heavy metals and other hazardous substances. This situation emphasizes the critical need for formalized waste management systems and regulatory frameworks to address the environmental and health impacts of industrial waste. (Wikipedia, 2011). A study published in Sustainability examined waste management in Kampala, Uganda, to understand the drivers of waste generation, collection, and disposal. The research highlighted factors such as rapid urbanization, economic activities, and consumption patterns as significant contributors to increased waste generation. The findings highlighted the importance of tailored waste management strategies that consider local socio-economic dynamics to achieve sustainability. (Rada, 2022).

At Hwange Power Station, a noteworthy study examined waste reduction via material and energy recovery. The study emphasized the value of energy and material recovery in industrial settings and the possibility of increasing power output through the use of waste management techniques. (Jerie & Baldwin, 2022). The importance of the Environmental Management Act and its related regulations, including the Effluent and Solid Waste Disposal Regulations, was highlighted in an examination of Zimbabwe's waste management policies (SI 6,2007). These legislative instruments are crucial for regulating waste disposal and promoting sustainable practices within the industrial sector (Nyakudya, et al., 2022).

Zimtile Pvt Ltd, a major player in the construction industry in Zimbabwe it produces concrete tiles, pavers, and other building materials. Like many other construction companies, Zimtile faces significant challenges in managing the solid waste generated by its manufacturing processes. Hence, this investigation is on the challenges faced by the brickmaking, tile manufacturing, and clay products industry in solid waste management. The company produces a variety of waste materials, including defective products, broken tiles, dust, cement residues, and packaging materials. These waste streams can pose environmental risks if not handled properly, including

land, water sources, and air pollution, especially in urban and peri-urban areas where the company operates.

Uncollected waste frequently builds up along the banks or surfaces of water bodies as well as in open drainage canals. Waste that is poured down drains during the rainy season can clog them, resulting in flooding and standing water, which makes mosquito breeding more likely. The methods of collection and disposal used today are damaging to the environment and inefficient. These dumpsites have become toxic and have exceeded their capacity to contain urban waste pollution. (Chituu, 2020).

Effective solid waste management is critical in minimizing environmental degradation, enhancing resource efficiency, and complying with environmental regulations. Zimtile Pvt Ltd, Harare, a leading brick and tile manufacturer in Zimbabwe, exemplifies these challenges. Despite having environmental policies and disposal systems, the company continues to struggle with improper waste handling, adversely affecting nearby communities, soil health, air quality, and water resources. Increasing pressure from regulatory authorities, local councils, and stakeholders emphasizes the urgent need for Zimtile to adopt more sustainable and effective waste management practices, highlighting the importance of this investigation.

This research aims to investigate the key challenges faced by Zimtile Pvt Ltd in managing its solid waste, and to identify the current waste management practices employed, strategies that can help the company align its waste management practices with both regulatory requirements and sustainability goals. By examining a case study of Zimtile, this research aims to enhance the broader understanding of industrial waste management in Zimbabwe's manufacturing sector and provide actionable insights for policymakers, businesses, and environmental management practitioners. The study will assess the forms and measures of waste produced by Zimtile, examine the challenges faced by Zimtile in implementing effective waste mitigation systems, and explore potential solutions and strategies for improving waste management.

1.1 TOPIC

Investigating the challenges faced by the brickmaking, tile manufacturing, and clay products industry on solid waste management. A case study of Zimtile Pvt Ltd, Zimbabwe.

1.2 MAIN OBJECTIVE

To investigate the challenges faced by the brickmaking, tile manufacturing, and clay products industry in solid waste management.

1.3 SPECIFIC OBJECTIVES

1. To identify the current waste management practices employed by Zimtile.
2. To assess Zimtile's challenges and the surrounding environment due to improper solid waste management.
3. To explore potential solutions and strategies for improving waste management.

1.4 HYPOTHESIS

Null Hypothesis (H_0)

There is no significant relationship between potential solutions and strategies for improving waste management practices at Zimtile, Harare

Alternative Hypothesis (H_1)

There is a significant relationship between potential solutions and strategies for improving waste management practices at Zimtile

1.5 PROBLEM STATEMENT

Broken bricks, defective goods, broken tiles, cement dust residue, scrap material (drums, steel residue, wooden racks, electric wires, broken machinery, tires, worn-out conveyor belts), sand dust, worn gloves, quarry dust, oxide residues, strapping codes, defective products, and packing materials are just a few examples of the solid waste that Zimtile produces and is difficult to dispose. Waste management methods currently in place are open burning of gloves, waste paper from offices, and packaging material, which results in air pollution of the surrounding environment. The

only dust suppression method so far at Zimtile is wetting down, and it is not accommodating to all areas, types, and quantities of dust produced. Shortage of water and machinery wetting down is also a concern, whereby a single water spraying truck is shared between two branches, making it difficult to meet the minimum requirement of spraying three times a day. Moreover, alternative machinery like the digger is not suitable for dust suppression, as it is already in high demand for numerous production processes.

Scrap material is kept in storage rooms, and with the quantity of scrap produced per day, there is not enough room to contain it. Some of the scrap material is stored in heaps in the yard awaiting disposal, which might occur once or twice a year. Some of the scrap material, like drums, wooden racks, and steel material, is given off to anyone who needs it, but the procedure is complicated and long. During the rainy season, gloves and masks are carried off into the streets and drains, clogging them, leading to drainage bursts and stagnant waters, and mosquito breeding.

There is a loss of aesthetic value of the surrounding community due to dust and waste, masks, and gloves. Constant sewage outbreaks from the toilets, kitchen, and drainage systems due to the lack of a septic tank and clogging from the improper disposal of gloves and masks. Rubble is stored in heaps in the yard and is supposed to be constantly collected, but it is sold off at least once or twice a year.

Zimtile operates under the oversight of Zimbabwe's Environmental Management Agency (EMA), which enforces the Environmental Management Act (Chapter 20:27) and requires industries to adopt sustainable practices, including proper solid waste management, pollution control, and environmental rehabilitation. Failure to comply leads to fines, operational restrictions, or shutdowns. The shortage of comprehensive studies on solid waste management in Zimbabwe's construction materials business also creates a void in comprehending the specific difficulties encountered by enterprises such as Zimtile. The absence of targeted solutions makes it difficult for the company to mitigate its environmental footprint effectively.

1.6 STUDY JUSTIFICATION

Effective management of solid waste is crucial to industrial sustainability, environmental protection, and regulatory compliance. (Guerrero, et al., 2012). Education 5.0 in Zimbabwe emphasizes the 5 pillars, which are teaching, research, community service, innovation, and

industrialization. This study contributes by supporting research into real-world industrial challenges, promoting community-responsive knowledge that addresses environmental and public health concerns, and providing practical recommendations that can lead to innovation in waste management techniques. (Fredrick, et al., 2018).

Zimbabwe's Vision 2030 seeks to elevate the country to upper-middle-income economic status by the year 2030 through sustainable industrial growth, environmental responsibility, and improved living standards. (Zimbabwe, 2018). This research contributes by identifying inefficiencies and environmental risks in the industrial sector that may hinder sustainable development, offering evidence-based solutions that support green industry, and informing policy direction and investment priorities in waste management infrastructure and innovation. (Kumba, et al., 2024).

SDG 6, Clean Water and Sanitation identifies risks of water contamination from improper waste disposal and recommends better waste containment, SDG 11, sustainable Cities and Communities addresses environmental and health risks affecting communities near Zimtile, SDG 12 promotes efficient waste handling, recycling and reduction of landfill reliance, SDG 13 climate action which states that by reducing practices such as open burning, the study supports efforts to mitigate emissions and climate impacts and SDG 9 encourages adoption of sustainable technologies and industrial waste management systems (Marale, 2022).

National Development Strategy 1 (NDS1) (2021-2025) aims to achieve sustainable, inclusive development through modernization, environmental management, and industrial growth and this study highlights the need for modern, eco-friendly waste management practices in manufacturing, calling for investment in recycling, waste segregation and pollution monitoring infrastructure and promoting public private academic collaboration in industrial problem solving. (ZELA, 2023).

Open burning as a waste management technique is unsustainable and fraught with difficulties. In Africa, it is contributing to diseases, early mortality, and climate change. In the 2020s, it must be curbed to reduce emissions and promote sustainable development. (Mebratu & Mbandi, 2022). Particulate matter, persistent organic pollutants, and short-lived climate pollutants like methane and black carbon are among the emissions from the open burning of waste that directly affect human health. (Velis & Cook, 2021).

Cement, sand, and quarry that accumulate on the ground floor are supposed to be scraped off daily. However, due to a shortage of machinery, particularly the reliance on a single digger for all production activities and this cleaning process is often overlooked and not regularly carried out, resulting in severe air contamination. The particulate matter produced during industrial operations like casting, welding, and tile manufacturing poses serious health risks to employees. Long term exposures to high dust concentrations can harm the respiratory system irreversibly by causing pulmonary fibrosis. (Yanbin & Lianxin, 2021).

With wetting down as the only dust suppression method at Zimtile, this approach is insufficient given the large quantity of dust generated from cement, sand, quarry, oxides, cleaning processes, the transportation of raw materials in and out of the company, machinery movement, and production activities. During the rainy season, cement residue, oil spills, and quarry residue leach into soil and water bodies, contaminating them and reducing soil fertility. Constant sewage outbursts contaminate nearby water bodies and spread diseases. Waste is washed away into water bodies, whilst leachate can pollute underground water and can pollute the soil. (Herald, 2014).

Communities near industrial operations often suffer from air pollution-related health risks and environmental degradation. As a result, air quality remains significantly affected, and a considerable amount of dust is still released into the environment. Despite the importance of sustainable waste management, limited research focuses specifically on Zimbabwe's tile, brickmaking, and clay products industries. Understanding how Zimtile's waste contributes to these environmental issues will help identify mitigation strategies, ensuring cleaner production and sustainable business practices.

Zimbabwe's Environmental Management Act (EMA, 2015) requires sustainable waste management techniques; however, enterprises frequently fail to satisfy these standards due to limited technological resources and high implementation costs (Sibanda & Nyoni, 2021). Zimbabwe's Environmental Management Act (Chapter 20:27) mandates that industries adopt sustainable waste management practices, but compliance remains challenging (EMA, 2015). This study will help assess how Zimtile complies with national environmental policies, offering insights

to close the compliance gap. As the study examines Zimtile's compliance with Zimbabwe's Environmental Management Act and related policies, other companies can use this information to strengthen their compliance efforts. This will help them avoid legal penalties and maintain a positive public image, which is essential for sustainable business operations.

Waste mismanagement harms the environment and affects operational efficiency through resource wastage and increased disposal costs. Identifying the challenges and opportunities in Zimtile's waste management systems can lead to cost-effective solutions that enhance efficiency and profitability. (Sasao, 2022). The study will highlight the economic impact of effective waste management, such as reduced disposal costs and resource conservation. Other NEC companies can benefit by implementing cost-saving strategies identified in the study, ultimately enhancing their operational efficiency and profitability.

This research will help align Zimtile's corporate social responsibility initiatives with sustainable waste management practices, improving the company's relationship with stakeholders and benefiting the communities it operates in. The findings from this study can contribute to developing policies and industry standards that promote sustainable practices across similar industries in Zimbabwe. Policymakers and environmental agencies can use the insights to design better waste management frameworks that address industry-specific challenges.

By studying the specific difficulties Zimtile Pvt Ltd faces, this study hopes to provide practical insights that will help improve waste management practices inside the company and across Zimbabwe's industrial sector. (Bank, 2018)). Addressing these issues is critical to improving environmental sustainability, assuring regulatory compliance, and meeting corporate social responsibility goals. (Tchobanoglous & Kreith, 2002) This study offers NEC companies in Zimbabwe actionable insights and a practical framework to improve waste management. By adopting these practices, they can achieve environmental, economic, and social benefits, ultimately contributing to a more sustainable and responsible industry.

1.8 STUDY AREA DESCRIPTION

ZIMTILE, HARARE, SOUTHERTON BRANCH

LOCATION: 77A Gleneagles Road /James Martin Drive,

Lochinvar, Southerton, Harare

P. O. Box 2754,

Harare

GPS Coordinates: 17.8734370,31.0051490

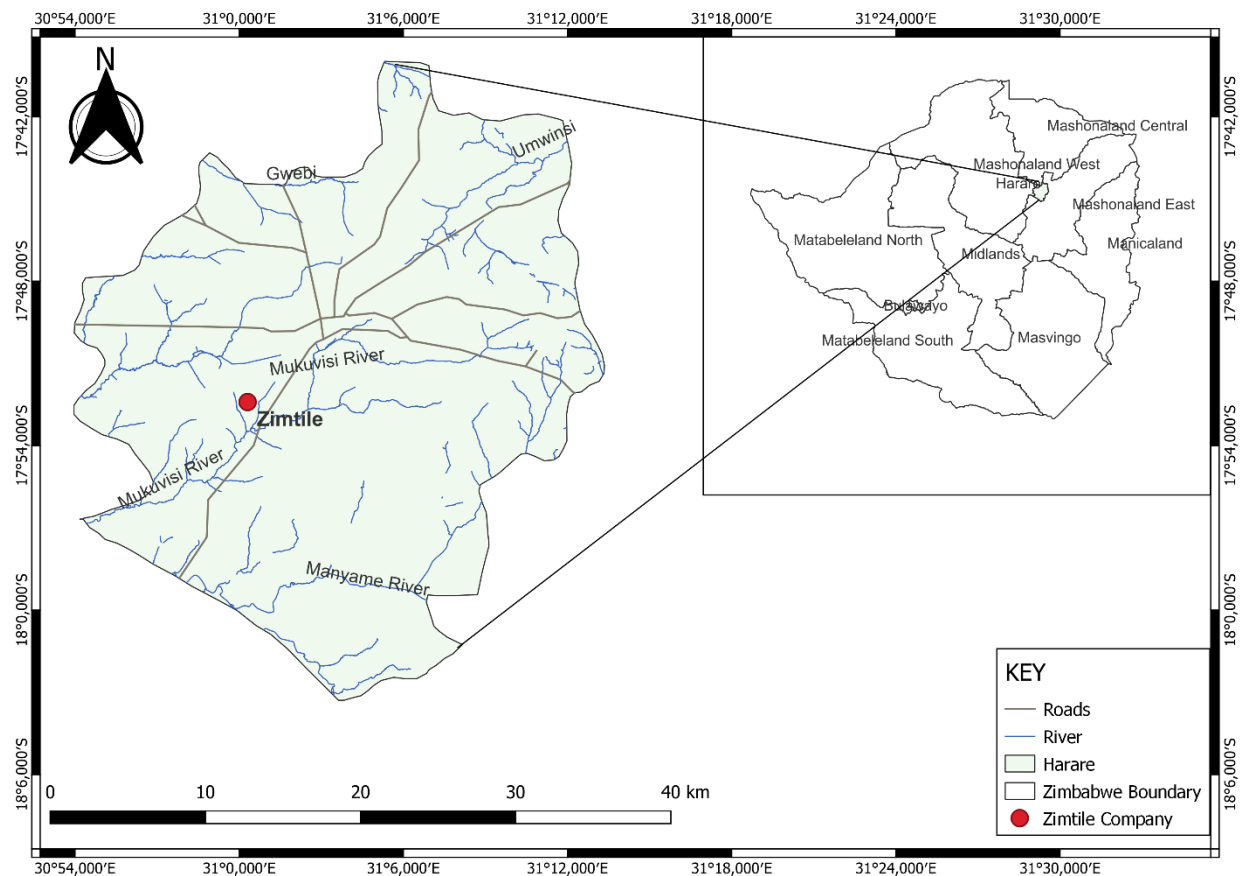


Figure 1.1: Study area description: Zimtile Map Location

This research centers on Zimtile Pvt Ltd, the largest manufacturer of concrete roofing tiles, pavers, and bricks in Harare, Zimbabwe. Headquartered in Harare, Zimtile is a key player in the construction sector, supplying materials for residential, commercial, and infrastructure projects

(ZIMTILE, 2025). Initially operating in Zimbabwe as Marley Roofing, a South African company, Zimtile was established as an independent entity in 1992 following Marley Roofing's disinvestment. The company has since broadened its reach, exporting goods to neighboring countries such as Zambia and Mozambique.

Zimtile operates manufacturing facilities in both Harare and Bulawayo, boasting a combined production capacity of 75,000 tiles and 300,000 bricks and pavers daily. It is dedicated to quality, evidenced by certifications like ISO 9001:2015 and ISO 9001:2008, which reflect its adherence to quality management standards.

The company's manufacturing facility is mainly situated in the bustling urban center of Harare, which acts as a central hub for construction and infrastructure growth. This location offers strategic access to raw materials, markets, and transport networks. Southerton, a mixed-use industrial suburb, is close to densely populated residential areas such as Highfield, Lochinvar, and Mbare, which affects its waste management practices and leads to regular inspections by the Environmental Management Agency (EMA) because of its urban surroundings.

The land in Southerton is already heavily occupied, limiting space for onsite landfill creation, segregation areas, or recycling centers. Additionally, Harare's geographical location presents logistical challenges for rubbish collection and disposal, impacting Zimtile's waste management initiatives. (Tsiko & Togarepi, 2012). The company functions in metropolitan areas where waste management difficulties are aggravated by high population density, scarce municipal garbage services, and community concerns about environmental pollution. (Mtetwa, 2021).

The topography and climate conditions also influence waste disposal methods, as certain areas face seasonal flooding that can worsen the spread of industrial waste. The brick and tile manufacturing industry offers job opportunities for both skilled and unskilled labor, aiding urban livelihoods. The demand for construction materials fuels production, leading to an increase in waste generation. Southerton is mostly flat to gently sloping, and in the absence of proper grading or sloped surfaces, waste, especially dust, rubble, and packaging materials, tends to gather in factory corners, yards, and access roads unless removed regularly.

Some sections of Southerton are near natural or artificial drainage channels, intensifying the risk of runoff pollution and regulatory scrutiny. Zimbabwe's expanding urbanization has led to a rise

in demand for durable building materials, making waste management a critical aspect of sustainable development.

1.9 LIMITATIONS OF THE STUDY

This study seeks to shed light on the challenges that industrial firms, particularly Zimtile Pvt Ltd, face in managing solid waste. However, several limitations could influence the scope and generalizability of the findings. The focus is solely on Zimtile Pvt Ltd, a single entity within Zimbabwe's construction materials industry. Hence, the findings may not necessarily apply to other sectors or locations, as various companies encounter distinct challenges depending on their industry, scale, and geographical context.

While the case study method allows for thorough investigation, the results might not capture the wider issues affecting the industrial sector in Zimbabwe or elsewhere. The research will depend on data provided by the company, which may lack depth or breadth. Zimtile's internal documents, including waste generation reports and management strategies, might not adequately reflect the complexities or long-term effects of their waste management practices.

Also, accessing current and precise secondary data regarding industrial waste management in Zimbabwe may present difficulties, particularly due to inadequate documentation or inconsistent reporting by regulatory agencies. The study will assess Zimtile's adherence to Zimbabwean environmental regulations, yet the enforcement of these rules differs by region, and some policies may be outdated or poorly enforced. This disparity could impact the evaluation of Zimtile's waste management efforts within the broader national context. Variations in how environmental policies are applied across industries could hinder the ability to form comprehensive conclusions about industrial waste management in Zimbabwe.

Furthermore, Zimtile's financial resources and access to waste management technologies restrict its capacity to adopt advanced waste reduction and recycling practices. Consequently, the findings might represent challenges specific to similarly constrained companies, which may not be relevant to larger, better-funded organizations.

Financial constraints prevent the researcher from having adequate transportation and the necessary resources for research. Conducting research within a limited time frame, while balancing

daily school commitments, affects the researcher's ability to thoroughly capture seasonal variations in waste production and long-term trends in waste management practices. Consequently, short-term data might not adequately reflect the overall waste management performance of the company. Community engagement and perceptions of Zimtile's waste management efforts fluctuate across different regions due to factors like local environmental awareness, economic conditions, and proximity to company facilities. Collecting accurate and representative data from local communities can be challenging, impacting the evaluation of the social effects of Zimtile's waste management practices.

Limited access to key stakeholders such as regulatory officials, waste management service providers, and community leaders may restrict the scope of data collection. Furthermore, information is often not readily available, particularly for a student conducting research. Although stakeholder participation is essential for understanding the wider challenges of waste management in the region, logistical or time limitations may deter meaningful engagement. Despite these challenges, the study aims to deliver a thorough analysis of Zimtile's waste management issues and provide valuable insights that can enhance industrial waste management strategies in Zimbabwe.

1.0 CONCLUSION

The chapter commenced by outlining the research context, motivation, and direction. It detailed the issue of industrial solid waste in Zimbabwe, particularly in the sectors of brickmaking, tile manufacturing, and clay products. The research problem, objectives, questions, and justification objectives were defined, and the study was aligned with national and global sustainability agendas such as Vision 2030, NDS1, and the Sustainable Development Goals. Additionally, the scope, limitations, and significance of the study were specified.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter reviews existing literature on the investigation of the challenges faced by the brickmaking, tile manufacturing, and clay products industry in solid waste management. It identifies the current waste management practices employed by Zimtile, assesses challenges faced by Zimtile and the surrounding environment due to improper solid waste management, and explores potential solutions and strategies for improving waste management. The review helps identify knowledge gaps and contextualizes the research problem.

2.1 THEORETICAL FRAMEWORK

2.1.1 THE ENVIRONMENTAL KUZENTS CURVE (EKC) THEORY

The Environmental Kuznets Curve (EKC) theory illustrates an inverted U-shaped relationship between economic growth and environmental degradation, drawing inspiration from Kuznets'(1955) original work on the link between income inequality and economic development. (1955) for the relation between income inequality and economic development (Delgado, 2023). It proposes that while economic growth initially harms the environment, there comes a stage when society starts to enhance its environmental practices, leading to reduced degradation. Zimtile Pvt Ltd exemplifies this phenomenon, as its industrial operations prioritize production output over environmental management, reflecting the early upward slope of the EKC.

During this phase, practices like resource extraction and cost-saving measures, which often involve inadequate waste disposal and emission controls, prevail. The increasing pressure from regulators, employees, and local communities signals a pivotal moment on the curve, highlighting the necessity for a shift toward sustainable practices. In the pursuit of a healthier environment through climate change mitigation, a study conducted in Kenya investigated the EKC hypothesis, finding that rising energy consumption intensifies carbon dioxide emissions, thus supporting the EKC concept. (Al-Mulali & Solarin, 2015).

Furthermore, a study exploring the applicability of the EKC to construction waste management, based on data from 27 European economies, confirmed the existence of the inverted U-shaped relationship between GDP per capita and construction waste management within the sample group. It was confirmed to apply to construction waste management. (Bao & Lu, 2023).

2.1.2 SYSTEMS THEORY

The systems theory highlights that an organization functions as a complex network of interrelated components. (Mele, et al., 2010). Waste management is not a standalone activity but an intertwinement of production processes, resource allocation, human behaviors, and external factors such as government regulations and community pressure.

A systems approach offers an outlook for identifying and addressing inefficiencies and gaps in an integrated way. A review compared the historical contexts and current models of solid waste management (SWM) agencies in industrialized nations with the complexities and challenges faced by SWM in developing countries. In industrialized countries, the shift toward integrated solid waste management (SWM) has been influenced by factors such as public health concerns, climate change, limited scarcity, and increased public awareness have driven the evolution toward integrated SWM. In contrast, issues like urbanization, inequality, economic growth, governance, policy, institutional challenges, and international influences have made SWM more complex in developing contexts. Thus, the review highlighted the necessity of exploring new SWM strategies for adaptation in these systems. (Marshall & Farahbakhsh, 2013).

Additionally, a study introduced an integrated methodology for selecting the best set of methods to tackle municipal solid waste management, considering local waste stream characteristics, engineering feasibility, socio-economic constraints, and societal concerns regarding public health and ecosystem protection. Based on the findings from this integrated method, biological and mechanical treatments were found most suitable, considering the volume, chemical composition, and properties of waste streams, as well as local community sensitivities. (Handakas & Sarigiannis, 2012).

2.2 EMPIRICAL FRAMEWORK

2.2.1 SOLID WASTE MANAGEMENT

Solid waste management refers to the systematic control of the generation, collection, storage, treatment, and disposal of solid waste in a way that is environmentally sustainable and economically feasible. (Wilson, et al., 2012). In industrial contexts, SWM is especially critical due to the large volumes and hazardous nature of solid waste produced by Zimtile and its effect on the surrounding environment due to improper solid waste management. (UNEP, 2019)

2.2.2 SOURCES AND TYPES OF INDUSTRIAL WASTE

Process waste such as broken tiles, bricks, scrap material, and off-cuts, raw material residues like unused clay, cement, and oxides, and packaging waste such as strapping codes, bags, and dust emissions from handling dry materials. These waste materials pose challenges in disposal and environmental management, especially in urbanizing areas. (Kumar & Agrawal, 2020).

2.2.3 CURRENT WASTE MANAGEMENT PRACTICES

Research was carried out to examine how the City of Harare can implement sustainable and responsible innovative practices for solid waste management. The findings showed that inefficiencies in solid waste collection, such as broken equipment, illegal littering and dumping, open burning of waste, and public indifference towards solid waste in their surroundings, stemmed from a lack of resources and innovative, sustainable approaches to waste management. (Sani & Zimucha, 2022).

In another study focusing on solid waste management practices at a secondary school in Masvingo, the researcher discovered that open dumping was the chief disposal method used, complemented by incineration, landfilling, and composting. (Chatira-Muchopa, et al., 2019). A chapter discussed the technical and non-technical challenges facing developing countries, highlighting the hidden opportunities and potential improvements that can be made at different stages of the municipal solid waste management system. It also emphasized effective solid waste management practices, such as reducing, reusing, recycling, as well as landfilling and incineration. (Kumari & Singh, 2022)

2.2.4 CHALLENGES DUE TO IMPROPER SOLID WASTE MANAGEMENT

A study examined the challenges of providing household solid waste management services to the increasing urban population. Its focus was on waste disposal issues in an urban suburb, aiming to develop sustainable waste management strategies for rapidly growing cities like Harare, using Highfield suburb as a case study. (Chikobvua & Makarati, 2011). The study highlighted serious concerns about waste disposal, citing widespread land, air, and water pollution caused by solid waste. It also noted that waste production significantly contributes to environmental and health problems in Pakistan, often without adequate consideration. (Sajid, et al., 2025).

Aquatic contamination, poor air quality is diminished unpleasant surroundings, harm to humans, cattle losses from ingesting plastics and other toxic waste materials, and poor health were among the undesirable societal and ecological effects of unlawful solid waste discarding that were studied. For instance, water bodies close to waste yards in Kolkata, India were polluted with nickel, far surpassing the World Health Organization's recommendations. Additionally, the study found that improper solid waste management practices like burning waste outdoors can lead to localized air contamination, while open pits of fire pose a risk to kids that frequently play near junk sites, obstruct waterways, provide breeding grounds for disease-carrying mosquitoes and rodents, and pollute urban green spaces. In the southern Italian region of Campania, widespread illegal solid waste disposal practices harmed air quality. (Ngalo & Thondhlana, 2023)

2.2.4.1 FINANCE

A study was conducted to establish a method for estimating construction and demolition waste generation using waste generation rates obtained through regression analysis. The study also examined the economic advantages of recycling such waste, revealing that waste production rates were 63.74 kg/m² for construction activities and 1,615 kg/m² for demolition. In the 2016 fiscal year, Dhaka city produced about 1.28 million tons of this waste, with 0.149 million tons from construction and 1.139 million tons from demolition. The major components were concrete at 60%, bricks/blocks at 21%, and mortar at 9%. The findings further indicated that recycling concrete and brick waste could generate an economic value of approximately 44.96 million USD. (Rashidul, et al., 2019).

2.2.4.2 TECHNOLOGICAL ADVANCEMENT.

Disposing of solid waste into the soil and water without proper treatment leads to serious environmental problems. The main goal of waste management is to recycle materials and recover energy.(Varjani, et al., 2021). Digital technologies, known as Smart Waste Technologies (SWT), include robotics, artificial intelligence, the Internet of Things, cloud computing, data analysis, and communication tools.(Paula, 2023).

To achieve effective solid waste management, techniques like anaerobic digestion, composting, incineration, material and energy recovery, refuse-derived fuels, and sanitary landfills are essential, as highlighted by a survey on waste treatment, technological progress, and challenges. When these strategies are correctly implemented, they reduce landfill waste and mitigate negative impacts on the environment and human health. Recycling materials and recovering energy also add additional benefits and advantages. (Pratap, et al., 2021) .

2.2.5 SOLUTIONS AND STRATEGIES FOR IMPROVING SOLID WASTE MANAGEMENT

A study was carried out in urban secondary schools to identify strategies for improving solid waste management. Solutions were discovered and they included reducing packaging, encouraging recycling and composting, adopting sorting and processing technologies, and using anaerobic digestion for organic waste. Infrastructure upgrades, educational programs that include waste management in the curriculum, community involvement, and policy support were also key discoveries.

Another study examined waste reduction and utilization strategies to enhance municipal solid waste management on Nigerian campuses. Major approaches involved preventing unnecessary waste, recovering and reusing materials, recycling recyclables, composting organic waste for energy, and managing disposal through sanitary landfills. (Ugwu, et al., 2021).

Additionally, a comparative analysis for medium-sized cities was part of research on enhancing municipal solid waste management. This study looked at how to improve a medium-sized city's current solid waste management procedures, especially concerning cleanliness surveys carried out as part of the Clean India Mission. It emphasized the necessity of efficient solutions to successfully

execute decentralized pickers, door-to-door collection, source segregation of waste, and street sweeping. These measures aimed to enhance the environment, public health, and overall aesthetics. (Chowdhary, et al., 2023). A study conducted in Mexico recommended increased budget allocations from the national institutions to develop substructures for waste collection, treatment, and final disposal, thereby promoting waste valorization and strengthening integrated waste management in smaller municipalities (Bernache-Pérez, et al., 2023).

2.3 GENERAL OVERVIEW OF INDUSTRIAL SOLID WASTE MANAGEMENT

2.3.1 GLOBAL PERSPECTIVE ON INDUSTRIAL SOLID WASTE MANAGEMENT

By 2050, it is projected that the amount of municipal solid waste generated will have increased from 2.1 billion tonnes in 2023 to 3.8 billion tonnes. Globally, an estimated USD 252 billion was spent in 2020 on direct waste management. When the hidden costs of pollution, ill health, and climate change brought on by inappropriate waste disposal techniques are taken into account, the price rises to USD 361 billion. By 2050, the annual global cost of waste management could almost triple to USD 640.3 billion if it is not addressed now. According to the report's findings, reducing waste through management and preventative strategies could keep net yearly expenses at USD 270.2 billion by 2050. According to predictions, a circular economy model that separates waste generation from economic growth through the implementation of sustainable business practices, waste avoidance, and complete waste management may result in an annual net gain of USD 108.5 billion (UNEP, 2024). In Asia and Europe, industries have adopted integrated waste management systems involving recycling, waste-to-energy, and circular economy approaches.

Over the past fifty years, Asia has studied solid waste management, observing the related problems and difficulties. Waste generation has increased across all countries, though Korea and Japan have recently seen a decline in the growth rate. The waste composition is mostly organic, with kitchen waste accounting for 45–50%. Technologies for waste management have advanced, with more countries gradually shifting from landfills to waste-to-energy options. Nevertheless, in many emerging Asian nations, open dumps and landfilling remain the main disposal methods. Concerns include managing dumpsites, the unorganized sector, garbage collection, open burning, and food

waste. Reports from India, Indonesia, Japan, Malaysia, Singapore, South Korea, Thailand, and Vietnam show a rising trend in recycling technology and volume. (Agamuthu & Babel, 2023).

Since MSWM is fundamentally a business, most of the funding comes from corporations and investors. The US government subsidizes recycling facilities that encourage recycling but restrict landfilling, while also funding landfills to promote clean practices. Tipping fees and user charges are the primary revenue sources for landfills and waste collection services. Consequently, the US maintains a stable financial cycle in MSWM that generally opposes landfilling. In 2009, waste collection, incineration, and landfilling costs in Europe ranged from 15 to 225 euros per ton, 21 to 250 euros per ton, and 30 to 164 euros per ton, respectively. The amount of money flowing into the system increases with the natural growth in MSW production. Europe's use of waste-to-energy (WTE) technologies has expanded considerably. However, WTE is more costly to maintain than other methods, which may hinder Europe's recycling efforts. Even if Europe adequately supports MSWM, greater investment in recycling and source reduction could optimize resource use. (Karim & Wetterhan, 2020).

2.3.2 REGIONAL STUDIES IN AFRICA

Based on available data, sub-Saharan Africa accounted for 81 million (65%) of the 125 million tonnes of municipal waste (MSW) produced in Africa in 2012. This is expected to rise to 244 million tonnes per year by 2025. However, because of an average waste collection rate of only 55% (68 million tonnes), nearly half of all MSW produced in Africa is still disposed of in our cities and towns, where it is dumped on sidewalks, open fields, drains, and rivers. The average MSW collection rate in sub-Saharan Africa is only 44% despite the fact that coverage varies widely between cities, ranging from less than 20% to over 90%. The average MSW collection rate on the continent is expected to fall by just 69% by 2025.(Godfrey, et al., 2019).

High-income nations produce the most waste per capita, and Sub-Saharan Africa is the region with the fastest rate of growth in this area. By 2050, its total generation is predicted to triple according to Kaza et al.2018. Consumption growth and shifting production and consumption patterns brought on by rapid urbanization are major factors driving this increase, according to UNEP 2018. Compared to other regions, African waste collection services are noticeably less extensive. Although North Africa has higher collection rates, only 44% of waste is collected throughout sub-

Saharan Africa; this is in contrast to an estimated 71% collection rate in East Asia and the Pacific and 84% in Latin America and the Caribbean. (Kumar, et al., 2022).

2.3.3 STUDIES IN ZIMBABWE

Previous research on industrial waste management in Zimbabwe identified many common difficulties, including a lack of infrastructure for effective waste segregation, limited recycling skills, and financial barriers to implementing sophisticated waste management technology. Cholera, malaria, air and water pollution, and the loss of urban beauty were the primary issues found in a study on the effects of solid waste management strategies in urban high-density suburbs in Amaveni Kwekwe. Sustainable solid waste determined that the solid waste management techniques employed in Amaveni were linked to numerous environmental and health issues. (Chireshe, et al., 2024).

An article highlighted the unique challenges that developing-country companies face, including limited infrastructure, regulatory compliance, and the cost of implementing sustainable waste management practices. However, there is little specific study focusing on the construction materials industry, where companies like Zimtile operate. Understanding Zimtile's specific challenges in handling solid waste is crucial for developing effective solutions to enhance industry sustainability. (Guerrero, et al., 2012).

In developing countries like Zimbabwe, the issue of industrial waste management is particularly pressing due to limited infrastructure, weak regulatory enforcement, and financial constraints faced by businesses. However, compliance with these regulations can be challenging for companies like Zimtile, given the high costs of waste disposal, limited access to recycling facilities, and inadequate technological solutions for waste reduction. Despite these efforts, compliance remains a challenge, particularly for industries that rely heavily on raw materials and generate large volumes of waste. (Makamba, 2022).

2.4 CONCLUSION

In Zimbabwe's industrial sector, solid waste management (SWM) is a critical issue, particularly in sectors like clay production, brickmaking, tile manufacturing, and turning. There is a noticeable dearth of focused research on industrial solid waste management within Zimbabwe's heavy

manufacturing sectors, especially about clay-based building materials, despite the fact that many regional and internal studies have examined urban solid waste in municipal settings.

Although the Environmental Management Agency of Zimbabwe has set regulatory standards through documents like SI 6 of 2006 and SI 10 of 2007, documented implementation and the effectiveness of waste management strategies at the factory level remain inadequate. (EMA, 2015). National frameworks, including the Zimbabwe National Development Strategy 1 (NDS1, 2021-2025) and Vision 2030, emphasize the importance of sustainable industrial growth, yet there is minimal empirical evidence to indicate how companies such as Zimtile Pvt Ltd are coordinating their operations with these national objectives.

Earlier investigations by Dube and Chikodzi, as well as Chikobvu and Makarati (Chikobvua & Makarati, 2011), have primarily addressed issues of industrial environmental degradation and urban pollution, often concentrating on mining or large-scale manufacturing, thus overlooking smaller yet significant sectors like brick and tile production. Although certain studies have evaluated the physical consequences of inadequate waste management, such as land degradation, dust emissions, and water pollution, there is a lack of research focusing on the organizational, behavioral, and policy-level obstacles that hinder effective SWM in Zimbabwe's industrial landscape.

This research fills a crucial gap by conducting an in-depth case study of Zimtile Pvt Ltd in Southerton, Harare, a key player in Zimbabwe's construction material sector, to examine its waste management practices, challenges, and opportunities for improvement. Using a mixed-methods approach that combines SPSS-based quantitative data with qualitative insights from interviews, document reviews, and direct observations through photographs, the study offers a comprehensive understanding of the dynamics and deficiencies of solid waste management at the industrial level. It contributes original knowledge on how companies in the clay manufacturing sector in Zimbabwe can transition toward more sustainable and regulatory-compliant waste practices.

CHAPTER 3

METHODOLOGY

3.0 INTRODUCTION

This study adopted a mixed-methods research design, combining qualitative (e.g., thematic analysis, content analysis) and quantitative (e.g., descriptive statistics, SPSS software, graphical representation) approaches. This chapter outlined the research design, methodology, and data collection techniques employed to investigate the challenges of industrial solid waste management at Zimtile Pvt Ltd. The research utilized questionnaires, in-depth interviews, an observational study, and document review for data collection. The chapter also discussed the study population, sampling methods, data analysis procedures, and ethical considerations.

3.1 THE RESEARCH DESIGN DESCRIPTION

The research design follows the structure illustrated in Figure 3.1 below:

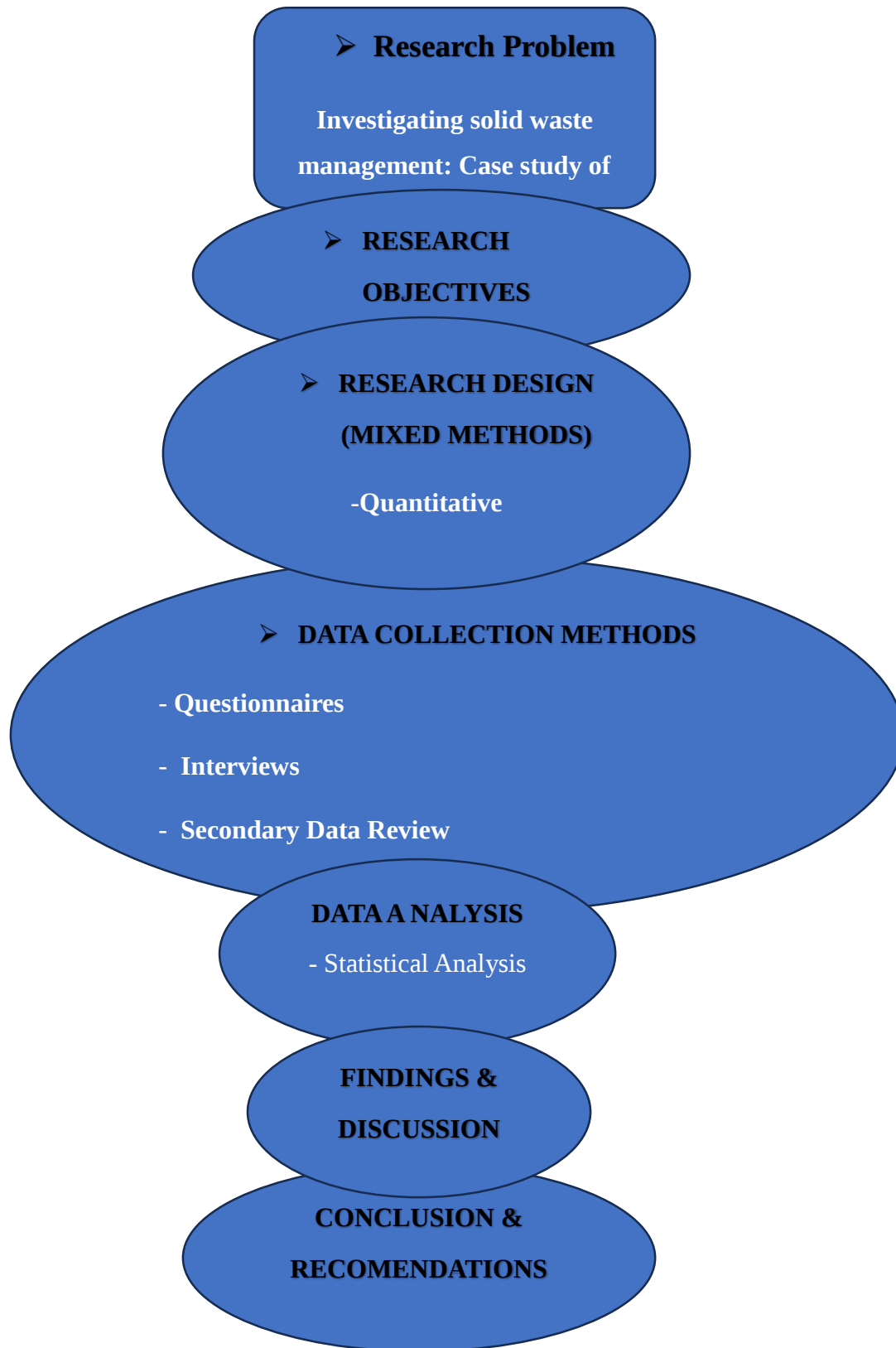


Figure 3.1 shows the Research Design Framework.

3.2 RESEARCH DESIGN

The study employed a mixed-methods approach, which is beneficial because it validates findings by comparing multiple data sources, and it brings about a comprehensive understanding that captures both measurable facts and subjective insights. (Catalyst, 2008).

The mixed method approach is flexible, which allows for in-depth exploration while supporting statistical analysis. This design allowed for a comprehensive understanding of industrial solid waste management challenges at Zimtile Pvt Ltd by collecting numerical data on waste generation, disposal rates, and compliance levels (quantitative approach) and exploring perceptions, experiences, and challenges faced by Zimtile employees, regulatory bodies, and local communities (qualitative approach). Combining these methods ensured a well-rounded analysis of the problem and enhanced the validity of the findings. (George, 2025).

This study made use of a descriptive research design to investigate and document the current solid waste management practices at Zimtile Pvt Ltd. (Mcombes, 2023). The researcher made use of a case study approach, which focused on Zimtile Pvt Ltd as a representative company in Zimbabwe's industrial sector. This approach's benefits include a detailed examination of waste management challenges specific to the brick and tile manufacturing industry. (Mudzengerere & Chigwenya, 2018) .

3.3 TARGET POPULATION

The target population for this study was individuals who are directly or indirectly involved in solid waste management at Zimtile Pvt Ltd. The target population was the community, factory workers, environmental officers, and the top management.

3.4 SAMPLING

In research methodology, sampling refers to selecting a subset of individuals, groups, or data points from a larger population to analyze and draw conclusions about the entire population (Mcombes, 2023). Since studying a whole population is often impractical due to time, cost, and accessibility constraints, researchers use sampling techniques to ensure that findings are representative and generalizable. Since collecting data from every stakeholder involved in Zimtile Pvt Ltd.'s solid

waste management was not feasible, a carefully chosen sample ensured the study remained practical, accurate, and reliable.

3.5 SAMPLING TECHNIQUE

A combination of probability and non-probability sampling techniques was used to ensure an accurate and diverse representation of stakeholders.

A. Stratified Random Sampling (For Employees and Community Members)

The Zimtile workforce was categorized into different strata (factory workers, supervisors, management), and a proportionate number of respondents was randomly selected from each category. Community members were also stratified based on proximity to Zimtile's industrial sites.

B. Purposive Sampling (Local Authorities)

Local people representatives were selected based on their direct involvement in industrial waste regulation and environmental policy enforcement. Purposive sampling ensured that only relevant and knowledgeable individuals were included in the study.

3.6 SAMPLE SIZE DETERMINATION

The study aimed to collect data from approximately 20-50 respondents out of 250 workers to try and keep the people of interest in check, however, 48 participated in the research, 37 through questionnaires and 11 through manual interviews, and these were factory workers, 17 questionnaires and 4 interviews, environmental officers, 5 questionnaire and 2 interviews, top management, 4 questionnaires 3 interviews, and community members, 11 questionnaires and 2 interviews. This was done to manage the accuracy of data by working with a small group to avoid bias. The sample ensured representation of all key stakeholders. Balanced depth and manageability of data collection allowed for statistical analysis without overwhelming data processing (Indrayan & Mishra, 2021).

TABLE 3.1 SAMPLE SIZE DETERMINATION

ID	QUESTIONNAIRE RESPONDENTS	INTERVIEW RESPONDENTS
TOP MANAGEMENT	4	3
ENVIRONMENTAL OFFICERS	5	2
FACTORY WORKERS	17	4
COMMUNITY MEMBERS	11	2
TOTAL	48 PARTICIPANTS	

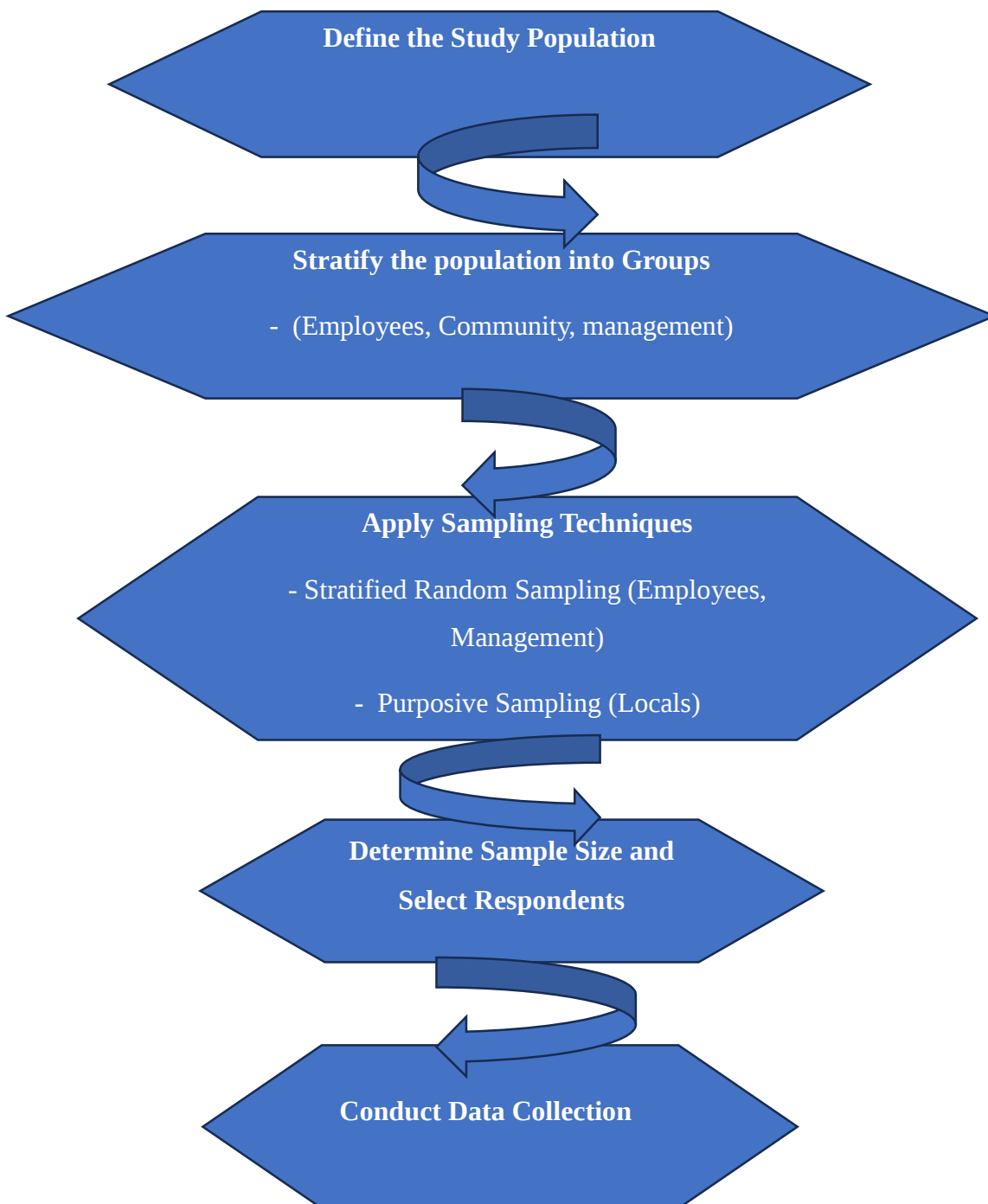


Figure 3.2 shows the Sampling Procedure Framework.

3.7 DATA COLLECTION TOOLS

3.7.1 QUESTIONNAIRE (QUANTITATIVE ANALYSIS)

Questionnaires are widely utilized as data collection instruments in research, enabling the systematic gathering of information from respondents regarding their attitudes, experiences, or opinions. (Bhandari, 2021). They are particularly effective in collecting quantitative and qualitative data, depending on the design and structure of the questions. A questionnaire is a structured data collection tool that consists of a set of questions designed to gather information from respondents systematically. In this study, questionnaires were used to collect quantitative data on solid waste management at Zimtile Pvt Ltd online using a data collection platform called Google Forms and manually using pen and paper.

They efficiently collected data from a larger sample, allowing for broad insights into waste management practices, challenges, and possible solutions. (Bhandari, 2020). The advantages of questionnaires were obtaining closed-ended questions (e.g., multiple-choice, Likert scale) for easy analysis, open-ended questions for detailed responses, cost-effectiveness, and the ability to reach a large audience. They provided standardized responses, making data analysis easier. However, the disadvantages were that low response rates, especially online, affected data reliability, and some respondents misinterpreted questions.

3.7.2 INTERVIEWS (QUALITATIVE ANALYSIS)

Interviews are a fundamental method of data collection in qualitative research, enabling researchers to gather in-depth insights into participants' experiences, beliefs, and perspectives. They facilitate a deeper understanding of complex phenomena by allowing participants to express themselves in their own words. (Blackman & Funder, 2002).

This approach ensured that each interview was presented with the same questions in the same order. This ensured that answers were reliably aggregated and that comparisons could be made confidently between sample subgroups and different survey periods. In this study, interviews were collected manually using pen and paper from 11 participants, as many were unable to partake in the interview sessions since it was mostly during working hours, and some just found it to be a

waste of time. The advantage of using interviews was the depth of information, which enabled the collection of detailed data and captured nuances in participants' responses. Interviewers adapted questions based on participants' answers, allowing exploration of unforeseen topics.

Interviewers sought clarification on unclear responses, enhancing the accuracy of the data collected. The challenges of interviews were interviewer bias, whereby the presence and behavior of the interviewer sometimes influenced participants' responses, and resource-intensive conducting and transcribing interviews were time-consuming and costly. Differences in how questions were understood led to variability, affecting the reliability of the data.

3.7.3 DOCUMENT REVIEW (QUALITATIVE ANALYSIS)

In this study, document review was used to assess policies, reports, regulatory frameworks, and previous studies on solid waste management at Zimtile Pvt Ltd. This method helped to complement primary data collected through interviews and questionnaires, providing a broader context and historical perspective on waste management practices. Document review was a vital methodology in this study, giving secondary data to validate primary findings. By analyzing company records, regulatory frameworks, and previous research, this method offered insights into trends, policies, and challenges in industrial waste management at Zimtile Pvt Ltd.

3.8 DATA ANALYSIS

This section outlines the techniques used to process, analyze, and interpret the data collected from Zimtile Pvt Ltd.'s solid waste management practices. Since the study employed a mixed-methods approach, both quantitative and qualitative data analysis methods were used to ensure a comprehensive understanding of the challenges and effects of industrial solid waste management. Before analysis, the collected data were checked for errors, missing values, and inconsistencies in survey responses, assigning numerical or categorical values to responses for ease of analysis, and categorizing data into key themes and variables (e.g., waste types, disposal methods, regulatory compliance).

Quantitative data (collected from surveys, questionnaires, and numerical records) was analyzed using statistical methods to identify trends and relationships. The study used SPSS (Statistical Package for Social Sciences) Excel to generate frequency distributions showing how common specific responses are, measures of central tendency like mean, median, and mode to summarize

numerical data (e.g., average waste produced per month) and bar charts, pie charts, and histograms to visually represent findings.

Qualitative data (collected from interviews, observations, and open-ended survey questions) were analyzed using thematic analysis to identify key themes and patterns, identifying recurring themes (e.g., lack of recycling facilities or regulatory pressure). (Dwadi, 2020). Content analysis is a qualitative data collection technique used to determine the presence of certain words, themes, or concepts within data. (Delve & Limpaecher, 2023). The data analysis process is summarized in Figure 3.3 below.

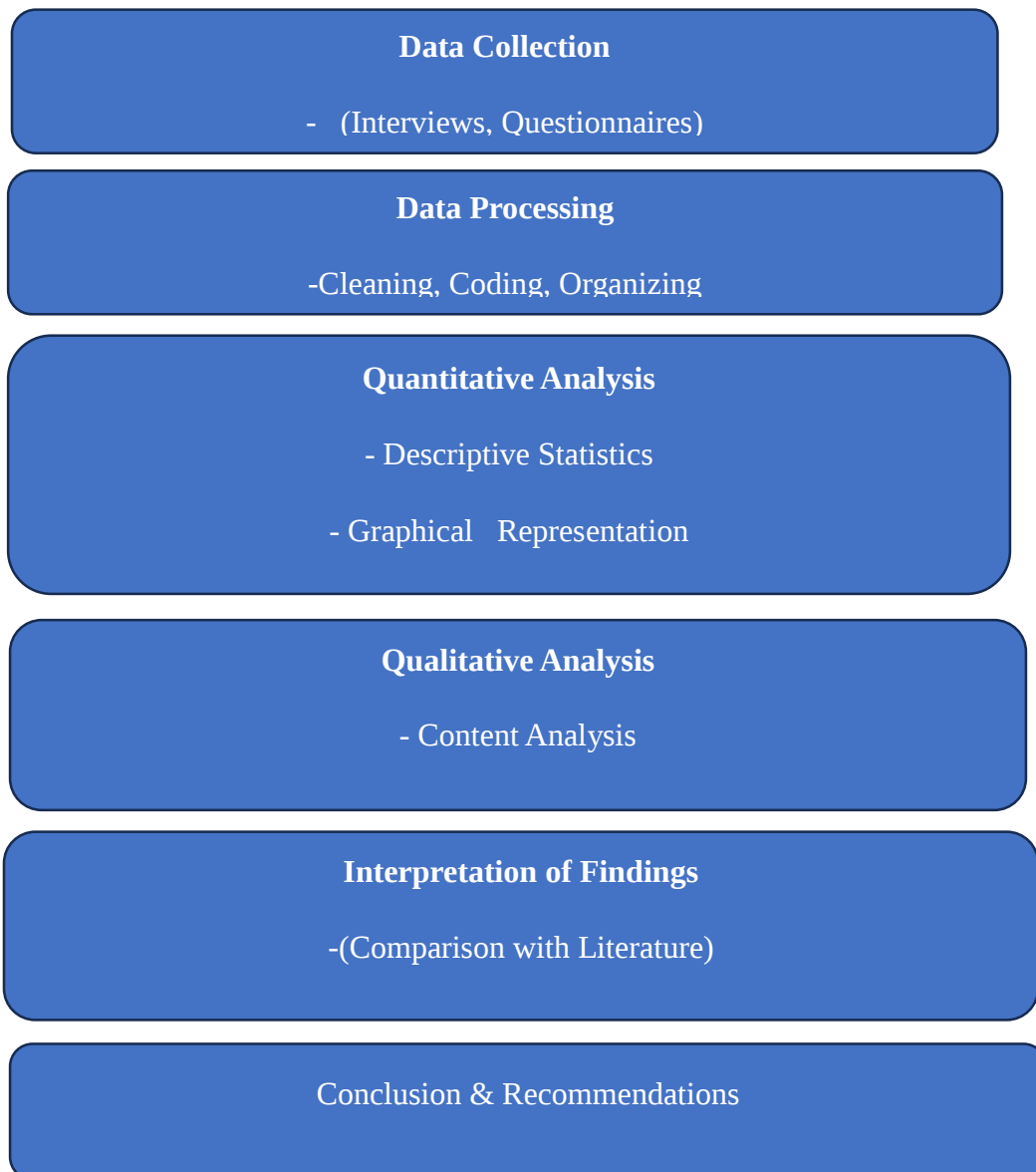


Figure 3.3 shows the Data Analysis Framework

3.9 ETHICAL CONSIDERATIONS

Participants were informed about the study and how they would willingly participate before making their informed decision. Respondents' data was kept anonymous. Findings were cross-checked with secondary data for validation. (Bhandari, 2025). Permission to conduct the study was granted by Zimtile's HR department and the Environmental Science department of Bindura University of Science Education.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.0 INTRODUCTION

This chapter presents findings from a sample of 37 respondents using descriptive statistics (frequency and percentage). The analysis focuses on demographic characteristics, current waste management practices, challenges faced and social impacts, and proposed strategies for improvement at Zimtile Pvt Ltd.

4.1 DEMOGRAPHICS

4.1.1 GENDER

TABLE 4.1 shows gender at Zimtile (SPSS output data)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	10	27.0	27.0	27.0
	Male	27	73.0	73.0	100.0
	Total	37	100.0	100.0	

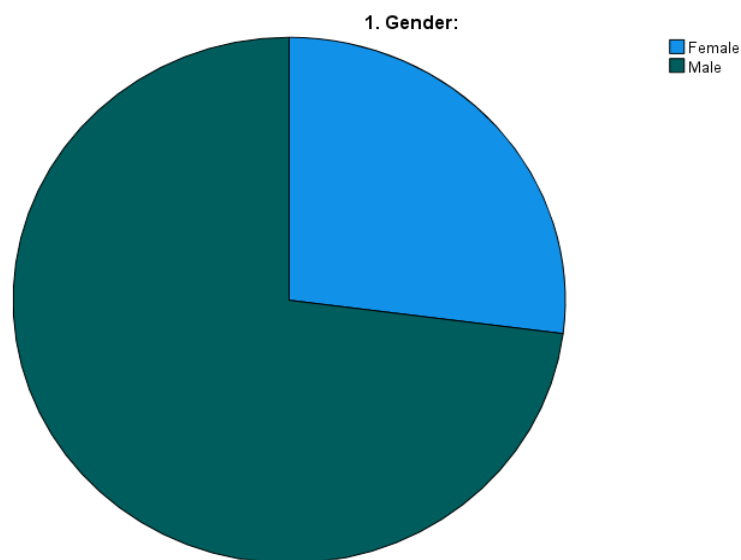


Figure 4.1 shows gender (SPSS output data)

NOTES

Due to the nature of work, gender norms and stereotypes, workplace conditions, and automated work in the brickmaking, tile manufacturing, and clay products industry, Zimtile, like many other companies in this NEC division, has more men than women.

4.1.2 JOB POSITION

TABLE 4.2 shows demographics of job positions at Zimtile (SPSS output data).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Factory worker	17	45.9	45.9	45.9
	Environmental Officer	5	13.5	13.5	59.5
	Management Representative	4	10.8	10.8	70.3
	Community Member	11	29.7	29.7	100.0
	Total	37	100.0	100.0	

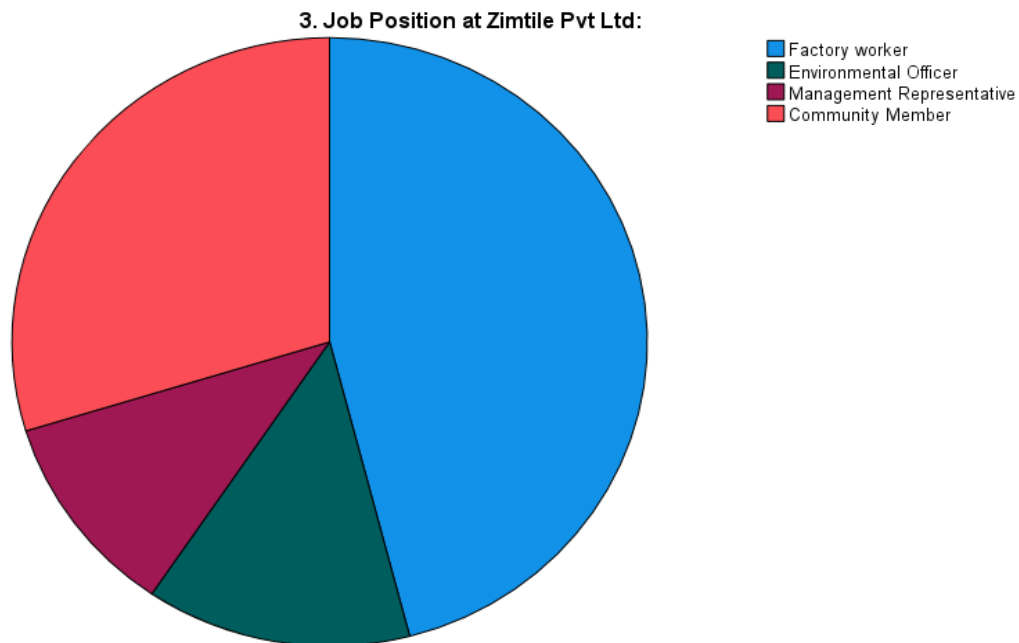


Figure 4.2 shows demographics of job positions at Zimtile (SPSS data output)

NOTES

Factory workers and community members provided a bottom-up perspective, whilst environmental and management staff offered top-down insights reflecting a balanced design for this research.

Factory workers made up the largest group of respondents, which is consistent with Zimtile's labor-intensive production environment, and they experience waste generation firsthand daily. Community members accounted for nearly a third of the respondents, and their inclusion reflected Zimtile's social and environmental footprint beyond company premises. Environmental Officers included SHE personnel and possibly technical staff overseeing compliance with environmental standards, and their responses provided insight into the company's formal waste policies, regulatory engagement, and monitoring mechanisms.

Management representatives, although a small group, these individuals hold decision-making power in budgeting, operations, and strategic planning. Their views have helped assess Zimtile's commitment to sustainability and the institutional challenges of implementing improved waste management systems.

4.2 OBJECTIVE 1: TO IDENTIFY THE CURRENT WASTE

MANAGEMENT PRACTICES EMPLOYED BY ZIMTILE.

4.2.1 TYPES OF SOLID WASTE GENERATED

Table 4.3 shows the types of solid Zimbabwe (SPSS output data)

	Responses		Percent of Cases
	N	Percent	
Types of solid waste (Dust)	13	15.3%	35.1%
(Broken tiles and bricks)	30	35.3%	81.1%
(Packaging materials)	18	21.2%	48.6%
(Chemical waste)	5	5.9%	13.5%
(Clay residue)	19	22.4%	51.4%
Total	85	100.0%	229.7%

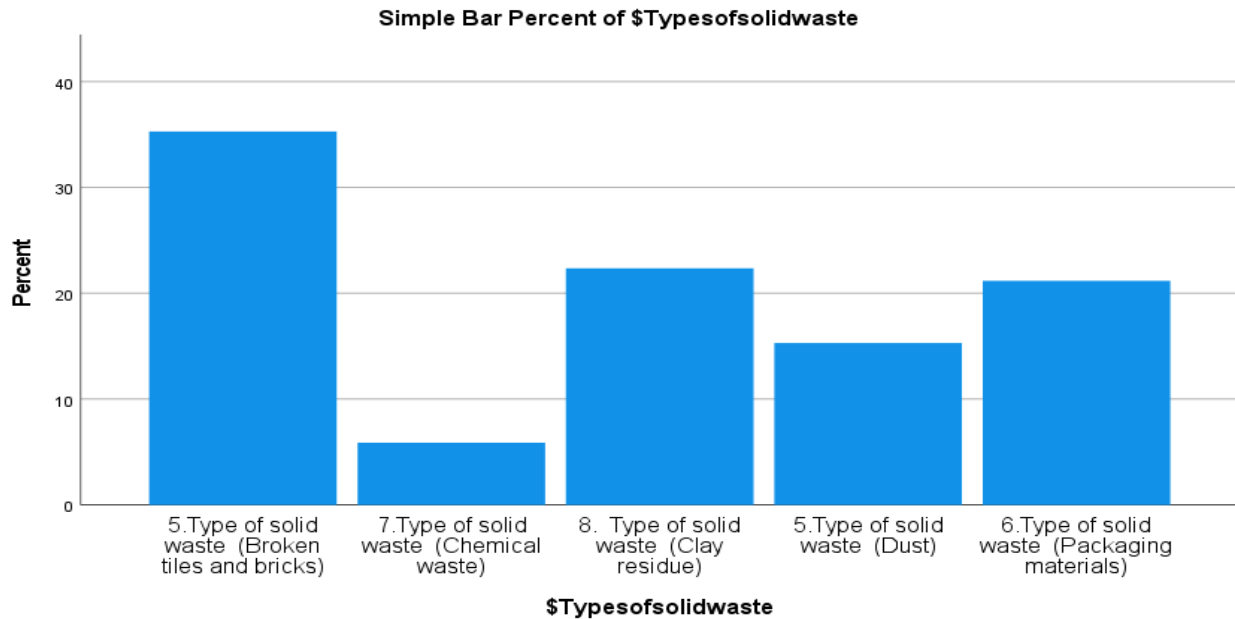


Figure 4.3 shows types of solid waste at Zimtile (SPSS output data)

Z

The most commonly reported types of waste include broken tiles and bricks (81.1%), Clay residue (51.4%), packaging materials (48.6%), dust (35.1%), and chemical waste (13.5%). These findings show that Zimtile primarily generates construction-related waste, including solid fragments, clay residues, and dust, which are typical in the tile and brick manufacturing process. The relatively low reporting of chemical waste suggests minimal use or limited awareness of chemical handling among respondents.

4.2.2 CURRENT WASTE MANAGEMENT PRACTICES

Table 4.4 shows current waste management practices at Zimtile (SPSS output data)

		Responses		Percent of Cases
		N	Percent	
Current waste management practices	(burned on site)	31	38.8%	86.1%
	(Disposed of through third-party contractors)	17	21.3%	47.2%
	(recycled or reused)	2	2.5%	5.6%
	(dumped in onsite landfills)	30	37.5%	83.3%
Total		80	100.0%	222.2%

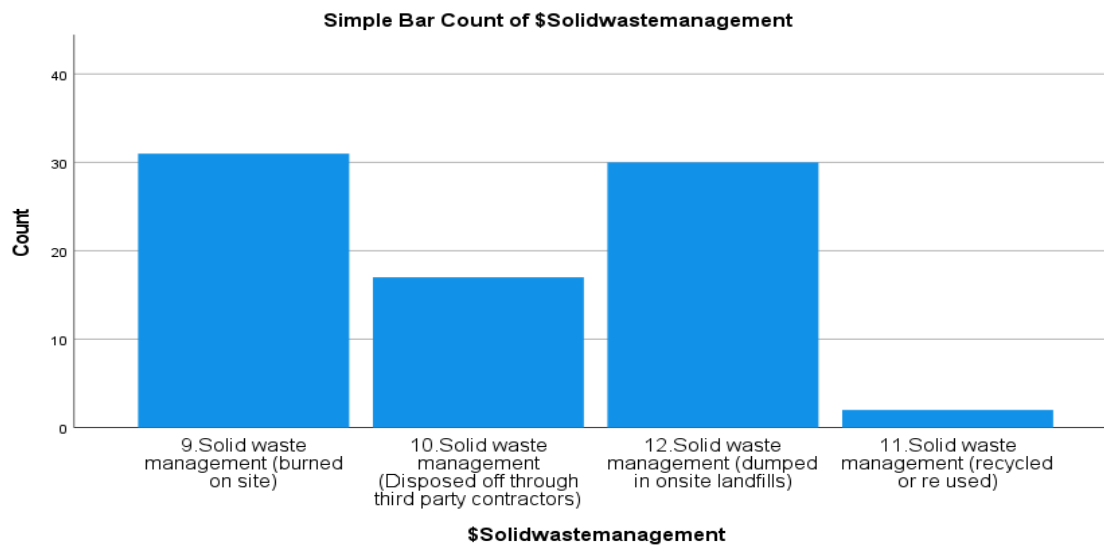


Figure 4.4 shows solid waste management practices (SPSS output data)

NOTES

The most frequent disposal practices include burning on site (86.1%), dumping in on-site landfills (83.3%), disposing through third-party contractors (47.2%), and recycling or reusing (5.6%). The data shows that waste management at Zimtile is dominated by informal and environmentally

hazardous practices such as open burning and onsite burning. The extremely low rate of recycling or reuse (5.6%) indicates a major gap in sustainable waste management practices, despite the high volume of reusable rubble.

4.2.3 WASTE COLLECTION AT ZIMTILE

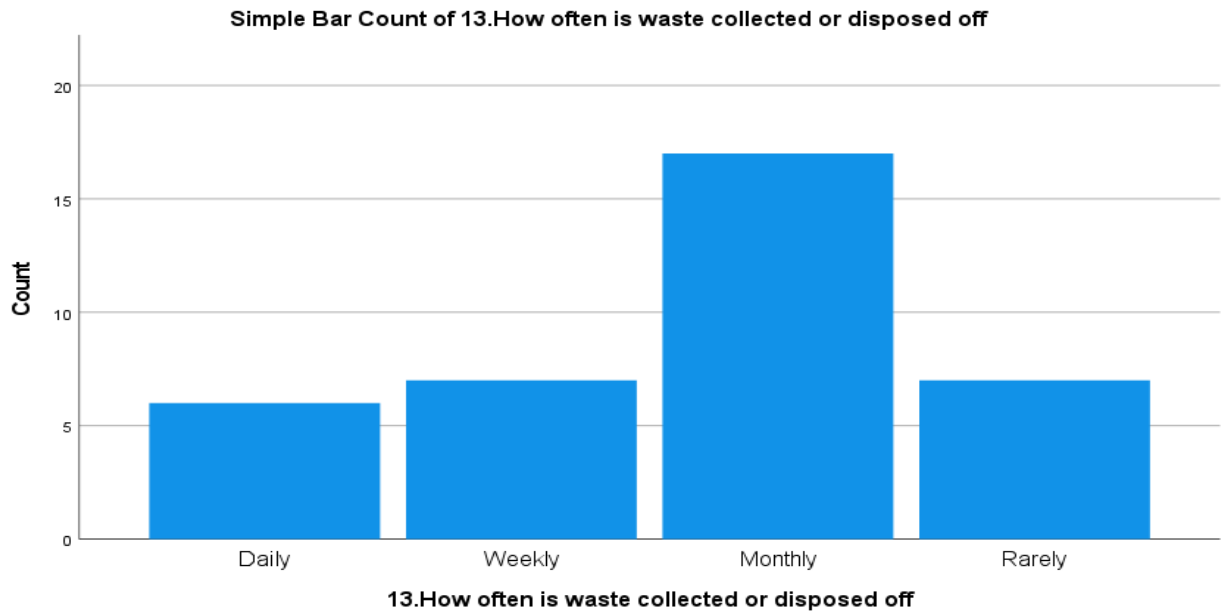


Figure 4.5 shows how often waste is collected at Zimtile (SPSS output data)

NOTES

Daily (10.8%), weekly (45.9%), monthly (32.4%), and irregularly (10.8%) interpreting shows that most respondents indicated waste is collected on a weekly or monthly basis. This demonstrates a reasonable routine rather than an intensive or immediate system. The presence of irregular collection (10.8%) suggests that some departments or types of waste may be managed inconsistently, potentially leading to overflows, unsanitary conditions, or environmental exposure.

4.2.4 WASTE MANAGEMENT POLICIES AT ZIMTILE



Figure 4.6 shows waste management policies at Zimtile (SPSS output data)

NOTES

Frequency results were yes 37.8%, no 43.2%, and not sure 18.9%. The majority of respondents either reported a lack of formal policies or were unsure of their existence. This reflects a lack of institutional clarity or poor internal communication regarding waste management procedures. If policies exist, they may not be well disseminated, enforced, or integrated into daily operations.

4.3 OBJECTIVE 2: TO ASSESS ZIMTILES' CHALLENGES AND THE SURROUNDING ENVIRONMENT DUE TO IMPROPER SOLID WASTE MANAGEMENT.

4.3.1 MAIN CHALLENGES IN SOLID WASTE MANAGEMENT

Table 4.5 shows the main challenges in solid waste management at Zimtile (SPSS output data)

	Responses		Percent of Cases
	N	Percent	
Main challenges faced at (lack of employee awareness and training):	15	18.8%	40.5%
(non-compliance with regulations):	9	11.3%	24.3%
(limited recycling and reuse options):	16	20.0%	43.2%
(High cost of waste management):	19	23.8%	51.4%
(Lack of proper waste disposal facilities):	21	26.3%	56.8%
Total	80	100.0%	216.2%

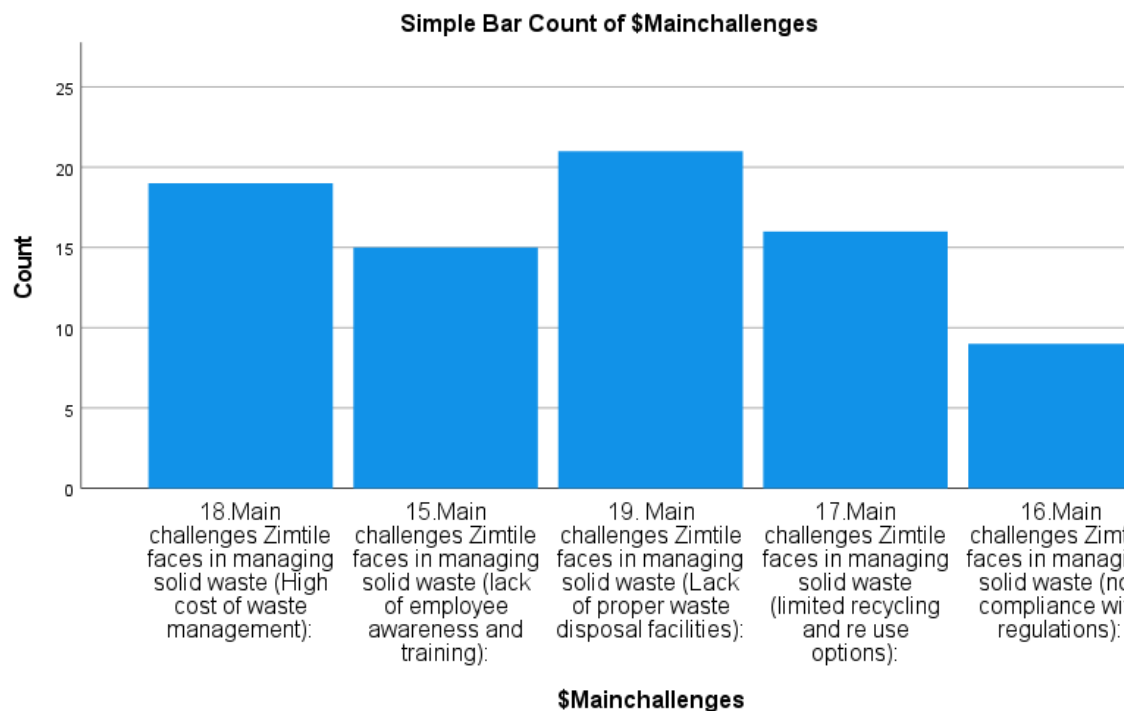


Figure 4.7 shows the main challenges in solid waste management at Zimtile (SPSS output data)

NOTES

Top challenges reported include lack of proper waste disposal facilities (56,8%), high cost of waste management (51.45%), limited recycling and reuse options (43.2%), lack of employee awareness and training (40.5%), and non-compliance with regulations (24.3%). The data confirms that Zimtile faces multifaceted challenges, such as a lack of infrastructure and high costs from the core barriers to effective solid waste management. Additionally, internal weaknesses such as limited staff training and compliance failures worsen the situation.

4.3.2 FINANCIAL RESOURCE ADEQUACY

Table 4.6 shows the financial ability of Zimtile to implement sustainable waste management (SPSS output data)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not sure	18	48.6	48.6	48.6
	Yes	9	24.3	24.3	73.0
	No	10	27.0	27.0	100.0
	Total	37	100.0	100.0	

Simple Bar Count of 20. Does Zimtile have adequate financial resources to implement sustainable waste management practices?

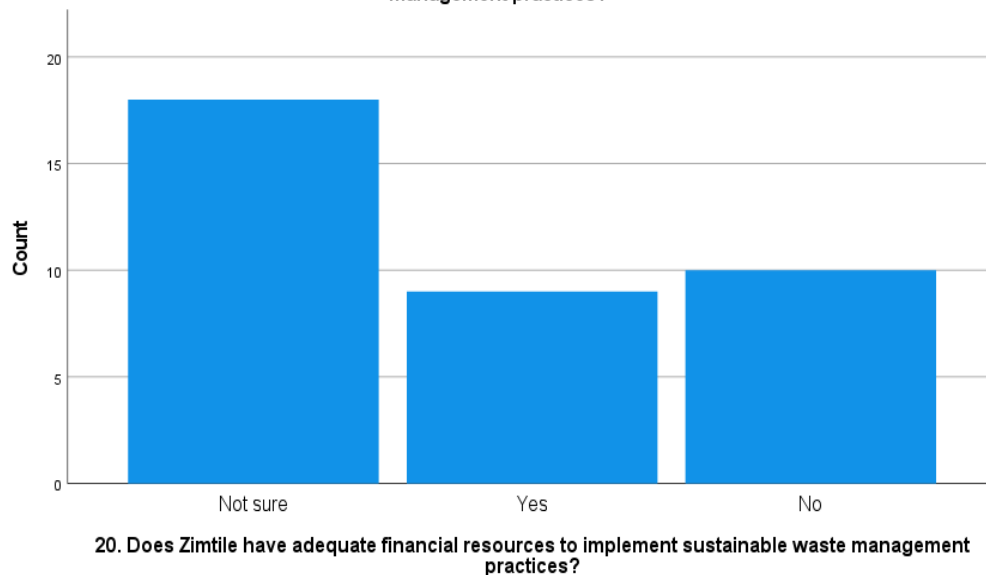


Figure 4.8 shows the financial ability of Zimtile to implement sustainable waste management (SPSS output data)

NOTES

48.6 % of respondents were not sure, 27.0% said no, and 24.3% said yes, which showed uncertainty and a general lack of confidence in Zimtile’s financial capacity to support sustainable waste management. Nearly half of the respondents expressed uncertainty, and only a quarter believed the company had adequate resources.

4.3.3 REGULATORY CHALLENGES ZIMTILE IS FACING

Table 4.7 shows the regulatory challenges Zimtile is facing (SPSS output)

	Responses		Percent of Cases
	N	Percent	
Regulatory challenges (Lack of government support) faced at Zimtile ^a	12	27.3%	32.4%
(High penalties for noncompliance)	11	25.0%	29.7%
(Strict environmental laws)	21	47.7%	56.8%
Total	44	100.0%	118.9%

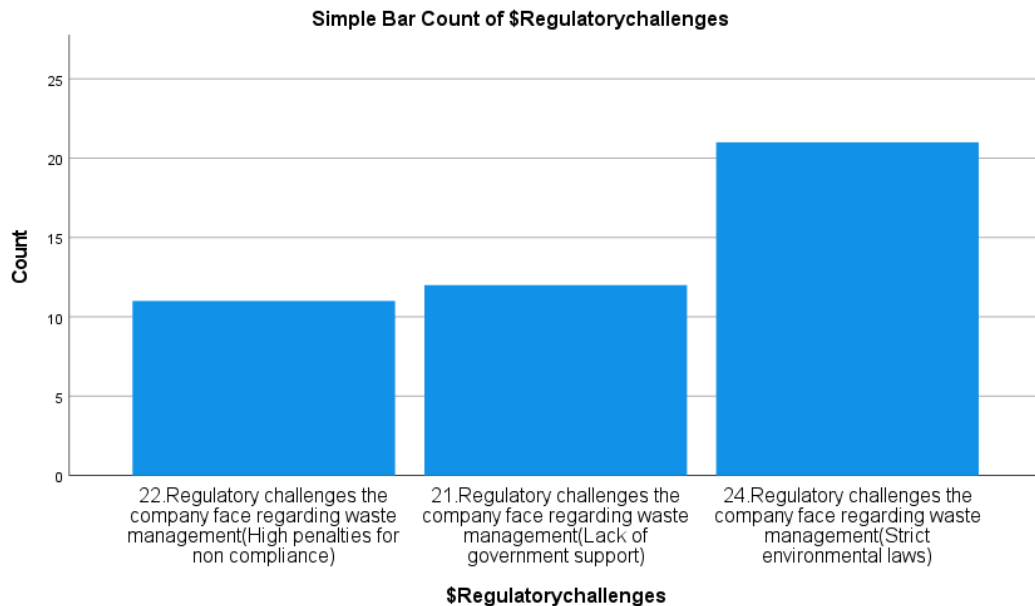


Figure 4.9 shows the regulatory challenges Zimtile is facing (SPSS output data)

Respondents reported strict environmental laws (56.8%), lack of government support (32.4%), and high penalties for noncompliance (29.7%). The regulatory environment in Zimbabwe is perceived as strict but not supportive. Respondents highlighted that while penalties are high, enforcement is often unaccompanied by adequate guidance or institutional support.

4.3.4 ENVIRONMENTAL IMPACTS OF IMPROPER WASTE MANAGEMENT.

Table 4.8 shows the environmental impacts of improper waste management (SPSS output data)

Environmental Impacts Frequencies

		Responses		Percent of
		N	Percent	Cases
Environmental impacts of solid waste	(Has no significant environmental impact):	5	7.1%	13.5%
	(Leads to land degradation):	19	27.1%	51.4%
	(Contaminates water sources):	18	25.7%	48.6%
	Environmental effects of waste disposal (Causes air pollution):	28	40.0%	75.7%
Total		70	100.0%	189.2%

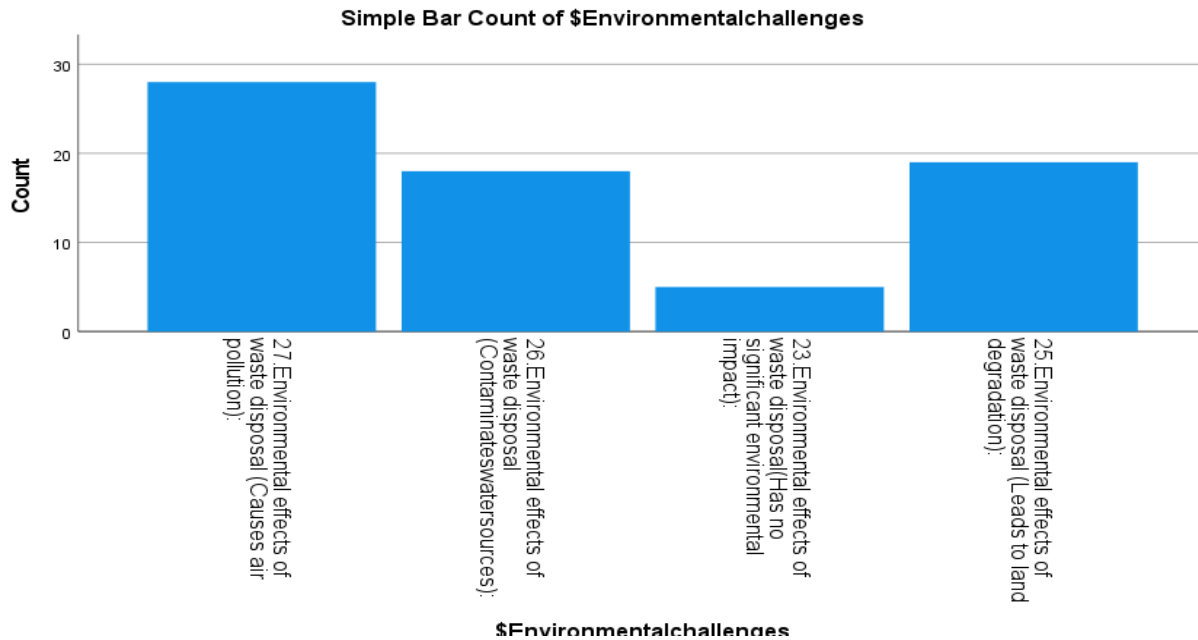


Figure 4.10 shows the environmental impacts of improper solid waste management (SPSS output data)

Reported impacts include air pollution (75,7%), land degradation (51.4%), water contamination (48.6%), and 13.5% said there was no significant impact. These results demonstrate widespread awareness of the environmental damage caused by current waste practices. Air pollution from open burning and dust, along with land and water contamination, presents significant risks to nearby communities and ecosystems.

4.3.5 COMMUNITY CONCERNS ON WASTE MANAGEMENT AT ZIMTILE

Table 4.9 shows that local communities raised concerns about waste management at Zimtile. (SPSS output data)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	18	48.6	48.6	48.6
	Not sure	7	18.9	18.9	67.6
	No	12	32.4	32.4	100.0
	Total	37	100.0	100.0	

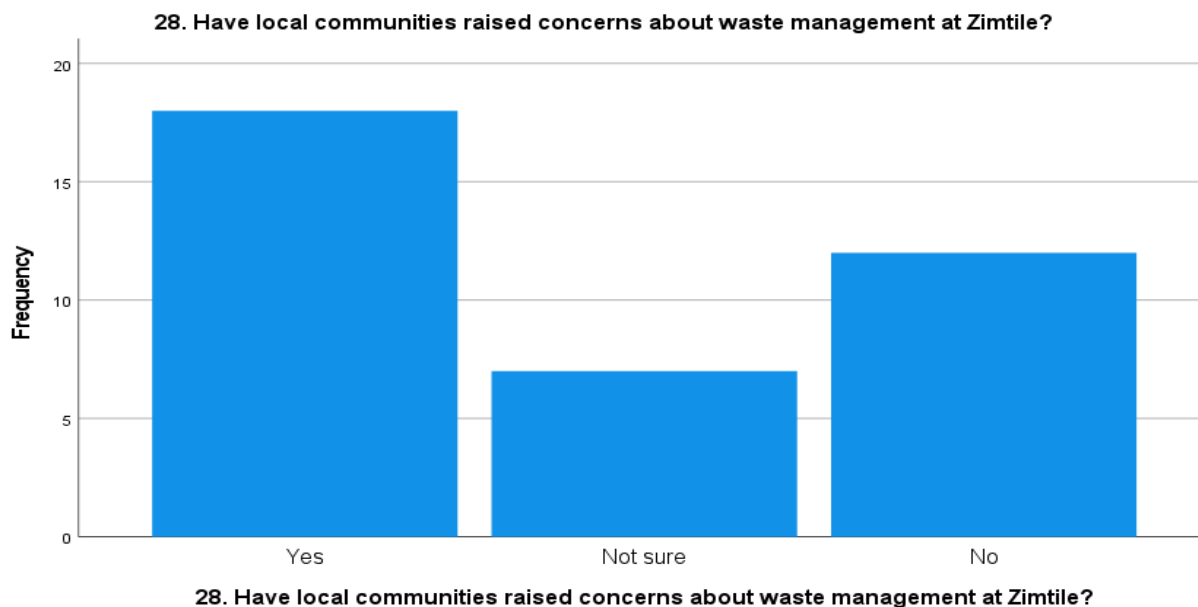


Figure 4.11 shows the frequencies of how communities raised concerns about waste management, Zimtile (SPSS output data)

48.6% said communities have raised concerns, 32.4% said no, and 18.9% were not sure. Nearly half the respondents acknowledged community backlash, indicating that Zimtile's waste disposal methods have social implications. However, a significant number of respondents either denied awareness or were unsure, which may reflect communication gaps

4.3.6 ZIMTILES ENGAGEMENT WITH LOCAL COMMUNITIES

Table 4.10 shows Zimtile's engagement with local community frequencies (SPSS output data)

		Responses		Percent of
		N	Percent	Cases
Zimtile's engagement with locals	(no engagement with communities)	19	44.2%	52.8%
	(Implements corporate social responsibility, CSR)	19	44.2%	52.8%
	(Conducts community meetings)	5	11.6%	13.9%
Total		43	100.0%	119.4%

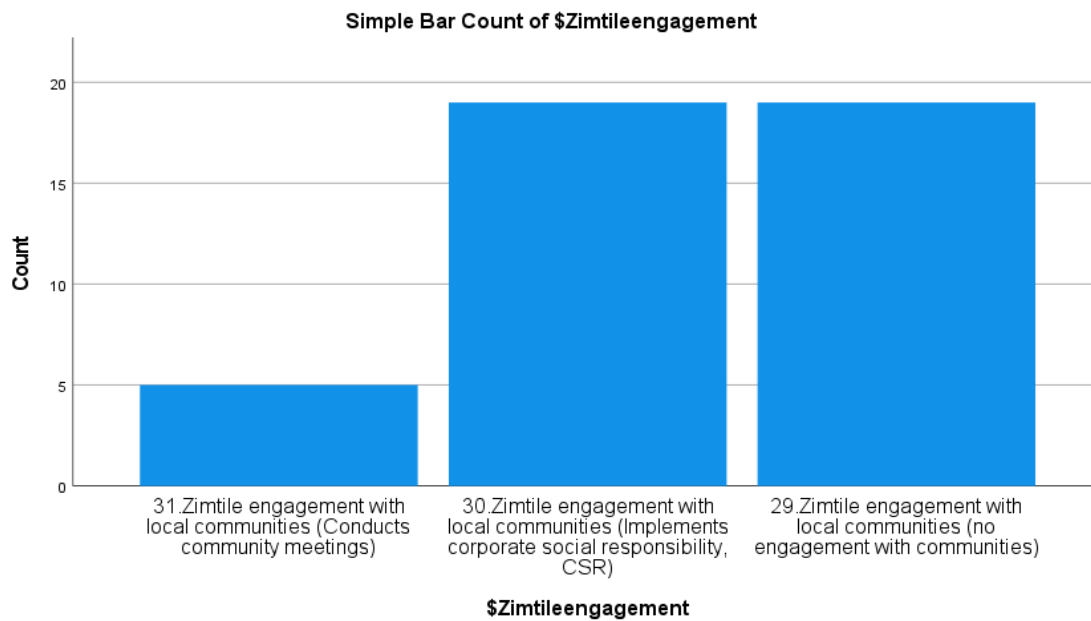


Figure 4.12 shows Zimtile's engagement with local community frequencies (SPSS output data)

NOTES

44.2% said no engagement, 44.2% said Zimtile implements CSR, and 13.9% said Zimtile holds community meetings. Zimtile's engagement with local communities appears to be minimal or inconsistent. While corporate social responsibility offers were noted by some, active consultation (e.g., community meetings) is rare.

4.4 OBJECTIVE 3: TO EXPLORE POTENTIAL SOLUTIONS AND STRATEGIES FOR IMPROVING WASTE MANAGEMENT

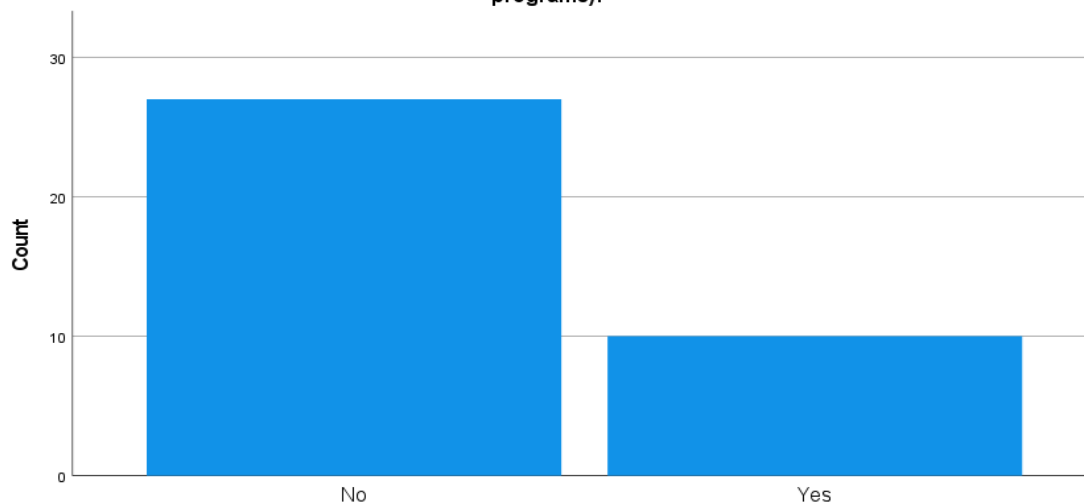
4.4.1 STRATEGIES TO IMPROVE WASTE MANAGEMENT

Table 4.11 shows strategies to improve waste management (SPSS output data)

Strategies to improve Frequencies

		Responses		Percent of
		N	Percent	Cases
Strategies to improve waste management	Collaborating with local environmental agencies	20	21.1%	57.1%
	Training employees on waste management best practices	26	27.4%	74.3%
	Investing in modern waste management technologies	22	23.2%	62.9%
	Better recycling and reuse programs	27	28.4%	77.1%
Total		95	100.0%	271.4%

Simple Bar Count of 35.Strategies to improve waste management at Zimtile(better recycling and re use programs):



35.Strategies to improve waste management at Zimtile(better recycling and re use programs):

Figure 4.13 shows strategies to improve waste management at Zimtile (SPSS output data)

NOTES

Respondents supported better recycling and reuse programs (77.1%), training employees on waste management (74.3%), investing in modern waste technologies (62.9%), and collaborating with environmental agencies (57.1%). The data shows strong support for operational reforms at Zimtile. Training, technology, and external collaboration are seen as key levers for improving the current system. The prioritization of recycling further suggests a readiness to shift from disposal-based to sustainability-oriented waste handling.

4.4.2 PERCEPTION OF ZIMTILES' EFFORTS TO IMPROVE SOLID WASTE MANAGEMENT

Table 4.12 shows the perception of Zimtile's efforts to improve solid waste (SPSS output data)

Do you believe Zimtile is making efforts to improve waste management?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	64.9	64.9	64.9
	Not sure	4	10.8	10.8	75.7
	No	9	24.3	24.3	100.0
	Total	37	100.0	100.0	

NOTES

64.9% said yes, 24.3% said no, and 10.8% were not sure. The majority of respondents believe Zimtile is attempting to improve waste management. However, nearly one-third of participants either see no improvement or are uncertain, highlighting a possible disconnect between planning and practice or a lack of transparency.

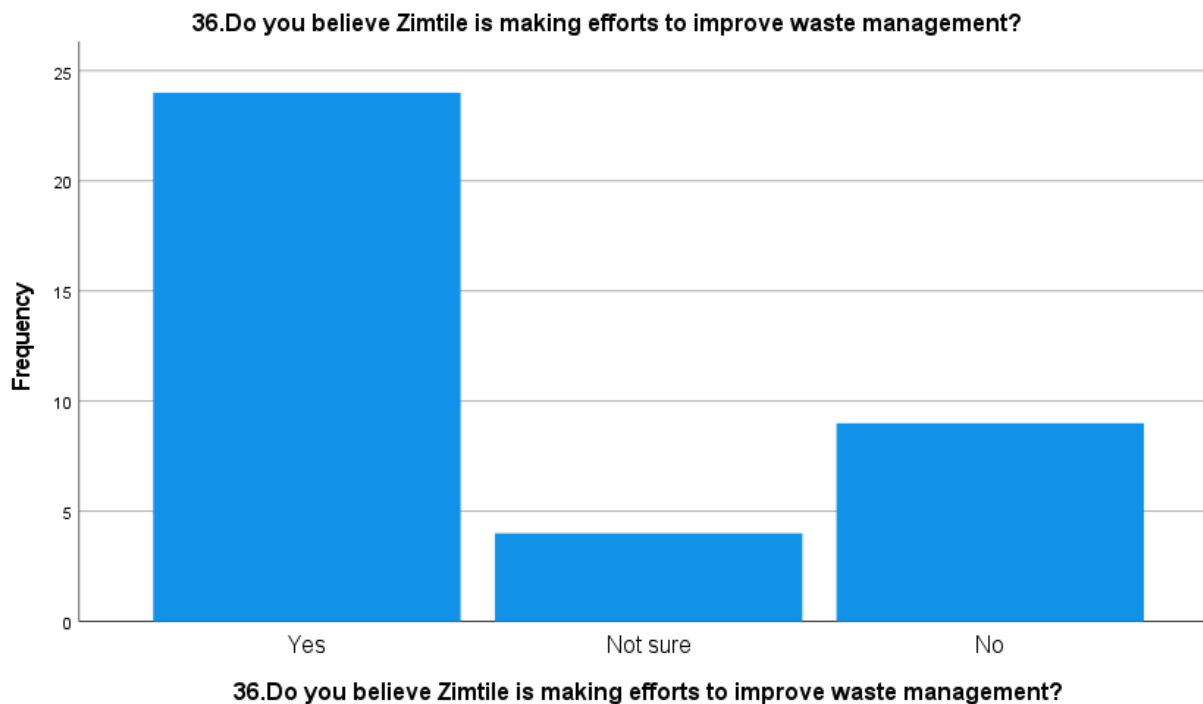


Figure 4.14 shows the perception of Zimtile’s efforts to improve solid waste (SPSS output data)

4.5 QUALITATIVE DATA ANALYSIS (THEMATIC ANALYSIS)

For qualitative analysis, thematic analysis, a flexible method suitable for exploring patterns across qualitative data, was used by the researcher using interview responses from 11 interviews.

Thematic Coding Summary: Zimtile Solid Waste Management

Table 4.13 shows a summary of the thematically coded qualitative data

Theme	Codes	Description	Sample Excerpts from Transcript

Types of waste produced at Zimtile	-brick and tile rubble -strapping codes -waste packaging material -cement, sand, and quarry dust -scrap material - mortar -gloves -mass -sewage	A variety of solid waste is produced at Zimtile. The type of waste produced varies from simple to complex.	Respondent 2 (Audit Clerk): 'Rubbles, used masks and gloves, strapping code.' Respondent 4(Factory Worker): 'Cement dust, gloves, waste packaging materials' Respondent 8 (Factory Worker): 'Rubbles, clay mortar, scrap material' Respondent 6 (Maintenance supervisor): 'Scrap material, clay residue, rubble, dust, broken products'.
Inconsistent Waste Disposal Practices	-Brick rubble is donated for road filling, -sold to construction -Brick rubble reused on site	Reflects unstructured and varied methods of waste management across departments Practice of bad waste management methods, such as	Respondent 4 (Factory Worker): "Dump at a landfill." Respondent 5 (Factory Worker): "Rubbles are only kept in designated areas."

	- Daily waste disposal, -burned on site -Waste is kept in designated areas, -Landfill waste dumping, -Departmental waste separation	open burning and on-site landfilling Good waste management practices are also present at Zimtile, such as donations to pothole filling.	Respondent 3(Environmental Officer): “Fill in potholes with rubble for roads, and use rubble on foundation buildings.” Respondent 11(Sales rep):” Office solid waste is burnt on site.”
Compliance and Operational Gaps	-ISO 9001 compliance, -Internal SOP adherence, - Delayed waste disposal, -Rubbles take a long time to get disposed of.	Highlights adherence to standards alongside inconsistent or delayed practices	Respondent 6 (Audit Clerk): 'Continue practicing ISO 9001-2015 environmental standards.'
Infrastructure and Resource Shortfalls	-Transport limitations, -Lack of heavy machinery, -Infrequent waste pickup, -delays the waste collection intervals - Need more funding	Indicates financial, technical, and logistical limitations in waste handling	Respondent 7 (Supervisor): 'Transport problems.' Respondent 8 (Environmental Officer): 'More funding's on waste management.' Respondent 3(Production Superintendent):' Challenge in getting affordable collection companies'

Environmental and Social Impacts	-Environmental pollution risk - Land degradation concern, A huge amount of dust is excreted into the environment -No -blockage of drainage systems from gloves and used masks -Community concerns rising	Points to the effects of poor waste management on the environment and community A lot of positive responses from company staff and many negative responses from community members show a bias. Waste produced at Zimtile has a severe long-term effect on the environment if not properly managed. There is no vibrant response from the company to the community, and this is now resulting in anger amongst community members and conflicts.	Respondent 9 (Warehouse supervisor): 'It does not affect since communities are helped by rubble for building houses. Respondent 10 (Factory Worker):' Zimtiles waste does not affect the local environment and communities' Respondent 1 (Community member):'Land degradation' Respondent 6 (Community member):' air pollution caused by the burning of waste'. Respondent 4 (Community member):' Death of poultry due to cement dust.' Respondent 2 (Audit Clerk):' Yes, it has raised concern, since we are burning waste near the residence, and they complain about the smoke leading to breathing of bad air. However, right as of now, the responses from the
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			company are not that vibrant.'
Toward Strategic Waste Improvement	-Train and educate all staff, -Employ qualified SHE, -Implement strict policies - Improve internal coordination and waste disposal schedule. -Introduce modern waste management technology for reuse and recycling -watering the yard before production and rubble during disposal -introduce waste champion, Policy awareness campaign	Proposed solutions and strategies to improve Zimtile's waste management system The company is implementing actions aimed at minimizing its environmental footprint and reducing its effects on the nearby community. Actions aimed at minimizing its environmental footprint and effects nearby community. Policies are being put in place and monitored closely.	Respondent 10 (SHE Representative): 'In-house training on how to manage waste, employ SHE officer with good qualities.' Respondent 2 (Audit Clerk):' Come up with policies and ensure people are complying Respondent 4(Management rep):' TO install a rubble crushing plant so that the crushed material can be reduced. Respondent 6(Environmental Worker):' Financial support to engage with waste collectors'.

4.6 OBSERVATIONAL ANALYSIS RESULTS (QUALITATIVE)

Pictures of different types of waste, some of the waste management practices, and solid waste management challenges at Zimtile, Pvt, Ltd, Harare were taken.

4.6.1 TYPES OF WASTE PRODUCED



Figure 4.15 shows scrap material at Zimtile



Figure 4.16 shows scrap material at Zimtile.



Figure 4.17 shows stained soil with oil spills at Zimtile.



Figure 4.18 shows brick off-cuts at Zimtile.

NOTES

Types of waste produced, such as scrap material, broken products, and soil contaminated with chemical and oil spills.

4.6.2 WASTE MANAGEMENT METHODS IN PLACE



Figure 4.19 shows drums used as bin cans at Zimtile.



Figure 4.20 shows on-site landfilling of rubble.



Figure 4.21 shows open burning at Zimtile.

NOTES

- Unlabeled drums used as bins
- Delays in bin disposal
- On-site landfilling of rubble
- Open on-site burning

4.6.3 CHALLENGES OF SOLID WASTE MANAGEMENT AT ZIMTILE



Figure 4.22 shows poor waste segregation at Zimtile.



Figure 4.23 shows cardboards used as bins for gloves at Zimtile.



Figure 4.24 shows a drainage blockage to mask waste.

NOTES

- There is no waste segregation, making it difficult to dispose of waste, e.g., the image shows sadza and gloves with different disposal techniques mixed.
- Cardboards and all sorts of things are being used as waste disposal facilities.
- Drains are being clogged in and outside the company with masks and gloves

4.7 DOCUMENT REVIEW

This review analyzes key documents obtained from Zimtile Pvt Ltd, including the Quality Policy and the Waste Management Plan.



Waste
Management Plan.p



Quality policy Zimtile.pdf

4.7.1 WASTE MANAGEMENT PLAN

The Waste Management Plan (WMP) provides a structured approach to handling all forms of waste generated at Zimtile's manufacturing plant. It is grounded in legal compliance, sustainability, and operational efficiency. It outlines responsibilities, waste reduction hierarchies, and specific protocols for managing different waste categories. Overall, the document is detailed, regulatory-aligned, and functionally structured. It reflects Zimtile's formal commitment to responsible environmental stewardship.

4.7.2 QUALITY POLICY ZIMTILE

This Quality Policy aligns well with the formal documentation expected under the solid waste management and sustainability framework. It demonstrated that Zimtile has an internal

commitment to structured, process discipline, and legal compliance. However, its limited mention of environmental quality and lack of recent revision suggest a gap between documented policies and operational practices.

4.8 CONCLUSION

Chapter 4 has provided a comprehensive overview of Zimtile Pvt Ltd.'s solid waste management landscape. Despite efforts to comply with environmental standards, the company continues to rely heavily on unsustainable practices such as open burning and on-site dumping. Stakeholders, including employees and local communities, support the introduction of improved training, recycling systems, and collaboration with regulatory bodies. The findings affirm the need for immediate strategic and policy-level reforms to align Zimtile's waste management practices with environmental sustainability and social responsibility. Several internal and external challenges were identified, including inadequate disposal facilities, high operational costs, weak regulatory compliance, and employee training. There is strong support for solutions such as investing in waste technology, increasing employee awareness, enhancing regulatory collaboration, and developing a formal waste policy.

CHAPTER 5

DISCUSSION

5.0 INTRODUCTION

This chapter interprets the results presented in Chapter 4 in light of the research objectives, theoretical frameworks, and empirical literature. The discussion integrates quantitative findings from SPSS analysis, qualitative insights from interviews and observations, and secondary data from document reviews. The aim is to evaluate how Zimtile Pvt Ltd manages solid waste, understand the constraints it faces, and explore viable strategies for sustainable waste management in the industrial sector.

5.1 OBJECTIVE 1: CURRENT WASTE MANAGEMENT PRACTICES AT ZIMTILE

Both questionnaires and interviews reveal that Zimtile produces various industrial wastes, such as broken tiles and bricks (81.1%), clay residue (51.4%), packaging materials (48.6%), and dust, with only 13.5% of respondents recognizing chemical waste. These waste types are common in the construction and ceramic production sectors, as noted by Kumar and Agrawal. (Goyal, et al., 2022), and signify broader trends in African industrial waste management (Godfrey, 2019). The major disposal methods employed include open burning (86.1%) and on-site landfilling (83.3%), while more organized systems like third-party disposal (47.2%) and recycling or reuse (5.6%) are underused.

These findings indicate a strong dependence on unsustainable and informal practices, reflecting issues similarly observed in studies of Harare's urban solid waste crisis. (Chikobvua & Makarati, 2011). The low recycling rate contradicts the objectives outlined in SDG 12 (Responsible Consumption and Production) and NDS1, which promote material recovery and waste reduction. Moreover, 43.2% of respondents indicated the absence of formal waste management policies at Zimtile, with 18.9% uncertain, underscoring inadequate internal communication and policy enforcement.

These results indicate a weak internal system as described by Systems Theory, where poor interdepartmental coordination hinders waste management efficiency. Comparable outcomes have been documented in industrial contexts in East and West Africa, where policy deficiencies and enforcement issues hinder the adoption of best practices. (Ajero & Chigbo, 2012).

5.2 OBJECTIVE 2: CHALLENGES AND ENVIRONMENTAL EFFECTS OF IMPROPER WASTE MANAGEMENT.

The key challenges reported include inadequate disposal infrastructure (56.8%), elevated operational costs (51.4%), limited recycling alternatives (43.2%), and insufficient training (40.5%). These complex barriers are consistent with findings from Pakistan. (Sajid, et al., 2025) and Nigeria (Ugwu, et al., 2021), highlighting the cost and capacity constraints faced by industrial waste handlers in developing countries.

Furthermore, almost half of the respondents (48.6%) expressed uncertainty about Zimtile's financial capacity to implement sustainable waste practices, reinforcing financial limitations as a significant hurdle, a concern also observed by (Mebratu & Mbandi, 2022). Strict environmental regulations were noted as a prominent regulatory challenge (56.8%), with 32.4% citing inadequate government support. This duality reinforces Stakeholder Theory, emphasizing a disconnect between enforcement and facilitation by regulatory bodies like the EMA. Despite the existence of high penalties, limited technical assistance, and weak institutional engagement, compliance motivation is diminished, as highlighted in Zimbabwe's national reports. (EMA, 2015).

Environmentally, 75.7% of respondents identified air pollution as the main consequence of improper waste disposal, followed by land degradation (51.4%) and water contamination (48.6%). Observational evidence revealed clogged drains, open burning, and oil-contaminated soil, affirming these environmental risks. These issues are similar to those observed in South Asia and Sub-Saharan Africa, where illegal dumping and open burning have been associated with vector-borne diseases, water pollution, and atmospheric toxicity. (Velis & Cook, 2021). Socially, 48.6% of respondents noted that communities have lodged complaints, while 44.2% indicated a lack of corporate engagement.

This has negatively impacted Zimtile's public image and heightened tensions with residents, particularly in Southerton, where the company is surrounded by densely populated areas like Lochinvar and Mbare. This situation highlights the significance of community involvement and transparency in industrial operations, supporting SDG 11 (Sustainable Cities and Communities).

5.3 OBJECTIVE 3: SOLUTIONS AND STRATEGIES FOR IMPROVING WASTE MANAGEMENT.

Respondents proposed several practical interventions, including enhanced recycling and reuse (77.1%), employee training (74.3%), technological upgrades (62.9%), and collaboration with environmental agencies (57.1%). These suggestions reflect a growing awareness of sustainability principles and are in line with Education 5.0, which emphasizes research, innovation, and industrial transformation. The interview data reinforced these points, with calls for improved internal coordination, training, policy awareness, and investment in machinery. Some suggested waste enhancement techniques, like crushing brick rubble for road construction, strategies that align with circular economy principles (UNEP,2024). These findings validate the relevance of the Environmental Kuznets Curve (EKC). Zimtile is at the potential point where institutional and stakeholder pressure can catalyze the transition from exploitative to sustainable practices. Despite challenges, 64.9% of respondents believe Zimtile is making efforts to improve its waste management. However, a significant proportion (24.3%) reported no visible improvement, suggesting that efforts may be inconsistent or inadequately communicated.

5.4 ALIGNMENT WITH BROADER DEVELOPMENT GOALS

This study contributes directly to multiple development frameworks like Education 5.0 which enhances innovation and research based solutions for real world industrial problems, Vision 2030 which encourages sustainable industrialization through evidence based reforms, SDG 6 which protects water sources by identifying contamination risks, SDG 12 promotes recycling and waste reduction strategies, SDG 13 reduces greenhouse gas emissions via alternatives to burning, SDG 13 reduces greenhouses emissions via alternatives to burning, SDG 9 advocates for technological upgrades in waste processing and NDS1 supports inclusive modernization through waste infrastructure improvement and policy alignment.

5.5 SYNTHESIS AND THEORETICAL ANALYSIS

The results demonstrate how the three guiding theories, EKC, Systems Theory, and Stakeholder Theory, intersect at Zimtile, explaining the industrial prioritization of productivity over environment, but community backlash and regulatory fines are prompting a shift. Systems Theory exposes organizational dysfunction in policy implementation, staff training, and interdepartmental communication. Stakeholder Theory reveals a disconnect between company efforts and community engagement, necessitating transparency and inclusive planning.

5.6 CONCLUSION OF DISCUSSIONS

Zimtile's waste management systems face significant challenges stemming from outdated disposal practices, poor infrastructure, and inconsistent policy enforcement. However, there is internal and external pressure to reform, and both employees and the community demonstrate readiness for change. If supported with financial resources, technological upgrades, and policy clarity, Zimtile has the potential to transition toward a model of sustainable waste management that could serve as a benchmark for other companies in Zimbabwe's NEC sector.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.0 INTRODUCTION

This chapter concludes the study by summarizing the major findings and drawing conclusions in line with the research objectives. It also offers targeted recommendations to improve solid waste management practices at Zimtile Pvt Ltd and provides suggestions for future research. The chapter aims to align industrial waste management strategies with national and international development goals, including the Sustainable Development Goals (SDGs), National Development Strategy 1 (NDS1), and Vision 2030.

6.1 SUMMARY OF KEY FINDINGS

The study sought to investigate the challenges faced by the brickmaking, tile manufacturing, and clay products industry in managing solid waste, using Zimtile Pvt Ltd as a case study. The findings were derived from a mixed-methods approach that included questionnaires, interviews, document reviews, and direct observations.

The study was guided by three objectives. The first objective was to identify the current waste management practices employed by Zimtile, whereby Zimtile primarily disposes of waste through burning and on-site dumping, which are unsustainable and environmentally harmful. Recycling and reuse are extremely limited, despite the potential for recovering brick and tile rubble. Waste collection is irregular, and many employees are unaware of any formal waste management policy.

The second objective was to assess the challenges faced by Zimtile and the surrounding environment due to improper solid waste management, and key challenges include a lack of equipment and funding, insufficient training, and poor internal coordination. The company faces growing pressure from local communities and regulatory agencies due to environmental impacts such as dust emissions, water contamination, and poor waste containment. There is weak engagement between Zimtile and the communities affected by its waste activities.

The third objective was to explore potential solutions and strategies for improving waste management. Employees and management suggested improved staff training, investment in waste

equipment, stricter policy enforcement, and collaboration with environmental regulators. There is a strong willingness to transition toward sustainable practices, supported by a growing awareness of environmental responsibility and corporate accountability.

6.2 CONCLUSIONS

Based on the findings, the study concludes that Zimtile's current waste management practices are outdated, poorly enforced, and environmentally unsustainable. The organization lacks a consistent waste management policy framework, resulting in uncoordinated efforts and fragmented compliance with legal requirements. Internal financial and technical limitations, coupled with insufficient training, undermine the company's ability to adopt best practices in waste disposal. Improper waste disposal has considerable environmental and social impacts, such as air contamination, soil degradation, and increased tension within communities.

The environmental and social effects of improper waste disposal are significant, including air pollution, land degradation, and strained community relations. Despite these challenges, there is a strong opportunity for improvement through policy reform, investment, and stakeholder collaborations. In addition to supporting the principles of education 5.0, Vision 2030, the Sustainable Goals (especially SDGs 6,11,12, and 13), and the National Development Strategy 1(NDS1), the study adds to the national conversation on industrial sustainability.

6.3 RECOMMENDATIONS

The following recommendations are proposed based on the research findings.

6.3.1 POLICY AND INSTITUTIONAL REFORM

Zimtile should develop and enforce a formal, site-specific waste management policy aligned with national environmental regulations (e.g., EMA Act Chapter 20:27). Regular internal audits and compliance monitoring should be institutionalized to assess adherence to environmental procedures.

6.3.2 INFRASTRUCTURE AND EQUIPMENT INVESTMENT

Invest in appropriate waste collection and disposal equipment, such as additional spraying trucks, labeled bins, waste crushers, and incinerators. Create a dedicated waste storage and segregation zone that complies with environmental standards.

6.3.3 TRAINING AND AWARENESS

Conduct frequent, structured training programs for all employees on proper waste handling, segregation, and emergency response procedures. Display visual waste management guides across all departments to reinforce daily compliance.

6.3.4 RECYCLING AND REUSE

Initiate a recycling program focused on reusing broken bricks and tiles for construction, road surfacing, or community projects. Collaborate with recycling firms and NGOs to explore cost-effective material recovery and recycling techniques.

6.3.5 COMMUNITY AND STAKEHOLDER ENGAGEMENT

Establish regular communication channels with surrounding communities (e.g., environmental meetings, awareness campaigns, complaint desks). Engage in environmental corporate social responsibility (CSR) initiatives to build goodwill and reduce conflict with affected populations.

6.3.6 GOVERNMENT AND REGULATORY COLLABORATION

Work closely with the Environmental Agency (EMA) and Harare City Council to ensure compliance and receive technical support. Seek government incentives or grants for sustainable industrial development and environmental innovation.

6.4 RECOMMENDATIONS FOR FURTHER RESEARCH

Conduct a comparative study between Zimtile and other companies in the clay and ceramic industry to identify sector-wide trends and best practices. Investigate the health impacts of industrial waste on communities living near manufacturing zones. Explore the role of automation and green technologies in reducing industrial waste footprints.

6.5 FINAL REMARKS

Efficient solid waste management is fundamental to promoting environmental sustainability and upholding industrial accountability. This study highlights that while Zimtile faces several structural and operational challenges, there is also significant potential for transformation. With

the right policy, investment, training, and stakeholder collaboration, the company can evolve into a model for sustainable manufacturing in Zimbabwe and beyond.

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APPENDICES

1.1 APPENDIX: QUESTIONNAIRE

I am Acqueline Mutezo (B212534B), a student at Bindura University pursuing a Bachelor of Science in Safety, Health, and Environmental Management. My research focuses on an investigation of the Effects of Brickmaking, Tile Manufacturing, and the Clay Products Industry in Waste Management: A Case of Zimtile Pvt Ltd, Zimbabwe. Only Bindura University of Science Education and Zimtile Pvt Ltd are allowed access to this information, and your cooperation on the matter is highly appreciated. All responses will be handled with the utmost confidentiality. If you have any questions, give me a call at 078 6226298.

Instructions:

- Please answer all questions honestly.
- Tick (✓) the most relevant answer where applicable.
- Your replies will be kept confidential and used for academic purposes only.

Section A: Demographic Information

1. Gender:

☐ Male ☐ Female ☐ Other

2. Age Group:

☐ 18 – 25 years ☐ 26 – 35 years ☐ 36 – 45 years ☐ 46 – 55 years ☐ 56 years and above

3. Job Position at Zimtile Pvt Ltd:

☐ Factory Worker ☐ Environmental Officer ☐ Management Representative ☐ Community Member ☐ Other (Specify): _____

4. Years of Experience in the Industry:

☐ Less than 1 year ☐ 1 – 5 years ☐ 6 – 10 years ☐ More than 10 years

Section B: Waste Management Practices at Zimtile Pvt Ltd

5. What types of solid waste are commonly generated in your department? (Tick all that apply.):

☐ Clay residue ☐ Broken tiles and bricks ☐ Chemical waste ☐ Packaging materials (plastics, paper, etc.) ☐ Other (Specify): _____

6. How is solid waste usually managed at Zimtile?

☐ Dumped in onsite landfills ☐ Recycled or reused ☐ Burned on-site ☐ Disposed of through third-party contractors ☐ Other (Specify): _____

7. How often is waste collected or disposed of?

☐ Daily ☐ Weekly ☐ Monthly ☐ Rarely

8. Are there formal waste management policies in place at Zimtile?

☐ Yes ☐ No ☐ Not Sure

Section C: Challenges in Waste Management

9. What are the main challenges Zimtile faces in managing solid waste? (Tick all that apply.):

☐ Lack of proper waste disposal facilities ☐ High cost of waste management solutions ☐ Limited recycling and reuse options ☐ Non-compliance with regulations ☐ Lack of employee awareness and training ☐ Other (Specify): _____

10. Does Zimtile have adequate financial resources to implement sustainable waste management practices?

☐ Yes ☐ No ☐ Not Sure

11. What regulatory challenges does the company face regarding waste management?

☐ Strict environmental laws ☐ High penalties for non-compliance ☐ Lack of government support ☐ Other (Specify): _____

Section D: Environmental and Social Impact of Waste Management

12. How do you think Zimtile's waste disposal affects the environment? (Tick all that apply.):

☐ Causes air pollution ☐ Contaminates water sources ☐ Leads to land degradation ☐ Has no significant environmental impact ☐ Other (Specify): _____

13. Have local communities raised concerns about waste management at Zimtile?

☐ Yes ☐ No ☐ Not Sure

14. How does Zimtile engage with local communities regarding waste management issues?

☐ Conducts community meetings ☐ Implements corporate social responsibility (CSR) programs ☐ No engagement with communities ☐ Other (Specify): _____

Section E: Recommendations for Improvement

15. What strategies do you think can improve waste management at Zimtile? (Tick all that apply.):

☐ Better recycling and reuse programs ☐ Investing in modern waste management technologies
☐ Training employees on waste management best practices ☐ Collaborating with local environmental agencies ☐ Other (Specify): _____

16. Do you believe Zimtile is making efforts to improve waste management?

☐ Yes ☐ No ☐ Not Sure

Section F: Additional Comments

17. Please provide any additional suggestions or comments regarding waste management at Zimtile Pvt Ltd.

Thank you for your cooperation!

1.2 APPENDIX: INTERVIEW

I am Acqueline Mutezo (B212534B), a student at Bindura University pursuing a Bachelor of Science in Safety, Health, and Environmental Management. My research focuses on an investigation of the Effects of Brickmaking, Tile Manufacturing, and the Clay Products Industry in Waste Management: A Case of Zimtile Pvt Ltd, Zimbabwe. Only Bindura University of Science Education and Zimtile Pvt Ltd are authorized to access this information, and your cooperation in this matter is highly appreciated. All responses will be handled with the utmost confidentiality. If you have any questions, give me a call at 078 6226298.

Instructions:

- [The purpose of this interview is to learn more about Zimtile Pvt Ltd.'s solid waste management procedures.](#)
- [Kindly give truthful and thorough answers.](#)
- [Your answers will be kept private and used only for academic research.](#)

Section A: General Information

1. Interviewee's Name (Optional): _____

2. Job Position at Zimtile Pvt Ltd:

☐ Factory Worker ☐ Environmental Officer ☐ Management Representative ☐ Community Member ☐ Other (Specify): _____

3. Years of Experience in the Industry:

☐ Less than 1 year ☐ 1 – 5 years ☐ 6 – 10 years ☐ More than 10 years

Section B: Waste Management Practices at Zimtile Pvt Ltd

4. What types of solid waste are generated during brick and tile manufacturing?

5. How does Zimtile currently manage solid waste disposal and recycling?

6. What measures are in place to ensure compliance with environmental regulations?

7. How often is waste collected or disposed of at Zimtile?

Section C: Challenges in Waste Management

8. What are the major challenges Zimtile faces in managing solid waste?

9. How do financial constraints affect the company's waste management efforts?

10. Are there any regulatory challenges Zimtile faces regarding waste management? Please explain.

11. Do employees receive training on proper waste management practices? If yes, how effective is the training?

Section D: Environmental and Social Impact of Waste Management

12. How do you think Zimtile's waste disposal affects the local environment and communities?

13. Have local communities raised any concerns about Zimtile's waste management practices? If so, how has the company responded?

14. What steps do you think the company should take to minimize its environmental impact?

Section E: Recommendations for Improvement

15. What strategies do you think can improve waste management at Zimtile?

16. Do you believe the company is making sufficient efforts to enhance its waste management practices? If not, what improvements do you suggest?

Section F: Additional Comments

17. Do you have any other comments or suggestions regarding waste management at Zimtile Pvt Ltd?

****Thank you for your cooperation! ****

1.3 APPENDIX: PLAGIARISM REPORT

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ORIGINALITY REPORT

10 %	7 %	7 %	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

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