International Journal of Advances in Engineering and Management (IJAEM)
Volume 8, Issue 1 Jan. 2026, pp: 301-308 www.ijaem.net ISSN: 2395-5252

Assessing Waste Management Practices at Kamba Abattoir in Nyimba District: Effectiveness, Challenges, And Implications

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Date of Submission: 08-01-2026 Date of Acceptance: 20-01-2026

Abstract: Abattoirs play a critical role in ensuring food security and employment; however, their operations generate large volumes of waste that, if mismanaged, czan harm the environment and public health. This study assessed waste management practices and their implications on environmental and public health at Kamba Abattoir in Nyimba District, Zambia. A mixed-methods approach was employed, combining questionnaires, interviews, and direct observations involving abattoir workers, management, regulatory officers, and nearby community members. Data were analyzed both quantitatively and qualitatively. The findings revealed that Kamba Abattoir generates approximately 517 kilograms of waste daily, mainly offal, wastewater, blood, and packaging materials. The study findings reveal that waste management practices at Kamba Abattoir 55%) of waste Burial in lined pits partially comply with national and international environmental and public health standards and open-air burning (30%). and packaging materials collected by the local council (15%) represent the only fully compliant disposal practice. On treatment Only a small proportion of waste receives basic treatment (10%), And 90% doesn't this pose significant risks of soil, water, and air contamination, consistent with findings in other rural abattoirs in sub-Saharan Africa (Mekonnen et al., 2019; Yusuf et al., 2020).

Institutional, financial, and technical challenges, including limited funding, inadequate infrastructure, and insufficient training, further weaken effective waste management. The study concludes that improved infrastructure, regulatory enforcement, and staff capacity building are essential to mitigate environmental degradation and safeguard public health. The findings provide evidence-based recommendations for policymakers, environmental regulators, and abattoir managers to promote sustainable waste management practices in rural abattoirs.

Keywords: Abattoir waste, environmental health, public health, waste management, Kamba Abattoir

I. INTRODUCTION

FAO, (2021) alludes that Abattoirs are essential components of the food supply chain, providing meat products that are vital for nutrition, food security, and economic development. However, slaughtering processes generate significant quantities of liquid, solid, and gaseous wastes, including blood, offal, wastewater, and odorous emissions. Improper disposal of these wastes can result in environmental degradation, such as soil and water contamination, air pollution, and proliferation of disease vectors. Furthermore, abattoir waste can harbor pathogenic organisms, increasing the risk of waterborne and zoonotic diseases in surrounding communities. Effective waste management is therefore critical to protect both public health and the environment.

WHO, (2022) agreed that globally, developed countries have implemented advanced waste management systems in abattoirs, integrating waste reduction, treatment, and recycling Techniques such as anaerobic digestion, wastewater treatment, composting, and incineration are widely applied to minimize environmental impacts. These practices are reinforced by strict regulatory frameworks and compliance monitoring, which have been shown to reduce pollution, improve occupational health, and protect community well-being.

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However, Osei-Tutu et al, (2019) Adds that in many African countries, including Zambia, abattoirs face challenges in managing waste due to inadequate infrastructure, weak enforcement of environmental regulations, and limited financial and technical resources. Studies in Nigeria, Kenya, and Ghana have reported common issues such as open dumping of solid waste, discharge of untreated effluents into rivers, and odor nuisances, all of which affect local communities (Adewumi et al., 2017)

In Zambia, abattoirs are regulated under the Public Health Act (Cap. 295), the Environmental Management Act (2011), and local council by-laws. While large urban abattoirs may have better oversight and infrastructure, smaller and rural facilities often operate under resource constraints, potentially compromising compliance with environmental and public health standards. Chitundu et al., (2021). Kamba Abattoir, located in Nyimba District, is not exceptional. It is a medium-scale facility supplying meat to local markets, schools, and businesses in Nyimba District. Preliminary observations at the facility indicate challenges in waste handling, including accumulation of solid waste and discharge of untreated liquid waste, which may have implications for Environment and Public health. .

The research objectives were to:

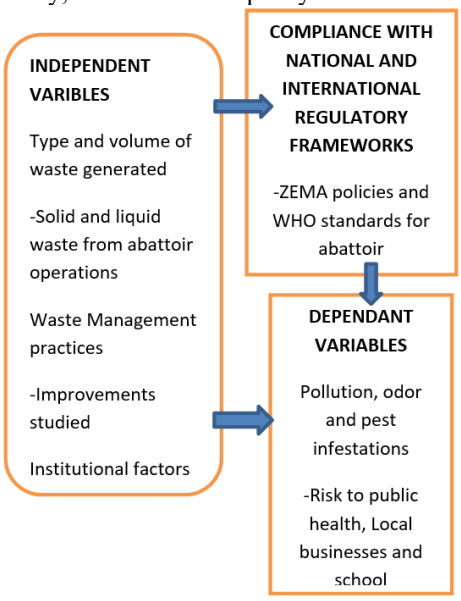
1. To identify and document the types and volumes of waste generated at Kamba Abattoir.
2. To evaluate the waste management practices against national and international regulatory standards.
3. To assess the environmental and public health risks associated with current waste practices.
4. To investigate institutional, financial, and technical factors influencing waste management effectiveness

Research Question

1. What types and volumes of waste are generated at Kamba Abattoir?
2. How do the waste management practices at Kamba Abattoir compare with the national and international regulatory standards for abattoir waste management?
3. What specific environmental and health risks are associated with the abattoir's waste handling?
4. How do institutional, financial, and technical factors affect waste management at Kamba Abattoir?

Conceptual Framework

The conceptual framework for this study illustrates the relationship between the independent, dependent, and moderating variables influencing waste management and its effects at Kamba Abattoir in Nyimba District. The independent variables include the types and volumes of waste generated, waste management practices such as collection, storage, treatment, disposal, and recycling, as well as institutional, financial, and technical factors. These variables represent the main drivers of the study and determine how effectively waste is handled within the abattoir system. For instance, inadequate infrastructure, limited funding, poor enforcement of regulations, and lack of technical capacity may result in inefficient waste disposal and environmental contamination. The dependent variables are the resulting environmental and public health outcomes that emerge from the abattoir's waste management activities. These include environmental risks such as water and soil pollution, unpleasant odour emissions, and pest infestation, as well as public health risks such as respiratory problems, vector-borne diseases, and occupational hazards among workers and nearby communities. The relationship between these independent and dependent variables is moderated by the level of compliance with national and international regulatory frameworks. High compliance, guided by institutions such as the Zambia Environmental Management Agency (ZEMA) and the World Health Organization (WHO), tends to weaken negative impacts by ensuring proper waste handling and disposal procedures. Conversely, low compliance increases environmental degradation and public health risks. In essence, this framework explains that effective waste management at Kamba Abattoir depends on institutional support, financial availability, and technical capacity



Source: field suvey2025

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II. Literature review

2.1 Global review

Adewumi, J. R., Adebayo, A. R., and Aluko, M. A. (2024) assert that globally, abattoir waste management is critical for safeguarding environmental integrity and protecting public health. This perspective is reinforced by the World Health Organization (WHO, 2020), which emphasizes that the health of human populations is closely linked to the state of the environment, making effective waste management in abattoirs an essential public health measure. Abattoirs generate a wide variety of waste, including organic materials such as blood, offal, and bones, as well as wastewater, packaging materials, and potentially hazardous substances like disinfectants and chemical residues. To mitigate environmental and health risks, abattoirs are expected to adhere to stringent waste management protocols, which include proper segregation of waste streams, treatment of effluents, and safe disposal of both solid and hazardous wastes.

In developed countries, including those in Europe and North America, abattoirs typically operate under robust environmental regulations enforced by national and regional authorities. These regulations mandate the adoption of advanced waste management technologies, such as anaerobic digestion systems that convert organic waste into biogas and nutrient-rich fertilizer, as well as comprehensive effluent treatment plants that remove pollutants from wastewater before discharge. Additionally, biogas recovery systems are increasingly used to harness energy from organic waste, reducing greenhouse gas emissions and promoting resource recovery. The enforcement of these standards is overseen by agencies such as the United States Environmental Protection Agency (EPA) and the European Environment Agency, ensuring that abattoirs minimize environmental pollution while complying with international and national sustainability requirements (FAO, 2018; WHO, 2020). These practices illustrate how modern abattoir waste management integrates environmental protection, resource recovery, and public health considerations in a sustainable and systematic manner.

2.2 In Africa

However, many developing countries, particularly in Africa, face significant challenges in implementing effective abattoir waste management systems. These challenges often stem from a combination of inadequate infrastructure, limited technical capacity, insufficient funding, and weak regulatory enforcement. As a result, abattoirs in these regions frequently operate under suboptimal conditions, failing to properly treat or dispose of the waste they generate. Studies conducted in Nigeria and Ghana indicate that many facilities discharge untreated blood and wastewater directly into nearby rivers, streams, and drainage systems, while solid waste including offal, bones, and packaging materials is often dumped in open pits or uncontrolled areas without proper containment. Such practices not only contravene national environmental regulations but also pose serious risks to public health, including the spread of waterborne and vector-borne diseases, and contribute to the degradation of local ecosystems.

For example, Adewumi et al. (2024) documented significant environmental degradation caused by abattoir waste in urban Nigeria, highlighting pollution of water bodies and contamination of surrounding soils. Similarly, Osei-Tutu, Asare, and Boateng (2025) reported comparable challenges in Ghana, including soil contamination, increased breeding of disease vectors such as flies and mosquitoes, and adverse impacts on nearby communities. These findings underscore the urgent need for capacity building, improved waste treatment technologies, and stronger enforcement of environmental regulations to mitigate the negative impacts of abattoir operations in developing countries.

2.3 In Zambia

In Zambia, the management of abattoir waste is regulated through a combination of environmental and public health laws that establish the standards for safe handling, treatment, and disposal of waste generated by slaughterhouses. The Environmental Management Act No. 12 of 2011 provides the central legal foundation by requiring all waste-generating facilities to adopt practices that prevent pollution, safeguard natural resources, and protect human health. This Act outlines the responsibilities of operators, sets out environmental quality standards, and empowers regulatory bodies to enforce compliance. Complementing this legislation is the Public Health Act (Cap. 295), which focuses on sanitation, site hygiene, disease prevention, and the maintenance of conditions that minimize the risk of public health hazards. Together, these laws form a comprehensive framework for guiding abattoir operations across the country. The Zambia Environmental Management Agency (ZEMA) plays a critical role in operationalising these laws by issuing detailed technical guidelines on effluent standards, waste storage, disposal methods, and environmental monitoring. These guidelines specify acceptable effluent discharge limits, recommended treatment technologies, and minimum hygiene standards that abattoir operators must follow. Local

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authorities and public health inspectors further support enforcement by conducting routine inspections and ensuring that facilities comply with the relevant environmental and sanitary regulations.

However, despite the existence of a well-developed regulatory structure, evidence from past studies shows that compliance remains inconsistent, especially in peri-urban and rural districts. Many abattoirs lack the infrastructure, financial resources, and technical capacity required to meet regulatory expectations. Chitundu and Chibale (2021) observed that several Zambian abattoirs continue to operate without functional drainage systems, effective waste segregation mechanisms, or basic effluent treatment facilities such as sedimentation tanks or lagoons. Wastewater and blood are often discharged untreated into nearby land or water bodies, while solid waste is commonly dumped in open pits or disposed of in ways that do not meet environmental safety standards. These shortcomings are further compounded by weak record-keeping practices, limited environmental monitoring, and insufficient enforcement mechanisms, all of which hinder the effective implementation of national guidelines.

In this context, evaluating waste management practices at Kamba Abattoir involves examining how its operational procedures align with the requirements of the Environmental Management Act, the Public Health Act, and ZEMA's technical guidelines. This includes assessing whether the facility properly segregates its waste streams, treats its effluents prior to discharge, maintains acceptable hygiene standards, and disposes of solid waste in ways that minimise environmental contamination. It also requires determining whether the abattoir has access to adequate infrastructure, equipment, and skilled personnel needed to meet regulatory expectations. By analysing these factors and comparing Kamba Abattoir's practices with both national regulations and international best practices, this study seeks to provide a detailed understanding of the effectiveness, challenges, and environmental and public health implications of waste management operations at the facility.

III. MATERIAL AND METHODS RESEARCH METHODS

3.1Research Design

The study adopted a descriptive case study design, employing a mixed-methods approach that integrates both quantitative and qualitative research techniques.

3.2 Study Area

The research was conducted at Kamba Abattoir, situated in Nyimba District in the Eastern Province of Zambia.

3.3 Target Population

Abattoir worker and surrounding member of community.

3.4 Population size

The total study population were 70 individuals.

3.5 Sample Size

The sample size of 60 was calculated using Yamane's (1967) formula for finite populations

3.6 Sampling Techniques

The study employed a combination of purposive and simple random sampling techniques to obtain a representative and informative sample.

3.7 Data Collection Methods

Questionnaires, were administered to community members and local business owners situated near Kamba Abattoir. Key informant interviews were conducted with abattoir management staff, regulatory officers from relevant government agencies, and selected abattoir workers. Observation checklists were systematically used to record direct field observations of waste generation, handling, and disposal practices at the abattoir.

Data Analysis

Quantitative data collected through questionnaires were systematically entered and analyzed using the Statistical Package for Social Sciences (SPSS) and Microsoft Excel. Descriptive statistics including frequencies, percentages, means, and deviations were calculated to summarize the characteristics of respondents, the types and volumes of waste generated, community perceptions of health and environmental impacts, and the frequency of regulatory inspections.

3.9 Ethical Considerations

Ethical clearance was obtained from the university's research committee. Informed consent was sought from all respondents before participation.

IV. RESULT

Types and volumes of waste generated at kamba abattoir

The study revealed that Kamba Abattoir generates multiple types of waste, including offal (180 kg/day), bones (60 kg/day), skins and hides (60 kg/day), blood (26 liters/day), wastewater (174 liters/day), and packaging waste (5–15 kg/day). These findings indicate that organic waste (offal, blood, skin, and bones) forms the dominant portion of the abattoir's waste stream. This study confirms that abattoir processes in developing countries particularly small- to medium-scale facilities produce significant volumes of biodegradable waste, similar to findings by Adelegan (2020) and Oloruntoba et al. (2021). However, the research gap identified in Chapter Two noted that there was limited empirical data on the specific quantities and composition of

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abattoir waste in rural or semi-urban districts of Zambia, such as Nyimba.

Table 1 4.1.1 Types and volumes of waste generated at kamba abattoir

Waste Type	Average Daily waste Volume	Observed at site (Yes/No)	Waste % Volume Estimated
Blood	26L/day=(27.56kgs/day)	Yes	5.3%
Offal/Condemned meat	180 kg/day	Yes	34.9%
Bones	60 kg/day	Yes	11.6%
Hides/skins	60kg/day	Yes	11.6%
Wastewater	174L/day =174kg/day estimated flow continuous Continues	Yes	33.7%
Packaging waste	5 – 15 kg/day	Yes	2.9%
Total	517 kg per Day Estimated		

Source: field suvey2025

Waste management practices against national and international regulatory standards

The study findings reveal that waste management practices at Kamba Abattoir Burial in lined pits partially comply with national and international environmental and public health standards. The predominant waste disposal methods is Burial in lined pits (55%), followed by open-air burning method(30%) this method pose significant risks water, and air contamination, consistent with findings in other rural abattoirs in sub-Saharan Africa (Mekonnen et al., 2019; Yusuf et al., 2020). Only a small proportion of waste receives basic treatment (10%), and packaging materials collected by the local council (15%) represent the only fully compliant disposal practice.

	PARAMETER		MEASURED VALUE (FIELD SURVEY)	NATIONAL STANDARDS	INTERNATIONAL STANDARDS	COMPLIANCE STATUS
1	Treatment on site		10% waste treated which is condemned meat, 90% disposal untreated	Treatment of waste encouraged before disposal	Treatment or safe disposal	Not Compliant (majority not treated)
2	Disposal method	Burial in lined pits	55% of waste disposed through open line pit burial such as offal	Disposal in line pity is required (ZEMA, 2013)	FAO support Burial in lined pity	Partial Compliant
		Burning in open space	30% of waste burn in open areas	Burning in open air discouraged (Environmental Management	Open Burning is prohibited(FAO,2018)	Non-compliant, burning produces smoke and Odor

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		Regulation, 2013)		
Collected by council	Only 15% of packing waste Collected by council	Local authority responsible for safe waste disposal(ZEMA 2013)	Municipal collection supported(FAO, 2018)	Non-Compliant to Organic waste

Source: field suvey2025

The environmental and public health risks associated with current waste practices

The study clearly shows that Kamba Abattoir's waste management practices are causing serious environmental and health problems for the surrounding community. The most common environmental issues include strong offensive odours and infestations of flies and rodents, which are directly linked to the open dumping of organic waste and untreated wastewater, as it shows below.

Table 3 Environmental and public health risks associated with current waste practices

Nuisance	Always		Sometimes		Never	
	N	%	N	%	N	%
Offensive odour	18	60%	9	30%	3	10%
Flies	21	70%	6	20%	3	10 %
Dirty water in streams	0	0%	3	10%	27	90%

Source: field suvey2025

Institutional, financial, and technical factors affect waste management at Kamba Abattoir

The study concludes that institutional, financial, and technical factors critically influence the effectiveness of waste management at Kamba Abattoir. Institutional challenges, particularly inadequate staffing and weak enforcement, limit the abattoir's capacity to implement environmental and public health standards. Show in the table 4 below.

Table 4 Institutional, financial, and technical factors

Factor	Specific Challenge	Workers (%)	Management (%)	Comment
Institutional	Lack of manpower	40%	20%	Shows inadequate staffing capacity affects proper waste handling and supervision
	Weak enforcement	2%	10%	Demonstrates weak regulatory enforcement and monitoring systems
Financial	Insufficient funds	23%	35%	Confirms limited funding affects investment in waste treatment facilities & PPE
Technical	Lack of equipment	20%	30%	Indicates absence of essential tools and waste handling infrastructure
	Lack of training	15%	5%	Confirms limited funding affects investment in waste treatment facilities & PPE

Source: field suvey2025

V. Conclusion

The study concludes that Kamba Abattoir generates large amounts of biodegradable waste, including dung, blood, offal, bones, and wastewater. The volume of waste produced exceeds the abattoir's management capacity, leading to the open dumping of solid waste and discharge of untreated effluent into the environment. The results also show that the waste management practices at Kamba Abattoir do not comply with national and international environmental and public health standards. Waste is mainly disposed of through open dumping and burial,

while liquid effluent is released without treatment. The absence of effective waste segregation, inadequate drainage infrastructure, and poor maintenance practices have contributed to non-compliance with environmental requirements. Environmental and Public Health Risks Associated with Abattoir Waste Handling: Offensive odours and frequent infestations of flies and rodents were reported as major challenges, reflecting poor waste containment and untreated wastewater. These conditions have resulted in discomfort, respiratory irritation, and increased risks of vector-borne diseases such as typhoid, and malaria. The study also concludes that institutional, financial, and technical constraints greatly affect the effectiveness of waste management at Kamba Abattoir. Weak enforcement of environmental regulations, inadequate staffing, and lack of coordination have undermined compliance efforts. Financial limitations have restricted the purchase of necessary equipment, facility maintenance, and staff training, while technical gaps such as insufficient tools and limited expertise have reduced operational efficiency.

Acknowledgments

First of all, I thank the Almighty God who gave me strength and ability to complete this research study. I would like to express my deepest gratitude to my supervisor, Dr. Tembo, for his invaluable guidance, patience, and constructive feedback which greatly contributed to the success of this study. My heartfelt appreciation goes to my brother, whose unwavering financial support and encouragement made it possible for me to pursue and complete this research. I am truly grateful for his sacrifice and generosity. I also wish to acknowledge Information and Communication University and ZRDC for the academic support and knowledge imparted to me throughout my studies.

Recommendation

- Improve Waste Handling and Treatment
- Enhance Compliance with Environmental and Public Health Standards
- Strengthen Occupational Safety
- Address Institutional and Financial Constraints

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