Scientific Research Publishing

Journal of Environmental Protection, 2024, 15, 1022-1034
https://www.scirp.org/journal/jep
ISSN Online: 2152-2219
ISSN Print: 2152-2197

Global Waste Management Practices in Abattoir: Challenges for Implementation in Nigeria

Ayorinde J. Thomas[1], Ifeoluwa Akande[2], Oluwagbenga M. Oso[3*], Akinyemi B. Oke[4], Temitope Akindamini[5]

[1]Department of Architecture, Caleb University Imota, Ikorodu, Lagos State, Nigeria
[2]Department of Architecture, Bells University of Technology, Ota, Ogun State, Nigeria
[3]Department of Architecture, Afe Babalola University, Ado Ekiti, Ekiti State, Nigeria
[4]Department of Architecture, Federal University, Oye Ekiti, Ekiti State, Nigeria
[5]Department of Architecture, Joseph Ayo Babalola University, Ikeji Arakeji, Osun State, Nigeria
Email: *thomasayorinde.j@gmail.com

How to cite this paper: Thomas, A.J., Akande, I., Oso, O.M., Oke, A.B. and Akindamini, T. (2024) Global Waste Management Practices in Abattoir: Challenges for Implementation in Nigeria. *Journal of Environmental Protection*, **15**, 1022-1034.
https://doi.org/10.4236/jep.2024.1512061

Received: July 2, 2024
Accepted: December 24, 2024
Published: December 27, 2024

Abstract

Huge amounts of wastes are accompanied by abattoir operations and these wastes are not handled properly in developing nations. Various accompanied risks imposed by the wastes generated by these aforementioned facilities have made it a solicitude to researchers and public health professionals. Often times, recycling such wastes, tends to reduce or eradicate its threats to human and the environment. Recuperating valuable materials from waste streams can be economical and environmentally friendly. Therefore, this study is aimed at investigating waste management mechanisms utilised in Nigeria and the challenges to the implementation of globally sustainable waste management practices. Data and information were gathered through questionnaire, interviews, observations, and literature reviews. Findings from the study show that abattoir waste in Nigeria is disposed of on land or streams without treatment or proper management practices. Although these wastes have shown reuse and recycling potentials such as cow dungs being used as fertilizers, bones for plastic manufacturing, and blood used as protein in animal feed. They are mostly bought/collected by farmers (65.18%), industries (28.14%), and others such as researchers (6.68%). The inability to effectively implement a waste recycling and global waste management practice in Nigeria is as a result of information gap, technical knowledge on sustainable waste management mechanisms, and lack of funds to incorporate such standards. Therefore, abattoir operations, waste treatment, disposal, and management should be a collaborative effort by the government, stakeholders, management, and operators of the abattoir.

Keywords

Abattoir Operations, Abattoir Waste, Recycling, Re-Use, Waste, Waste Management

1. Introduction

Abattoir also known as slaughtered house (SH) refers to any acclaimed and registered site by the controlling authority in which animals are butchered and packed for human consumption [1]. Abattoir is for production of hygienically prepared meat using hygienic techniques for slaughtering and packaging [2]. A huge amount of wastes are accompanied by abattoir operations, and these wastes are not handled properly in developing nations [3]. There is a high risk of environmental pollution, such as underground water pollution, air pollution, nuisance, offensive smells, soil pollution, and public health risks through the transmission of zoonotic diseases to humans [4] [5]. Such health problems can be spread to the general populace if care is not taken [6]. There is little or no attention to SH waste management in Nigeria, with operators, policymakers, and the government demonstrating negligible concern and lacking a cohesive strategy for waste management, treatment, and recycling [5] [7]. Therefore, this study aims to investigate waste management mechanisms used in Nigeria and the challenges of implementing globally sustainable waste management practices.

2. Materials and Methods

2.1. Literature Review

Abattoir wastes consist of several pollutants such as faeces, blood, bone, hone, fat, animal trimmings, paunch content and urine from operations, stunning or bleeding, carcass processing, and by-product processing. These abattoir wastes can be classified as solid, liquid, and gas. Odours and emissions, on the other hand, are the forms of slaughterhouse gaseous nutrient input for agricultural production including waste [8]. Abattoir waste can be detrimental to public health, animal health, and the economy of the country if they are not properly and effectively managed and controlled [9]. Abattoirs often have difficulties in disposing of, treating, and processing these wastes in an environmentally acceptable mode [3]-[5].

2.1.1. Abattoir Waste Handling

The handling of wastes from Abattoir including management is based on the category of waste. Liquid Abattoir waste in abattoirs in developing nations is poorly managed. Researchers recorded blood, wash water, and intestinal fluid, which is discharged into the public drain without treatment. Scavengers visit abattoir facilities sometimes to collect the blood, boil and dry it into blood meals for animal feed [3] [4]. At present, there is no concrete arrangement for the use or management of liquid water from most abattoirs in Nigeria [5].

The solid waste includes bones, horns, animal dung/faeces/droppings, paunch,

or intestinal content. These are mainly heaped (see **Figure 13**) in the abattoir for further processing. In the facility, they constitute a nuisance due to the odour and the flies and rodents it attracts [4] [8].

2.1.2. Abattoir Waste Disposal, Treatment, and Management Mechanism

It is essential to put into consideration appropriate safe waste disposal, treatment, and management (**Figure 1**) mechanism of an abattoir waste in a way that it will not harm the environment and its constituents.

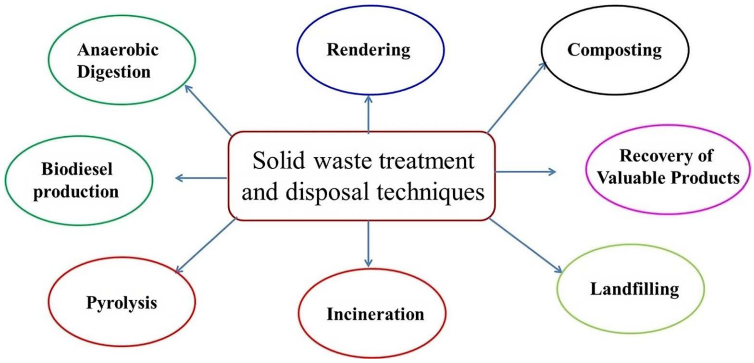

Figure 1. Solid waste treatment and disposal mechanisms [8].

- Controlled incineration: Controlled Incineration involves burning at a temperature to about 850˚C or above, for at least 15 minutes until all organic matter has turned to ash. It is a safe method and serves as a means of waste sterilization since it evacuates all pathogens. This method decreases waste volume by about 90% - 93% approximately and the resultant ash is considered prion-free, as long as the incineration is conducted correctly [8] [9].
- Composting: Composting is a natural biological decomposition process where aerobic organisms break down materials in the presence of oxygen, (air) [10] [11].
- Burial: Burial is a commonly used option for farmers' traps and skips. This reduces the volumetric and organic load on the wastewater treatment stream. At each slaughterhouse, adequate tools should be provided for the de-hiding of the animals, and also hides and skins should be immediately transported out of the slaughtering area in a closed wheelbarrow or similar other devices [5] [12].
- Biogas generation employs the use of a process of anaerobic digestion (ad). Ad (**Figure 2**) is the biological degradation of matter by microorganisms in the absence of oxygen. the biogas technology is utilized for the treatment of solid and fluid materials produced in a slaughterhouse. Further research can be done to produce material balance on the exact quantity of waste and economic viability as a feed for a biogas plant [13] [14]. The carbon-rich waste and its possibility of appropriate carbon/nitrogen (c/n value) can be harnessed as complements from other agro wastes, such as sawdust [15] [16]. The utilization of waste such as dung, and rumen content to produce biogas for cooking and electricity would serve as a source of renewable and sustainable energy.

the incorporation of the ad system as a means of bio-waste utilization reduces the emission of landfill gas into the environment ([17] [18]).

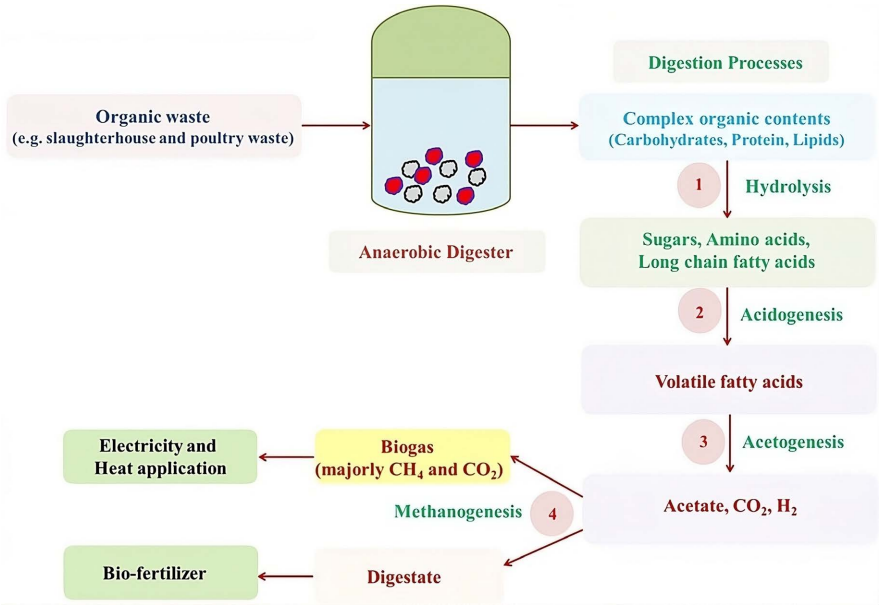

Figure 2. Schematic diagram of anaerobic digestion process [8].

- Biomethane filtration uses bone that is burnt and crushed source of filter for the purification of the biogas to obtain rich methane biogas for use. These could produce biogas of appropriate calorific value for roasting of the skin which can substitute the car tyre and firewood which has environmental consequences. Also, the biogas will have little or no health effect compared with the fuel currently used for roasting the skin [8].
- Blood processing uses blood which is a rich source of iron and protein for incorporation into livestock feed to serve as a source of animal proteins and as fertilizers to enrich the soil. The blood wastes available from the slaughterhouses should be collected for use in the pharmaceutical and feed industry [13] [19].
- Pyrolysis is a method of decomposing organic matter using thermal and chemical processes. It involves high temperature in the absence of oxygen or halogens. It involves the simultaneous change of chemical components and physical phases irreversibly. The final products are in form of liquid (bio-oil), solid (bio-char), and gaseous products such as syngas with other pyrolysis oil depending on temperature (**Figure 3**) [8] [20]-[22]. These include alcohols, phenols, aldehydes, aromatics, and furfural. Slow pyrolysis is often employed to produce valuable bio-oil from organic waste.
- Biodiesel production: Biodiesel is the mono-alkyl esters (ethyl or methyl) of long chain fatty acids produced by trans-esterification of triglycerides in reaction with alcohols (methanol or ethanol) in presence of acid/alkali catalyst (**Figure 3**). Animal wastes are potential sources for its production [8] [20] [22] (**Figure 4**).

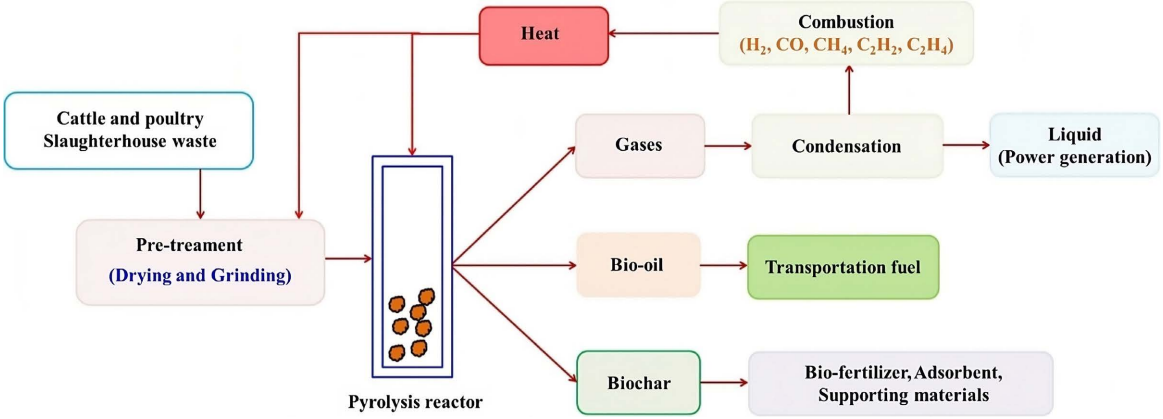

Figure 3. Pyrolysis process of organic waste [8].

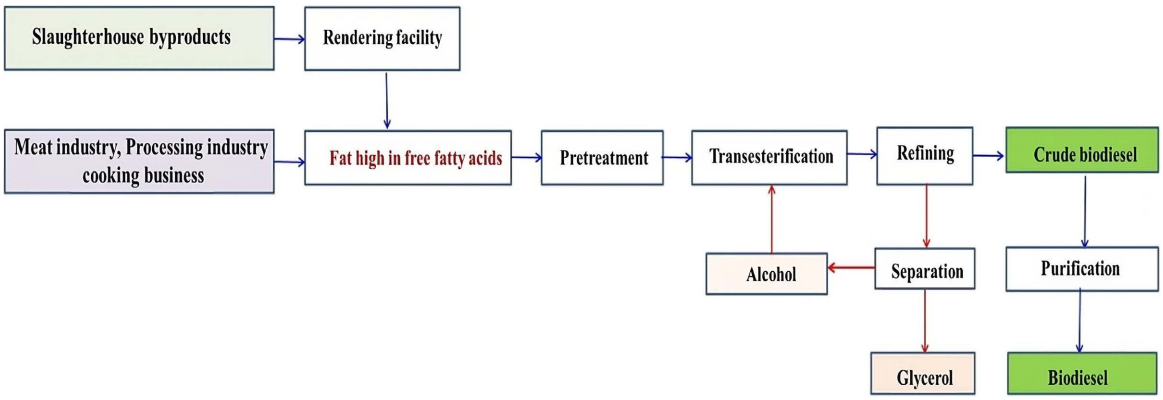

Figure 4. Steps involved in biodiesel production from animal fat waste [8].

2.2. Study Area (Ogun State, Nigeria)

Ogun State is located in the extreme southwestern part of Nigeria and served as the study area of this research. Geographically, the State is contained within longitudes 2˚45'E and 4˚45'E; and latitudes 6˚15'N and 7˚60'N and has a total land area of 16,762 km^2. The study made use of one abattoir each in Ota, Abeokuta, and Ijebu as a case study (**Figure 5**).

2.2.1. Study Population and Size

The study population of this research was abattoir operators including (cow owners, operators, cleaners, and butchers). The purposive random sampling method was utilised in this study.

2.2.2. Data Collection Method

Data for this study was sourced using questionnaire administration, personal observation, and a one-on-one interview with some operators within the abattoir facility. The questionnaire collected personal data of respondents, the type of waste generated within the abattoir, the method of waste disposal, and management within the facility. The secondary data collection involved the use of documented literature in form of review articles, published research work, systematic reviews, and books.

Figure 5. Map of Ogun state showing its regional settings. Source (Google Images, 2022) [26].

2.2.3. Data Analysis

The data collected from this study was analysed using descriptive statistic tools such as frequency, percentage, and mean. Represented in tables and charts.

3. Results and Discussions

3.1. Respondents' Data

A total number of 192 abattoir operators from the three locations (Ota, Ijebu, and Abeokuta) participated in the survey (**Table 1**). The socio-demographic profile collected was to determine the characteristics of the operators involved in the process. Various researches conducted by [5] [7] [23] have shown that socio-economic or socio-demographic factors influence perception about waste management and disposal. Based on this, the socio-demographic profile collected and documented were gender, age, marital status, level of education, income, tribe, work involvement, and years of experience.

Table 1. Frequency of questionnaire respondents.

S/N	Area	Frequency per area	Percentage (%)
1	Ota	48	25
2	Abeokuta	74	38.54
3	Ijebu	70	36.46
		192	100

The gender frequency from the three areas is presented in **Figure 6**. The

frequency chart showed that a significant number of female were also involved in operations at the abattoir aside from the figure generated from Ota showing just 2 females out of the 48 responses. Although, studies have shown that abattoir operational works are majorly male-dominated [5] [7]. The major age of the respondents working in the abattoirs ranged from 21 to 40 years across the three study areas (**Figure 7**) indicating youth involvement in abattoir operations with similar findings reported in the literature [2] [5].

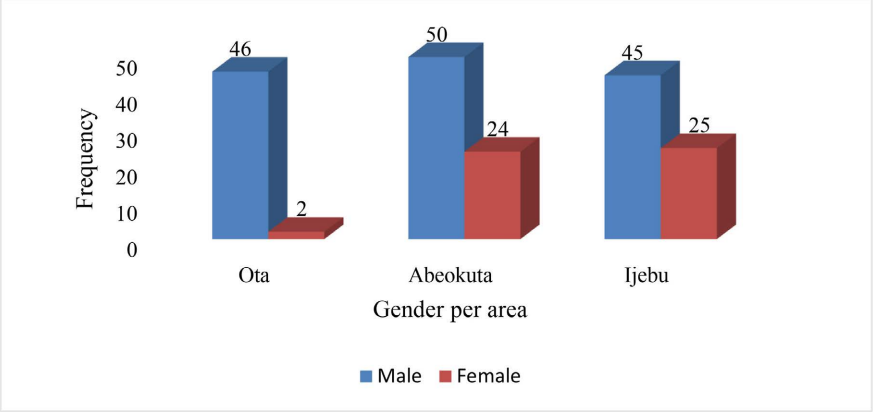

Figure 6. Gender frequency per area.

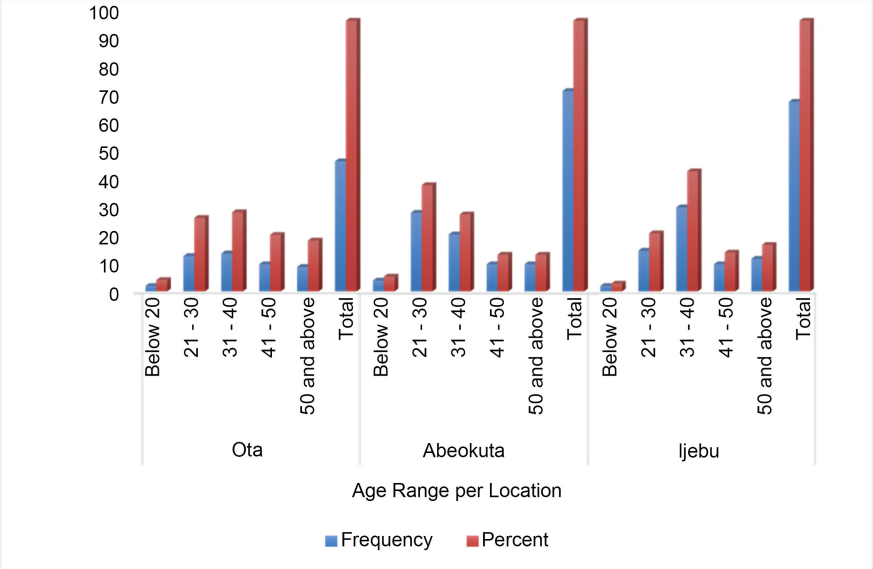

Figure 7. Showing the age range of abattoir operators per area.

Recent studies emphasize the importance of income and education levels in shaping waste behaviors [24] [25]. **Figure 8** reveals that the majority of respondents have attained only primary education or have no formal education across the study area. This finding aligns with research conducted by Joachim *et al.* [5], which suggests that most abattoir workers lack formal education, and their tasks do not require specialized skills.

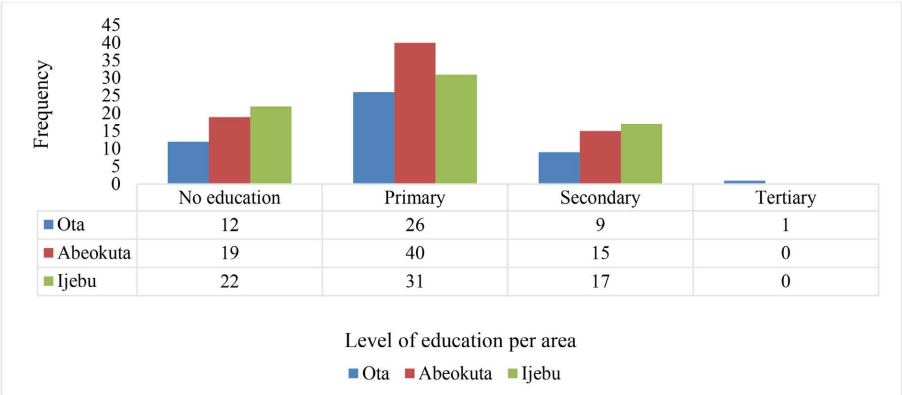

Figure 8. Level of education of respondents.

For instance, the sampled respondents worked as cow owners/sellers, laborers, butchers, and cleaners (**Figure 9**). **Figure 10** illustrates the monthly income of respondents across the three areas.

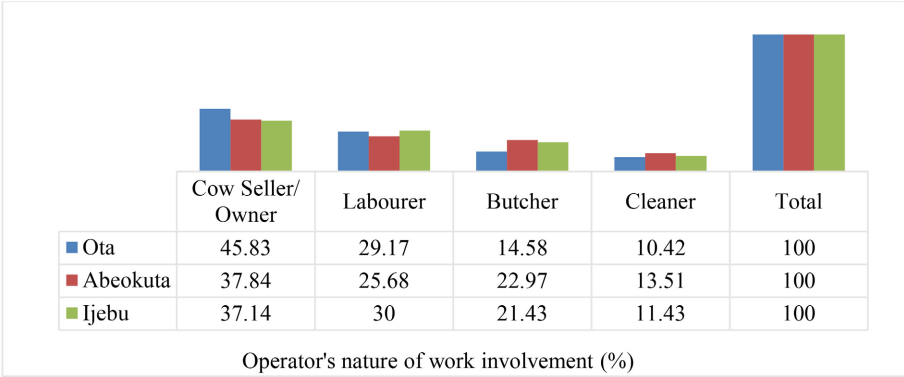

Figure 9. Operators' nature of work involvement.

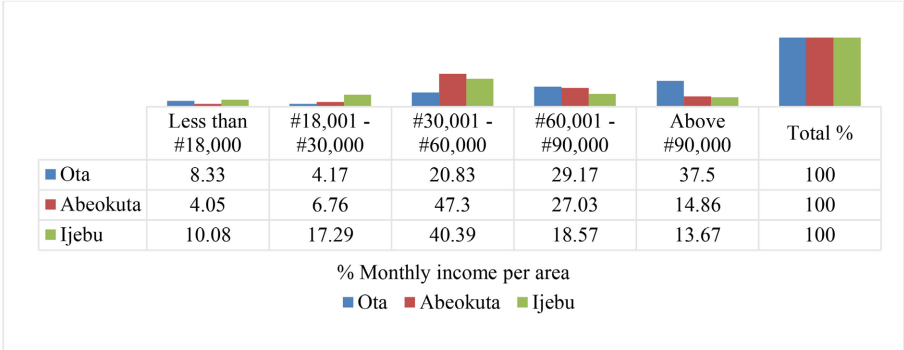

Figure 10. Percentage monthly income per area.

Notably, a significant percentage of abattoir operators at each location have more than five years of experience (**Figure 11**), indicating extensive familiarity with abattoir operational practices.

The socio-demographic characteristics of the three areas suggest that a substantial proportion of respondents are well-acquainted with abattoir operations.

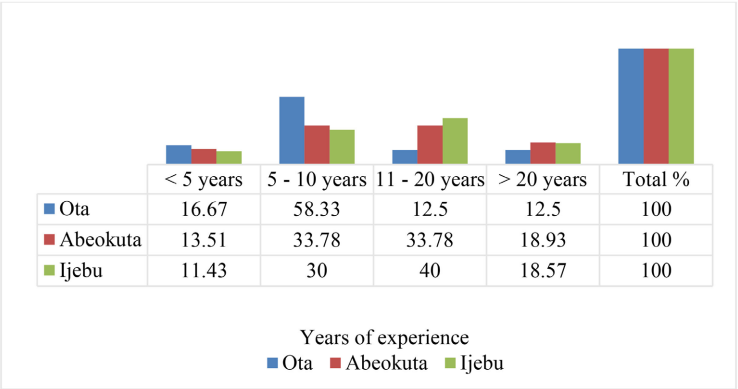

Figure 11. Operators' years of experience.

3.2. Waste Generation, Disposal, and Management

Analysis from observations, interviews, and questionnaire administration showed that various wastes are generated. Some of the wastes are sold while others are discarded not properly (**Figure 12**). Buyers include farmers, industries, horticulturists, and individuals. Interviews with respondents align with research conducted by Adebowale [4], Akanni *et al.* [3], and Joachim *et al.* [5], which shows that waste from slaughterhouses serves multiple purposes, such as cow dung being used as fertilizer, bones for plastic manufacturing, and blood as protein in animal feed. However, these wastes are frequently not sold or collected (**Figures 13-15**).

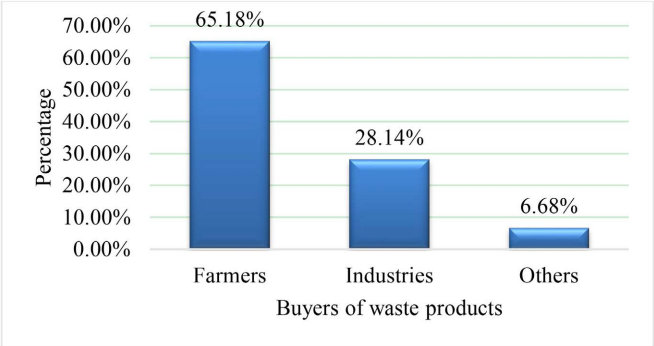

Figure 12. Buyers of abattoir waste products.

Figure 13. Bones, horns, and hooves dumped within the abattoir. Source Authors' field work.

Figure 14. View of slaughter slab with cow dung and rumen fluid to be removed. Source Authors' field work.

Figure 15. Cow blood being stored in a container. Source Authors' field work.

The results from questionnaires on waste disposal and collection showed that there are no proper waste disposal, collection, and management practices in the study area (Table 2).

Table 2. Waste disposal and collection methods.

Question	Category	Frequency	Percentage (%)
Waste Collection Responsibility	Government Sector	35	18.23
	Private Waste Collector firm	131	68.23
	Cow sellers and owners	26	13.54
	Total	192	100
Effectiveness of Waste Collection Method	Very effective	77	40.10
	Fairly effective	105	54.69
	Not effective	10	5.21
	Total	192	100
Waste Disposal Methods	Dumping in an open space	150	78.12
	Disposal outside Abattoir	22	11.46
	Burning	20	10.42
	Total	192	100

4. Conclusion and Recommendations

4.1. Conclusion

In conclusion, to tackle abattoir waste management challenges in Ogun State, Nigeria, a partnership-based approach involving government, abattoir operators, management, and local communities is essential [5]. Effective waste management in Nigerian abattoirs requires a multifaceted approach integrating waste reduction, recycling, energy generation, and policy enforcement. By adopting this holistic framework, abattoirs can mitigate environmental pollution, prevent zoonotic disease transmission, and contribute to Nigeria's renewable energy targets. This integrated approach addresses the critical gaps in existing waste management practices, promotes sustainable livelihoods, and ensures public health and environmental protection.

4.2. Recommendations

To address the challenges of abattoir waste management in Nigeria, it is therefore recommended that policymakers and stakeholders collaborate to establish a comprehensive national policy framework. This framework should prioritize the engagement of professionals (such as Architects, Engineers, Environmentalists, Biofuel experts, and Public Health Consultants) from design to operation, while focusing on waste recycling, biogas generation, and proper waste disposal practices. Additionally, training programs for abattoir operators on sustainable waste management practices should be implemented, and public-private partnerships encouraged to develop necessary infrastructure. Furthermore, community education and awareness campaigns should focus on promoting proper waste disposal practices, emphasizing the economic, environmental, and public health benefits of effective waste management.

Acknowledgements

The authors acknowledge their research supervisor for his vital contribution to the study's success and manuscript preparation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Studdert, V., Gay, C. and Hinchcliff, K.W. (2020) Saunders Comprehensive Veterinary Dictionary. Elsevier.

[2] Adeolu, A., Opasola, A., Salami, O., Iyanada, A. and Omenta, R. (2019) Sanitary Status and Compliance with the Standard Slaughter Practices in Karu Abattoir Abuja Municipal Area Council of the FCT, Nigeria. *International Journal of Current Innovations in Advanced Research*, **2**, 1-14.

[3] Akanni, A., Ogbiye, A. and Onakunle, O. (2019) The Impact Assessment of Abattoir Waste Facility Discharge on Water in Osogbo, Nigeria. *Cogent Engineering*, **6**,

Article 1614317. https://doi.org/10.1080/23311916.2019.1614317

[4] Adebowale, O.O. (2020) Waste Management and Practices in a Slaughterhouse in Abeokuta Nigeria: Case Study, Implications and Alternative Methods. *Sokoto Journal of Veterinary Sciences*, **17**, 52-55. https://doi.org/10.4314/sokjvs.v17i3.9

[5] Joachim, T.A., Akande, I. and Oke, T. (2022) Abattoir Waste Management Strategies in Nigeria: A Case of Ota, Ogun State Nigeria. *International Journal of Scientific and Research Publications*, **12**, 84-92. https://doi.org/10.29322/ijsrp.12.08.2022.p12810

[6] Odjadjare, E.E. and Ebowemen, M.J. (2020) Antibiogram of Pseudomonas Isolates and Potential Public Health Impact of an Abattoir Effluent in Benin City, Nigeria. *African Journal of Clinical and Experimental Microbiology*, **21**, 240-249.

[7] Ogunseye, N.O., Ademola, I.T., Dada, O.T., Badiora, A.I., Odufuwa, B.O. and Alaka, C.D. (2021) Operators' Perceptions of Abattoir Waste Management: Evidence from a Semi-Urban Nigerian City. *EQA-International Journal of Environmental Quality*, **43**, 16-29.

[8] Mozhiarasi, V. and Natarajan, T.S. (2022) Slaughterhouse and Poultry Wastes: Management Practices, Feedstocks for Renewable Energy Production, and Recovery of Value Added Products. *Biomass Conversion and Biorefinery*, 0123456789. https://doi.org/10.1007/s13399-022-02352-0

[9] Mohapatra, S., Menon, N.G., Mohapatra, G., Pisharody, L., Pattnaik, A., Menon, N.G., *et al.* (2021) The Novel Sars-Cov-2 Pandemic: Possible Environmental Transmission, Detection, Persistence and Fate during Wastewater and Water Treatment. *Science of the Total Environment*, **765**, Article 142746. https://doi.org/10.1016/j.scitotenv.2020.142746

[10] Singh, A. and Rathi, S. (2020) Sustainable Waste Management Practices in Abattoirs: A Review of Challenges and Opportunities. *Journal of Environmental Management*, **272**, Article 111014.

[11] Harindintwali, J.D., Zhou, J. and Yu, X. (2020) Lignocellulosic Crop Residue Composting by Cellulolytic Nitrogen-Fixing Bacteria: A Novel Tool for Environmental Sustainability. *Science of the Total Environment*, **715**, Article 136912. https://doi.org/10.1016/j.scitotenv.2020.136912

[12] Stringer, N., Haghdadi, N., Bruce, A. and MacGill, I. (2021) Fair Consumer Outcomes in the Balance: Data Driven Analysis of Distributed PV Curtailment. *Renewable Energy*, **173**, 972-986. https://doi.org/10.1016/j.renene.2021.04.020

[13] Liu, T., Tan, W., Tang, X., Zhang, J., Xing, Y. and Cao, D. (2021) Driving Conditions-Driven Energy Management Strategies for Hybrid Electric Vehicles: A Review. *Renewable and Sustainable Energy Reviews*, **151**, Article 111521. https://doi.org/10.1016/j.rser.2021.111521

[14] Jadhav, H.S. and Patil, S.A. (2022) Biogas Production from Animal Waste and Its Economic Feasibility for Renewable Energy Generation. *Journal of Environmental Management*, **314**, Article 113021. https://doi.org/10.1016/j.jenvman.2022.113021

[15] Stringer, N., Haghdadi, N., Bruce, A. and MacGill, I. (2021) Fair Consumer Outcomes in the Balance: Data Driven Analysis of Distributed PV Curtailment. *Renewable Energy*, **173**, 972-986. https://doi.org/10.1016/j.renene.2021.04.020

[16] Sahu, S.K. and Rathi, S. (2022) The Role of C/N Ratio in Optimizing Biogas Production from Organic Waste: A Systematic Review. *Waste Management & Research*, **40**, 260-277. https://doi.org/10.1177/0734242X211056634

[17] Hantoko, D., Li, X., Pariatamby, A., Yoshikawa, K., Horttanainen, M. and Yan, M. (2021) Challenges and Practices on Waste Management and Disposal during COVID-

19 Pandemic. *Journal of Environmental Management*, **286**, Article 112140. https://doi.org/10.1016/j.jenvman.2021.112140

[18] Ukpaka, C.P. and Azuatalam, C. (2024) Renewable Energy Potential from Anaerobic Digestion of Abattoir Waste in Sub-Saharan Africa. *Energy and Environmental Sustainability Journal*, **19**, 45-56. https://doi.org/10.1234/eesj.2024.0019

[19] Nara, R. (2023) The Utilization of Animal Blood in Agricultural and Pharmaceutical Industries. *Global Agricultural Studies Journal*, **28**, 15-24.

[20] Pandit, S., Savla, N., Sonawane, J.M., Sani, A.M., Gupta, P.K., Mathuriya, A.S., *et al.* (2021) Agricultural Waste and Wastewater as Feedstock for Bioelectricity Generation Using Microbial Fuel Cells: Recent Advances. *Fermentation*, **7**, Article 169. https://doi.org/10.3390/fermentation7030169

[21] Vinayak, V., Khan, M.J., Varjani, S., Saratale, G.D., Saratale, R.G. and Bhatia, S.K. (2021) Microbial Fuel Cells for Remediation of Environmental Pollutants and Value Addition: Special Focus on Coupling Diatom Microbial Fuel Cells with Photocatalytic and Photoelectric Fuel Cells. *Journal of Biotechnology*, **338**, 5-19. https://doi.org/10.1016/j.jbiotec.2021.07.003

[22] Mirmotalebi, S., Rahman, S., Tithi, M.R. and Apu, I.K. (2024) Assessment of Municipal Solid Waste Management in the Farmgate Area of Dhaka North City Corporation. *World Journal of Engineering and Technology*, **12**, 1-23. https://doi.org/10.4236/wjet.2024.121001

[23] Adzawla, W., Tahidu, A., Mustapha, S. and Azumah, S.B. (2019) Do Socioeconomic Factors Influence Households' Solid Waste Disposal Systems? Evidence from Ghana. *Waste Management & Research*: *The Journal for a Sustainable Circular Economy*, **37**, 51-57. https://doi.org/10.1177/0734242x18817717

[24] Siregar, S.P. and Putra, R.R. (2023) The Role of Income and Education in Shaping Waste Management Behaviors. *Environmental Sustainability Journal*, **15**, 47-55.

[25] Sahu, S.K. and Rathi, S. (2024) The Role of Socio-Economic Factors in the Adoption of Sustainable Waste Management Practices. *Journal of Waste Management*, **49**, 116-130.

[26] Google Images (2022) Map of Ogun State Showing Its Regional Settings. https://www.google.com/images