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# ENVIRONMENTAL RISK ASSESSMENT OF ABATTOIR OPERATIONS IN PORT-HARCOURT METROPOLIS.

**Emeka Ozioma James Nwagwu (Ph.D.)[1*], Olanrewaju Lawal[2],**

**and Tornubari Pedro Deekor[3].**

[1-3]Department of Geography and Environmental Management, University of Port-Harcourt, Nigeria.

[*]Corresponding Author's Email: jamekaa@yahoo.com

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**ABSTRACT:** *The operation of abattoirs in urban ecosystems such as Port-Harcourt metropolis, Nigeria, presents a significant threat to public space and environmental quality. This risk assessment study applied fuzzy logic to determine operational risks across 30 sampled abattoir locations within Port Harcourt Metropolis, consisting of the core Obio-Akpor, Port-Harcourt City, and its peripheral towns. Data were collected using semi-structured questionnaires (administered to workers and nearby residents), direct measurement/observation, and geo-spatial analysis in addition to secondary sources. The key risk criteria analyzed include Aesthetics, Hygiene, and Facility deficiency risk factors, and the results are presented in two folds. 1. Bayesian information criterion (BIC) two-steps cluster analysis which indicates clustering patterns and risk rating of the selected risk criteria in the entire study area with cluster 1 for major risk and cluster 2 for minor risk and the results revealed, Aesthetics sum (66.5%,33.5%), Hygiene sum (76.7%,23.3%) and Facility deficiency sum (70%,30%). 2 Fuzzy aggregated final risk classification results which provided clear pattern of the risk severity of each abattoir location. The findings indicate significant disparities between the worst condition and the good condition, which shows poor operational conditions within the study area. This highlights the urgent need for targeted interventions to improve infrastructure and abattoir operation in the study area. This research contributes vital information to the scientific community, institutions, and policymakers challenged with this kind of impact on the third world environment or any other scientific puzzle similar to this.*

**KEYWORDS:** Abattoir Operation, Cluster Analysis, Environmental Quality, Fuzzy Logic, Public Space Nuisance, Risk Assessment and Urban ecosystem.


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## INTRODUCTION

This is an environmental risk assessment of abattoir operations in Port Harcourt, Nigeria. The study focuses on assessing and analyzing key operational risk factors associated with abattoir activities, including aesthetics, hygiene, and facility deficiency, and their impact on environmental quality. This is quite necessary based on the complexities of environmental risks associated with an evolving cosmopolitan city such as Port Harcourt, Nigeria. This is achieved by applying an innovative analytical tool such as Fuzzy Logic-based Bayesian information criteria (BIC) two-step cluster analysis, and aggregated fuzzy risk summary. These approaches are particularly suitable because they enable the identification of homogeneous risk groups and uneven distribution of risks across different clusters based on multiple variables, thereby providing a nuanced understanding of the spatial distribution and relative severity of abattoir risk to the environment within the study area. This offers a practical roadmap for tailored regulatory and operational interventions.

This study contributes to the broader discussion on urban blight, environmental protection, environmentally responsible behaviours/awareness, and environmental stewardship, particularly in the context of abattoir operations in rapidly urbanizing cities like Port Harcourt. It will also serve as a guide for policymakers, urban planners, and environmentalists to develop more effective strategies for managing abattoir facilities in urban ecosystems, ultimately contributing to a cleaner, safer, and more sustainable living environment for residents of the city.

## LITERATURE/THEORETICAL UNDERPINNING

One of the most pervasive forms of urban environmental pollution in the world arises from the discharge of waste generated by anthropogenic activities into the urban ecological system. Rapid urbanization and industrialization have profoundly altered environmental amenities and will continue to do so, even as its population remain fundamentally dependent on this same ecosystem for its survival (Benson & Jordan, 2015) The urban ecosystem represents a distinctive and highly dynamic environment in which human activities serve as the primary driving force influencing multiple factors, including environmental quality, and also degradation (Francis & Chadwick, 2013). Consequently, it is pertinent to understand and effectively communicate the interrelationship between the urban ecosystem and anthropogenic activities, particularly in the domain of environmental quality, landscape modification, aesthetics, and socio-economic dependence. This is essential to ensure long-term resource sustenance and environmental stewardship. Failure to address the relationship can result in adverse impacts on both the natural and human environment, with its remediation often requiring substantial financial resources and an extended time frame.

Activities with significant impact on the human ecosystem include the operation of an abattoir with aftermath effects on the physical and social environment varying with space and time. (Omole & Longe, 2008). Within this broader context, abattoir operation in an urban setting occupies a pivotal position in the urban food supply, but with significant environmental and public space costs. In rapidly growing urban centers characterized by increasing population and industrial activities, this raises serious concerns because it relates to urban blight and other prevailing conditions within its situated environment. Abattoir activities, which involve the


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slaughtering and processing of animals for human consumption, generate large volumes of solid and liquid wastes, including blood, offal, carcass remnants, and wastewater (Akinwunmi et al., 2024).

Several Scholars have conducted related studies in Nigeria and beyond. For instance, Meharu, (2019) studied the environmental implications of waste from 12 abattoirs situated within a 100km radius of Addis-Ababa, Ethiopia, using a structured questionnaire and visual observation. It aims to estimate and quantify the volume and composition of abattoir waste contributing to environmental problems. Its findings reveal that the majority of the abattoirs discharges its waste with little or no treatment, and it causes bad odour and stench within the study area. It recommends treatment of waste at its source and waste reutilization. Similarly, Gali, Umaru & Abdullahi, (2019) conducted a cross-sectional assessment to evaluate the operational, functional and sanitary practices in Zango Shamu abattoir in Sabon Gari, Kaduna, Nigeria, using semi -structure questionnaire and close observation. The findings revealed that the abattoir operates below the standard procedures based on the provisions of the Kaduna state ministry of environment, and these causes numerous environmental issues within the study area. It recommends sanitary improvement and structural renovation of the existing facility. Fearon et al., (2014) evaluated the volume of meat produced and the corresponding waste (solid and Liquid) generated and its method of disposal from abattoirs in Tamale metropolis, Ghana, using participatory observation and data from desk research. The study reveals a lack of operational facilities and poor waste management methods as the major contributors to several cumulative environmental risks within the study area. It recommends waste reutilization and policy reforms. Furthermore, Ogeleka et al., (2021), on ecotoxicological risk assessment of untreated abattoir effluent on surface water from abattoirs in Effurun, Delta State, Nigeria, using direct measurement and laboratory testing. The study revealed the deleterious effect of the effluents on aquatic life and their cumulative effect on human health. It suggests close monitoring by relevant authorities and pretreatment of effluents before discharge.

The legal framework for the establishment and operation of abattoirs in Nigeria was established by the Federal Ministry of Environment through the national environmental sanitation policy (Regulation, 2005) on policy guidelines on market and abattoir sanitation. It saddled the local government councils to set up, own, and regulate public facilities such as markets, motor parks, public toilets, and abattoirs. However, the LGAs are more concern in revenue generation and collection rather than their primary responsibility to maintain strict adherence to the protocols of operation. Safe and hygienic meat production, therefore, requires strict adherence to established operational standards, including good hygiene practices, standard operating procedures, and good production practices. To meet these requirements, abattoirs should be equipped with adequate facilities such as standard premises, standard lairage, slaughter slabs, gut and tripe rooms, offal rooms, condemned meat rooms, hide and skin rooms, veterinary inspection units, designated waste collection areas as specified in Food and Agricultural Organization, (FAO, 1985) of the United Nation, on animal production and health paper 91 in guideline for slaughtering meat, cutting and further processing. Furthermore, FAO, (1991) supports the best international practice for abattoir operation through the Codex Alimentarius code for hygiene practice for meat CAC/RCP58-2005, which stipulates a risk assessment approach called Hazard analysis and criteria control point (HACCP). This emphasizes four cardinal approaches with several subdivisions, and these include general principles, Animal handling and welfare, Slaughter and dressing operations, and ~~post-~~processing and waste management.


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However, in many developing countries, including Nigeria, modern abattoir facilities capable of sustaining these standards are often lacking. In fact, many abattoirs are operated by untrained personnel who are largely unaware of the importance of hygiene, sanitation, and environmental management practices in abattoir operation, and as a result, waste generated from such activity is frequently discharged indiscriminately into the surroundings, including surface water bodies and nearby land use. Inhumane animal welfare practices such as poor premortem/postmortem handling, ineffective stunning techniques, improper restraint methods and a paucity of Veterinary personnel are norms in this area, with a significant measure of public health risk. (Omotosho et al, 2016). These practices not only pose serious threats to environmental quality, but it undermines urban harmony and increase the risk of transmitting severe infectious and zoonotic diseases that are pathogenic to human health (Mor & Ravindra, 2023). In Port Harcourt, intense and unguided abattoir activities have caused unpleasant odours, public space nuisance, and decayed infrastructure, which gradually diminishes the environmental quality of the once known Garden City and by extension adversely affects both its environment and the quality of life of its residents. (Elenwo, 2015).

Chukwuma et al., (2021) discloses the link between the sustainable operation of an abattoir and environmental quality, food/ energy production, and resource conservation. This emphasizes the need to carry out further detailed investigation on this current sensitive activity so as to provide a pathway for possible mitigation/remediation. This will also furnish stakeholders in the environment with relevant information and unravel inherent economic opportunities in abattoir operation in this area that could ultimately support sustainable development.

## METHODOLOGY

This is more of cross-sectional design to investigate and analyse the aesthetic, hygiene, compliance/animal welfare, and facility deficiency risks associated with abattoir operations in Port Harcourt, Nigeria. The design allows for the collection of data from available sample locations due to limited sample site settings, aside from randomisation, and allows a robust analysis of the environmental risks posed by identified abattoir locations in the area. A total of 30 locations were identified and sampled. This includes abattoirs situated in Port Harcourt city and Obio- Akpor Local Government and its peripheral towns in Ikwerre, Oyigbo, Eleme, and Etche, local government areas, Rivers State, Nigeria. These areas are verged within the geographical boundary of what is currently regarded as greater Port-Harcourt, and it specifically captures both urban and peri-urban conditions, including those near riverbanks and creek corridors, where the environmental risks may differ significantly due to varying operational practices and geographical contexts. The population targets abattoir workers and residents living near abattoir facilities, specifically individuals aged 18 years and above. This group was selected to provide valuable information on operational challenges faced by abattoir workers and the perception of residents regarding the environmental impact of the operations.

The study area is located within the geographical coordinates of 04 °, 07’ 50’’ to 05 ° 00’ 00’’ N and 06 ° 08’ 50’’ to 07 ° 15’ 00’’ E verged within the geographical boundary of what is currently regarded as greater Port- Harcourt which encompasses the core Port-Harcourt city and Obio-Akpor, with the peripherals/lipped frog towns in Oyigbo, Etche, Ikwerre, and Eleme local government areas. The GIS maps allow nuance understanding and interpretation of


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geographical phenomenon such as River, Roads, Residential area etc and how these features nest and interact to shape its particular geographical boundary. See figures 1 and 2.

**Figure 1. Port-Harcourt and Its Environs**

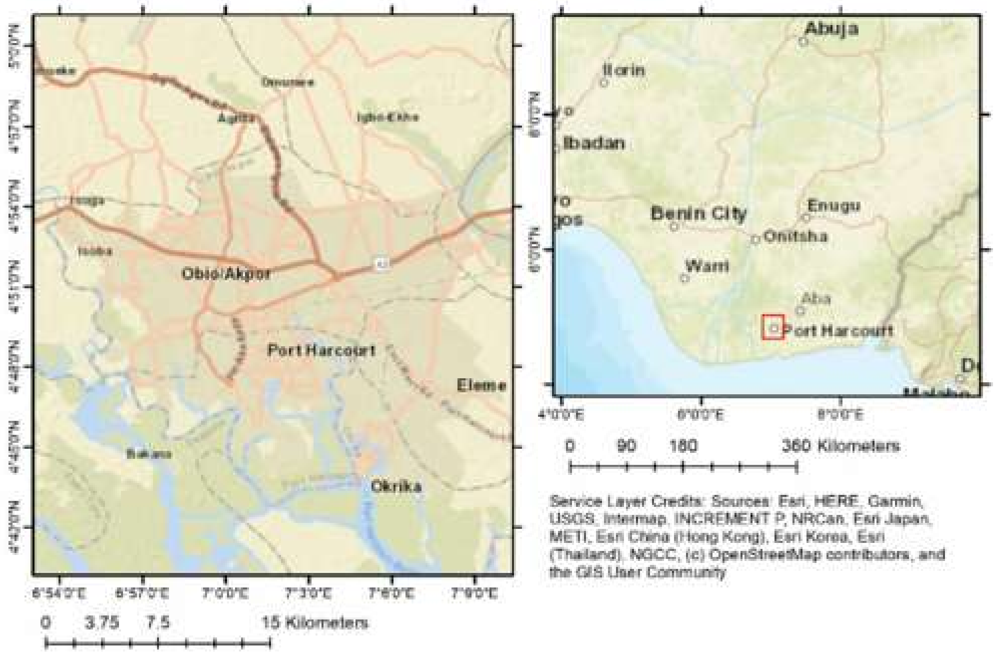
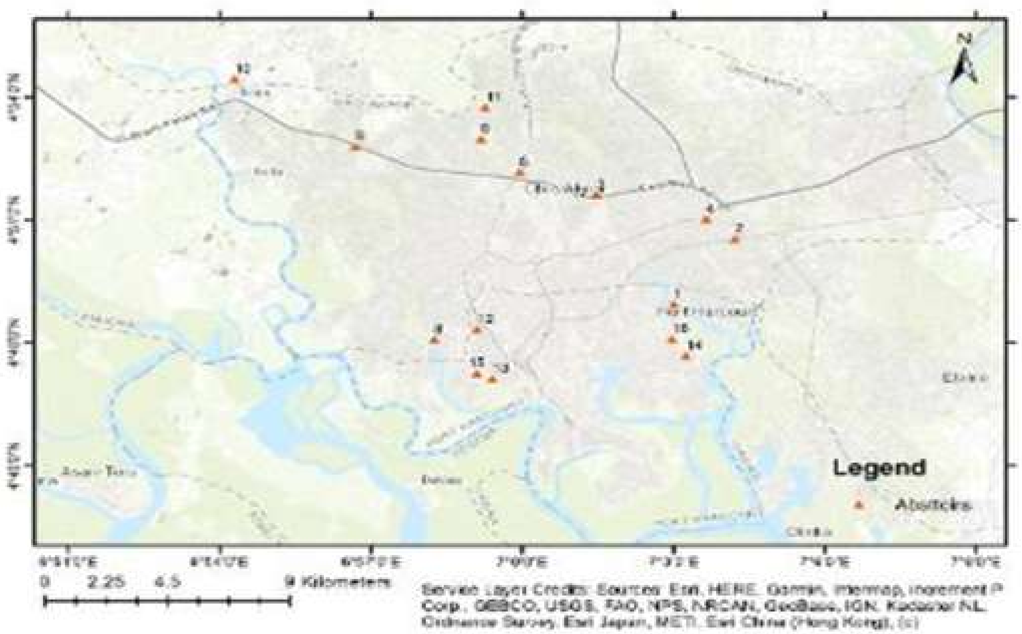



**Figure 2. Sample location of Port Harcourt and Environs.**





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Data for this study were gathered from both primary and secondary sources. Primary data were obtained through fieldwork, including the administration of structured questionnaires administered to abattoir operators and residents, on-site observations, and measurements. This is particularly crucial for understanding the operational practices at the sampled abattoir sites, including waste disposal methods, sanitation conditions, and overall aesthetic quality. The administration of structured questionnaires was a key component of the data collection process, as it allowed for the collection of both qualitative and quantitative data from the workers and residents.

Data analysis - Fuzzy logic is applied in this study due to its adaptability to accommodate vague, imprecise, and precise data. This is because in the real world, some environmental issues (for example, odour) lack numeric value and therefore rely on human discretion that is linguistically defined. Integrating varied and complex data is achievable by applying an innovative analytical tool that provides concise and reliable results by analysing key risk criteria with vague properties consistently. Chukwuma et al (2020) successfully applied fuzzy logic in the assessment of abattoir operation and facility deficiency in Onitsha metropolis, Nigeria, and it yielded the desired result, even though it was used in only five abattoirs locations. This study applies this analytical method to 30 abattoirs locations across six local government areas, thereby balancing coverage deficit.

The fuzzy results are presented in two folds: Bayesian Information Criterion (BIC) two-step cluster analysis (Measurement of fitness), and final fuzzy aggregated risk summation that provides insight into the risk status of individual abattoir locations. Data on the fuzzy logic relied on the three key linguistic risk criteria. These linguistic variables were assigned by classification/grouping of identified risk factors in the data collection form into three thematic categories of environmental risks, consisting of Aesthetic conditions (e.g., odour impact, smoke impact, site visual quality, waste disposal), Hygiene conditions (solid and liquid waste management), and Facility conditions (availability of operational facility and access to water supply). The elements of the linguistic variables (very bad, bad, moderate, good and excellent) were converted into numeric crisp value weighed on the fuzzy rating scale from 5 to 1 in a descending order, where very bad is rated 5-Very Risky, bad rated 4 – Risky, moderate is rate 3 - considerably risky, good is rated 2- Less risky, and finally excellent is rated 1- not risky. This method was similarly applied by Chukwuma et al., (2020).

**Fuzzy Risk Rating analysis**

**Data Processing**

Q1-Q9 and Q12-Q13 were used for the analysis from the respondent's questionnaire

Q4, Q5, Q8, Q9, Q12, and Q13 were recoded (i.e., from 1 being good to 5 being bad) *See appendix 1 of the field data form representing the questions 1 to 13.*

**Fuzzy Membership**

Fuzzy members were created using the totally fuzzy and relative (TFR) approach based on rank orders (Cheli & Lemmi, 1995) from the questionnaire responses. This was implemented in R using the QCA library by Duşa (2018)

This process created a new dataset with values ranging between 0 and 1


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Further to this, dimensions were created from the questions in the following way

Aesthetics-dim consists of ("Q1TFR", "Q2TFR", "Q3TFR", "Q9TFR")

Hygiene_dim ("Q4TFR", "Q5TFR")

Facilities_dim ("Q6TFR", "Q8TFR")

From this dataset, a higher number indicates a poor risk rating, while a lower number indicates a better risk rating.

Deriving Risk Rating for Each Abattoir

Mean rating for each dimension was calculated for each Abattoir (i.e., the mean of the fuzzy membership scores was computed for each abattoir. Thus, the average rating from multiple respondents was averaged over the respective questions within each dimension)

Based on the 3 dimensions, an equal-weight risk Index was computed, which summed all the average scores for each dimension.

abattoir_index = (aesthetics_sum +hygiene_sum +facilities_sum)

This created a new dataset with 30 Abattoirs and their risk rating across the 5 dimensions, as well as the index risk rating combining the 5 dimensions

Two-step cluster analysis was used to identify natural clusters within each of the 5 dimensions and the final risk rating index. This approach is deemed adequate based on the work of Lawal (2017). This method utilised the Silhouette measure of cohesion and separation (Rousseeuw, 1987) to assess the internal consistency of the members within the groups. In this case, a silhouette measure value > 0.5 is considered to have a good cluster quality, while < 0.5 but > 0.2 is considered fair.

## RESULTS

### Aesthetic Risk Factor

The Two-Step Cluster analysis results provided clues on the clustering patterns for aesthetic risk factor and the configurations ranging from 1 to 15 clusters. Schwarz's Bayesian Criterion (BIC) serves as a metric for model fit, with lower BIC values indicating better suitability, as shown in Table 1. Notably, the analysis reveals that the two-cluster solution stands out with the lowest BIC value of 21.005, suggesting it provides the most concise representation of the data. However, alongside BIC scores, other factors such as interpretability and practical relevance should be considered to determine the optimal number of clusters.


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**Table 1. Auto Clustering for Aesthetics Index.**

| Number of Clusters | Schwarz's Bayesian Criterion (BIC) | BIC Change[a] | Ratio of BIC Changes[b] | Ratio of Distance Measures[c] |
|---|---|---|---|---|
| 1 | 27.093 | | | |
| 2 | 21.005 | -6.087 | 1.000 | 4.528 |
| 3 | 24.961 | 3.956 | -.650 | 1.417 |
| 4 | 29.755 | 4.794 | -.788 | 2.282 |
| 5 | 35.678 | 5.922 | -.973 | 1.069 |
| 6 | 41.657 | 5.979 | -.982 | 3.199 |
| 7 | 48.202 | 6.545 | -1.075 | 1.416 |
| 8 | 54.822 | 6.621 | -1.088 | 1.262 |
| 9 | 61.481 | 6.658 | -1.094 | 2.226 |
| 10 | 68.218 | 6.738 | -1.107 | 1.038 |
| 11 | 74.958 | 6.740 | -1.107 | 1.176 |
| 12 | 81.708 | 6.749 | -1.109 | 3.479 |
| 13 | 88.495 | 6.787 | -1.115 | 1.044 |
| 14 | 95.283 | 6.788 | -1.115 | 1.247 |
| 15 | 102.073 | 6.791 | -1.116 | 1.285 |

a. The changes are from the previous number of clusters in the table.
b. The ratios of changes are relative to the change for the two-cluster solution.
c. The ratios of distance measures are based on the current number of clusters against the previous number of clusters. (Same for Hygiene and Facility indexes)
Emeka Nwagwu, 2025

Examining the distribution of data points across clusters, Cluster 1 emerges as predominant with approximate of 66.7% observations, while Cluster 2 represents the remaining 33.3% (Table 4). This uneven distribution indicates potentially distinct patterns or subgroups within the dataset.

**Table 2. Cluster distribution for Aesthetics Index**

| **Cluster Distribution** | | | | |
|---|---|---|---|---|
| | | N | % of Combined | % of Total |
| Cluster | 1 | 20 | 66.7% | 66.7% |
| | 2 | 10 | 33.3% | 33.3% |
| | Combined | 30 | 100.0% | 100.0% |
| Total | | 30 | | 100.0% |

Emeka Nwagwu,2025.

The findings from the Two- Step Cluster analysis on aesthetics issues related to abattoir operations in Port Harcourt, Nigeria, reveal significant differences in environmental risk based on the visual and structural conditions of the facilities. The results show that most of the


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abattoirs fall into a higher risk category on the aesthetics criterion, which indicates a greater impact on the environment and public space due to poor maintenance, uncleanliness, and poor waste management practices

**Hygiene Risk Factor**

The results from the Two -Step Cluster analysis on hygiene risk of abattoir operation in Port Harcourt present insightful patterns within the dataset, as shown in Table 5. Through varying configurations from 1 to 15 clusters, Schwarz's Bayesian Criterion (BIC) serves as a gauge for model fit, with lower BIC values indicating better-fitting models.

**Table 3. Auto-Clustering for Hygiene Index.**

| Number of Clusters | Schwarz's Bayesian Criterion (BIC) | BIC Change[a] | Ratio of BIC Changes[b] | Ratio of Distance Measures[c] |
|---|---|---|---|---|
| 1 | 27.093 | | | |
| 2 | 19.201 | -7.892 | 1.000 | 5.240 |
| 3 | 23.199 | 3.998 | -.507 | 1.946 |
| 4 | 28.561 | 5.361 | -.679 | 3.138 |
| 5 | 34.904 | 6.343 | -.804 | 1.500 |
| 6 | 41.400 | 6.496 | -.823 | 1.762 |
| 7 | 48.029 | 6.629 | -.840 | 1.052 |
| 8 | 54.666 | 6.637 | -.841 | 2.049 |
| 9 | 61.388 | 6.722 | -.852 | 1.039 |
| 10 | 68.112 | 6.725 | -.852 | 2.623 |
| 11 | 74.885 | 6.773 | -.858 | 2.100 |
| 12 | 81.674 | 6.788 | -.860 | 1.252 |
| 13 | 88.465 | 6.791 | -.861 | 1.298 |
| 14 | 95.258 | 6.794 | -.861 | 1.306 |
| 15 | 102.054 | 6.796 | -.861 | 1.168 |

Emeka Nwagwu, 2025

The cluster distribution table (Table 7) reveals an uneven distribution of data points across identified clusters. Cluster 1 emerges as the dominant cluster, encompassing approximately 76.7% of observations, while Cluster 2 represents the remaining 23.3%. This disparity suggests potentially distinct patterns or subgroups within the dataset, emphasizing the need for a nuanced understanding and interpretation.

**Table 4. Cluster Distribution for Hygiene Index**

| | | N | % of Combined | % of Total |
|---|---|---|---|---|
| Cluster | 1 | 7 | 76.7% | 76.7% |
| | 2 | 23 | 23.3% | 23.3% |
| | Combined | 30 | 100.0% | 100.0% |
| Total | | 30 | | 100.0% |

Emeka Nwagwu, 2025


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The findings from the hygiene operations within Port Harcourt, Nigeria, based on the above cluster analysis, highlight two distinct groups with different hygiene standards. The larger cluster (Cluster 1) had a higher score of 76.6% hygiene scores, indicating poorer hygiene practices in most of the population, while the smaller cluster of 23.3% (Cluster 2) demonstrated better hygiene standards. This suggests that although there are segments of the population maintaining acceptable hygiene practices, a significant portion faces hygiene-related challenges, which could have severe implications on environmental quality and public health in the study area.

**Facility Deficiency Risk Factor**

The Two- Step Cluster analysis on facility deficiencies of abattoir operation in Port-Harcourt, reveals significant insights into the dataset clustering patterns in Table 9. The configurations ranged from 1 to 15 clusters, and Schwarz's Bayesian Criterion (BIC) serves as a critical metric for assessing model fitness, with lower BIC values indicating better-fitting models. In this analysis, the two-cluster solution emerges as particularly noteworthy with a BIC value of 15.700. This suggests that the two-cluster solution provides the most concise representation of the data concerning facility-related factors.

**Table 5. Auto Clustering for Facility Index**

| Number of Clusters | Schwarz's Bayesian Criterion (BIC) | BIC Change[a] | Ratio of BIC Changes[b] | Ratio of Distance Measures[c] |
|---|---|---|---|---|
| 1 | 27.093 | | | |
| 2 | 15.700 | -11.392 | 1.000 | 10.826 |
| 3 | 20.822 | 5.122 | -.450 | 5.708 |
| 4 | 27.330 | 6.508 | -.571 | 5.331 |
| 5 | 34.077 | 6.747 | -.592 | 2.187 |
| 6 | 40.854 | 6.777 | -.595 | 1.889 |
| 7 | 47.643 | 6.789 | -.596 | 1.781 |
| 8 | 54.438 | 6.795 | -.596 | 1.570 |
| 9 | 61.236 | 6.798 | -.597 | 1.113 |
| 10 | 68.034 | 6.798 | -.597 | 1.699 |
| 11 | 74.834 | 6.800 | -.597 | 2.096 |
| 12 | 81.635 | 6.801 | -.597 | 1.176 |
| 13 | 88.436 | 6.801 | -.597 | 1.136 |
| 14 | 95.238 | 6.801 | -.597 | 1.034 |
| 15 | 102.039 | 6.802 | -.597 | 1.031 |

Emeka Nwagwu, 2025.

Examining the distribution of data points in the clusters, it becomes evident that Cluster 1 is predominant, comprising approximately 70.0% of observations, while Cluster 2 represents the remaining 30.0%. See Table 10. This uneven distribution implies potentially distinct patterns or subgroups within the dataset, suggesting the need for detailed analysis and interpretation.


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**Table 6. Cluster Distribution for Facility Index.**

| | | N | % of Combined | % of Total |
|---|---|---|---|---|
| Cluster | 1 | 9 | 70.0% | 70.0% |
| | 2 | 21 | 30.0% | 30.0% |
| | Combined | 30 | 100.0% | 100.0% |
| Total | | 30 | | 100.0% |

Emeka Nwagwu, 2025.

The result indicates that abattoir facilities in Port Harcourt, Nigeria, generally exhibit significant deficiencies in meeting standard operational requirements, potentially leading to numerous environmental risks.

**Aggregated Fuzzy Risk**

Table 9 below represents the total of all aggregated risk factors in the fuzzy risk rating and clusters, culminating in the final classification of environmental risk based on its severity to both the public space, public health, and environmental quality. This classification, grounded in selected risk criteria, reveals variations in risk levels across different locations. This provides a lucid breakdown of the operational status of individual abattoir location bases on the operational risk levels. The fuzzy rating classification provides an in-depth analysis of the diverse risk levels, offering a clearer understanding of how each abattoir's operations contribute to environmental and possible public health hazards.

Specifically, the column labeled TSc-5189 captures the aesthetic risk total, TSc152 represents hygiene-related risks, and TSc-333 reflects infrastructure or facility-related risks. The column marked TSc-7226 corresponds to compliance-related risks, and TSc4481 details the risk associated with animal welfare, which are not part of the scope of this study, but the cumulative total of these risk categories is shown in column TSc9669, offering a holistic perspective on the environmental risk profile of each abattoir. Significance is the TSc9669 column, which summarizes the overall risk level at each site based on the fuzzy-based risk criteria. This metric illustrates the environmental quality and operational conditions at each abattoir. The result reveals that eighteen abattoir sites accounting for 60% of the sampled facilities operate under conditions deemed very risky. Four sites, representing 13,3%, are classified as operating under risky conditions. Seven abattoirs representing 33.3% are classified as considerably risky. Only one site situated in Mgbuosimiri was found to pose no risk, representing just 3.3% of the total sample. This reveals the deplorable condition of abattoirs in the study area. These findings highlight the urgent need for remedial action in most of these facilities due to the substantial risks they present to both public space and the environment.


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**Table 7: Fuzzy Final Classification of Environmental Risk on Abattoir Operation in Port-Harcourt Metropolis**

| V1 | Name & Location | Aesthetics_sum | Hygiene Sum | Facilities_sum | Compliance_sum | animal_welfare_sum | Total_sum | Abattoir_index | Normalized_score | TSC_5189 | TSC_152 | TSC_333 | TSC_7226 | TSC_4481 | Tsc-9669 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AKPAJO ELEME | 2.77786865887000 | 1.136310388227320 | 1.666492295986300 | 1.134254185270630 | 0.657539682539683 | 7.37246521089575 | 1.474493042179150 | 1.97585560661149 | VR | V R | VR | VR | CR | VR |
| 2 | ALUU | 2.89728176123000 | 1.011236236897000 | 1.652221280716620 | 1.292277290954860 | 0.780113636363636 | 7.63313020617171 | 1.526626041234340 | 2.04571506035325 | VR | VR | VR | VR | VR | VR |
| 3 | AMADA II | 2.02208651926179 | 1.282838932455550 | 0.243384946662104 | 0.883430881850536 | 0.693472222222222 | 5.12521350245220 | 1.025042700490440 | 1.37358150146777 | R | VR | NR | CR | CR | CR |
| 4 | AMADI SLUAGHTE | 2.08230953965653 | 1.393399305699630 | 0.155499876031427 | 0.898582544752580 | 0.701934523809524 | 5.23172578994968 | 1.046345157989940 | 1.40212729916294 | R | VR | NR | CR | CR | CR |
| 5 | CHOBA | 3.24440776539967 | 0.930896020911995 | 1.787093399277150 | 1.340720618525930 | 0.649603174603175 | 7.95272097871792 | 1.590544195743580 | 2.13136690158860 | VR | R | VR | VR | CR | R |
| 6 | CHOBA/OZUOBA | 2.42743084017810 | 0.989014102688224 | 0.907260151239696 | 1.159063653641400 | 0.796620370370370 | 6.27938911811780 | 1.255877823623560 | 1.68290603484865 | VR | R | R | VR | CR | R |
| 7 | CHOKOCHO | 2.81746970841058 | 1.076033175202500 | 1.788415446071900 | 1.261863869899930 | 0.758472222222222 | 7.70225442180714 | 1.540450884361430 | 2.06424067764800 | VR | VR | VR | VR | CR | VR |
| 8 | EAGLE ISLAND | 2.59092353058628 | 0.858159066705393 | 1.714143047365420 | 1.352454657495110 | 0.395188492063492 | 6.91086879421569 | 1.382173758843140 | 1.85214557993802 | VR | R | VR | VR | VR | VR |
| 9 | ELELENWO ABATT | 1.73292285152404 | 1.429197958590930 | 0.176723310390804 | 0.736462779983482 | 0.551736111111111 | 4.62704301160036 | 0.925408602320073 | 1.24006944963153 | CR | VR | NR | CR | CR | CR |
| 10 | ELIOZU | 2.70550639772260 | 1.043054575882050 | 1.650798934753660 | 1.260794067768900 | 0.564632936507937 | 7.22478691263515 | 1.444957382527030 | 1.93627712299086 | VR | VR | VR | VR | VR | VR |
| 11 | ELIPRANWO | 2.16611846792864 | 0.790157047425418 | 1.523112041088070 | 1.161119877068110 | 0.509375000000000 | 6.14988243351024 | 1.229976486702050 | 1.64819762978255 | R | CR | VR | VR | VR | VR |
| 12 | IGWURUTA | 2.63730371305444 | 0.880921261911677 | 1.741582651702490 | 1.156279860521780 | 0.680753968253968 | 7.09684145544436 | 1.419368291088870 | 1.90198713426941 | VR | R | VR | CR | CR | R |
| 13 | IRIEBE | 3.21923733966917 | 0.987671673374549 | 1.833650370933990 | 1.014911106088450 | 0.462797619047619 | 7.51826810911378 | 1.503653621822760 | 2.01493147413522 | VR | R | VR | CR | VR | VR |
| 14 | IWOFE | 2.37005085769141 | 0.925904181016002 | 1.738253756895570 | 1.421268865168680 | 0.560069444444445 | 7.01554710521611 | 1.403109421043220 | 1.88019986324276 | R | R | VR | VR | VR | VR |
| 15 | MGBUOBA/MBAR | 1.86782289161212 | 1.535256835815940 | 0.212485151745189 | 0.716821468728988 | 0.591765873015873 | 4.92415222091811 | 0.984830444183622 | 1.31969612540597 | R | VR | NR | CR | VR | CR |
| 16 | MGBUOSIMI/AGII | 0.37976495817950 | 1.000000000000000 | 0.125190918472652 | 1.005163669893960 | 0.198472222222222 | 2.70856570012349 | 0.541713146500121 | 0.60181160368515 | NR | VR | NR | NR | NR | NR |
| 17 | MILE 1 DIOBU | 3.04714590366319 | 1.011830767741310 | 1.636278048257640 | 1.379001031539910 | 0.719849537037037 | 7.79410528823909 | 1.558821057647820 | 2.08885714503308 | VR | VR | VR | VR | CR | VR |
| 18 | MILE 3 DIOBU | 3.09603920386456 | 0.904619033788363 | 1.574478473146920 | 1.310809609573750 | 0.497129629629630 | 7.38307595000322 | 1.476615190000650 | 1.97869933496504 | VR | R | VR | VR | VR | VR |
| 19 | OGBOGORO ABT | 2.84290093150181 | 0.818844999515926 | 1.822141906030060 | 1.354201831184730 | 0.513293650793651 | 7.35138331902617 | 1.470276663805230 | 1.97020555970629 | VR | R | VR | VR | VR | VR |
| 20 | OKURUAMA | 2.39126436168036 | 0.957609270388823 | 1.855730820444540 | 1.318191358180610 | 0.626175213675214 | 7.14897102436955 | 1.429794204873910 | 1.91595810572667 | VR | R | VR | VR | CR | VR |
| 21 | OYIGBO1 | 2.99048715116762 | 1.020033401103690 | 1.759225794179190 | 1.251997998518790 | 0.655158730158730 | 7.67690307512802 | 1.535380615025600 | 2.05744639662554 | VR | VR | VR | R | CR | VR |
| 22 | OYIGBO2 | 2.58353412388469 | 0.969875754348598 | 1.808300044385260 | 1.015437608419490 | 0.615601851851852 | 6.99274938288989 | 1.398549876577980 | 1.87408996564574 | R | R | VR | CR | CR | CR |
| 23 | RUKPOKWU | 2.83203920844732 | 1.063485655274790 | 1.762716378162450 | 1.354866845113120 | 0.498842592592593 | 7.51195067959028 | 1.502390135918060 | 2.01323837309150 | VR | CR | VR | VR | VR | VR |
| 24 | RUMUAGHORLU / | 1.75579774532852 | 1.418996353309450 | 0.181839831033682 | 0.699643107091091 | 0.575324074074074 | 4.63160111083682 | 0.926320222167364 | 1.24129104182277 | CR | CR | NR | CR | VR | CR |
| 25 | RUMUNDURU | 1.57971879656117 | 1.553324550848510 | 0.238275767942611 | 0.758981433703067 | 0.615525793650794 | 4.74582634270615 | 0.949165268541231 | 1.27190394515285 | CR | VR | CR | CR | Vr | R |
| 26 | RUMUOKORO | 2.18586789127405 | 0.996481750411463 | 1.687927208166890 | 1.298778935357940 | 0.687407407407407 | 6.85646319261775 | 1.371292638523550 | 1.83756462094082 | R | R | VR | VR | CR | VR |
| 27 | RUMUOKWURUSI | 2.38849638419175 | 0.932994135789663 | 1.661118508655130 | 1.192252505049900 | 0.643154761904762 | 6.81801629559120 | 1.363603259118240 | 1.82726067037969 | CR | R | VR | VR | CR | VR |
| 28 | RUMUOKWURUSI | 2.87631133249082 | 0.880635105044051 | 1.811007545494900 | 1.284809961159700 | 0.682500000000000 | 7.53526394418946 | 1.507052788837890 | 2.01948643846027 | VR | R | VR | VR | VR | VR |
| 29 | RUMUOSI/EKINI | 1.95947116618990 | 1.033440866907320 | 0.223518060248137 | 0.586809201127539 | 0.418204365079365 | 4.22144365955226 | 0.844288731910452 | 1.13136690158860 | CR | VR | CR | CR | CR | CR |
| 30 | WOJI | 2.85395223443003 | 1.045283390730680 | 1.583086255036040 | 1.263017446149780 | 0.659920634920635 | 7.40525996126716 | 1.481051992253430 | 1.98464475508966 | VR | VR | VR | VR | VR | VR |
| | Severity Index | | NR Not Risky | | SNR - Slightly Not Risky | | CR Considerably Risky | R - Risky | VR- Very Risky | | | | | | |

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## DISCUSSION

In almost all the locations, aesthetic issues emerged as a dominant risk factor affecting the local community, the consumers, and the operators. The burning of animal skin is a norm, and anywhere there is an abattoir, there is bound to have heavy smoke and stench odor in the vicinity. This, combined with a make-shift arrangement and poor waste control reduces the site's visual quality, making it vulnerable to environmental degradation. In comparison to other literature and findings that align with studies, Meharu, (2019) in Ethiopia emphasized the environmental risks posed by poor waste management of abattoirs, which result in odour and stench within a 100km radius of Addis Ababa.

The anchor consideration in hygiene risk is the solid and liquid waste management procedure. It is well known that most of these abattoirs lack appropriate sewerage systems to accommodate their compound waste of blood, offal, fats, intestinal water, and spent fuel, which ought to have gone through a segregation process. Unhygienic abattoir operation impacts negatively impact worker morale due to its potential exposure to illness, infectious diseases, and offensive odors. In many areas visited, blood is the only liquid collected with a local basin during animal killing. However, not all is recovered. The remaining waste containing materials such are offal and animal craps are either disposed of indiscriminately or stored inappropriately. This aligns with similar studies conducted such as. Fearon et al., (2014) and Ogeleka et al., (2021) that the effects of unhygienic practices and poor waste disposal methods are the leading causes of diminishing environmental quality and cumulative health on the surrounding dwellers.

Abattoirs in the study area are faced with challenges of infrastructural limitations. Many do not have the capacity, standard equipment, and infrastructure for best practice as recommended by FAO (1985). The result clearly reveals that the majority of the abattoirs lack basic facilities for operation based on the recommended baseline and it raises serious environmental and public health concerns in the study vicinity. This corresponds to similar studies by Gali et al., (2019), where it was observed that poor sanitary conditions and inadequate maintenance of abattoir facilities contributed to substandard meat production and pollution in Zangon Shanu Sabon Gari, Kaduna. The sampled abattoirs are classified or rated based on the availability of operational facilities and space, as recommended by the Kaduna state Ministry of Environment. The finding reveals a paucity of the necessary facilities, leading to a deplorable state of the majority of the abattoirs.

Chukwuma et al., (2020). Reports that poor hygiene practice and facility deficiency in abattoirs operation are directly linked to high environmental, social, and health risk in Onitsha metropolis in Nigeria.

## IMPLICATIONS TO RESEARCH AND PRACTICE.

From a research perspective, the study demonstrates the analytical strength of employing data-driven fuzzy logic with Bayesian Information Criterion (BIC) two-step cluster analysis that identifies subgroups and major groups of abattoir classification in environmental risk assessment. This typology allows human discretion to be part of quantitative data and it provides a more nuanced and context-sensitive framework for analyzing complex, multi-dimensional environmental problems characterized by uncertainties and informed the


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stakeholders on the actual level of the problem with transparent interpretation to research puzzles and simultaneously releasing solid decision-making framework. Future research can build on this by applying similar hybrid models to other urban environmental challenges, including solid waste management, informal industrial activities, and water pollution in other developing regions.

In terms of practical implications, the findings underscore an urgent need for policy reform, stricter enforcement of environmental regulations, and targeted infrastructural investment in abattoir facilities. The high proportion of abattoirs classified as "very risky" indicates systemic failures in compliance, monitoring, and facility provision. Regulatory agencies and local government authorities must prioritize the upgrading of abattoir infrastructure to meet established standards set by organizations such as the Food and Agriculture Organization, particularly in areas of waste management systems, water supply, slaughtering facilities, and veterinary inspection units. There is also a critical need to transition from informal and makeshift slaughtering practices to more centralized and modernized abattoir systems that incorporate environmental safeguards and waste treatment technologies.

Equally important is the role of capacity building and behavioural change among abattoir operators. The study reveals that poor hygiene practices and indiscriminate waste disposal are partly driven by limited awareness and a lack of technical knowledge. Therefore, training programs focused on hygiene standards, environmental stewardship, and best operational practices should be institutionalized. Public awareness campaigns targeting both operators and nearby residents can also enhance community participation in environmental monitoring and reporting.

## CONCLUSION

The evaluation of abattoir operation within Port Harcourt reveals a complex myriad interplay of factors influencing their impact on environmental quality and public space. The results and findings from the Two-Step Cluster analysis and fuzzy final risk summary are common and point towards the same trajectory, which clearly depicts the abnormal operational conditions of abattoirs in the study area. Specifically, the assessment showed that while a very few abattoirs have appreciable maintenance and operational standards, the majority have unsatisfactory conditions contributing significantly to diminishing environmental quality, public space nuisance, and structural deterioration of the city, which potentially culminates in economic misfortunes. Lapses in its key operational criteria, such as inadequate facilities, poor hygiene practice, lack of compliance, and animal welfare, are the core concern reflecting the diverse challenges faced by operators and stakeholders in this environment and in the region. Port Harcourt is therefore generally challenged with escalated waste generation, scaled diminishing environmental quality, and other sanitation issues arising from poor abattoir operation, which potentially places a huge burden on public funding and infrastructure, and this is the same issue in other third-world cities.

It is obvious now that most environmental challenges we are facing in our immediate communities emanate from our wrong decisions, particularly on the operation of sensitive anthropogenic activity such as abattoir operation, rather than its aftermath, causal, or elemental impact. As we face this challenge in an urban ecosystem, it requires our practical understanding


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of this kind of urban pathology and how it could be cured in a complex, paradoxical city like Port-Harcourt. The good news is that this report convincingly reveals the diverse operational risk levels, which are a vital tool for decision-making and action. Substantial improvement is possible if there is strategic investment and policy reforms that will propel the abattoir operation into a viable and sustainable endeavor. Improvement in abattoir infrastructure/ facility, proper land administration, enhanced regulation, and local operators' capacity building are key pathways to propel abattoir operation not only as a visible, sustainable business, but also an environmental protection strategy.

These goals are achievable even within the resource constraints of this region if all stakeholders prioritize and action these sustainable strategies in a holistic manner to transform the abattoir operation in Port-Harcourt into a model of ecological modernization. Moreover, there is also an urgent and important need for attitudinal change towards the use of environmental amenities, knowing fully well that we do not have any other apart from our current earth.

## FURTHER RESEARCH

Significantly, rather than viewing abattoir waste solely as an environmental burden, this report identifies animal crap and other vital waste such as cow bones, fats, and blood as a big business that contributes to bio-economy, specifically useful for bio-medicine, Agro-allied food production and waste reutilization in agriculture, which represents a shift in discourse towards broader circular economy models. This perspective not only promotes environmental sustainability, but also presents economic opportunities through employment creation and revenue generation, which align with broader sustainable development goals. This constitutes another prospect from this study.

## REFERENCES

Akinwunmi, I., Isaac, I. L., Samuel, M., & Ehuda, I. D. (2024). Impact of abattoir waste on water quality and public health around slaughterhouses in Jos Metropolis, Plateau State, Nigeria. Journal of Science Research and Review. 1(1)87-96. Doi10.70882/josar.2024.vlil.18.

Benson, D. & Jordan, A. (2017). Environmental governance: The International Encyclopedia of Geography. Doi:10.1002/9781118786352wbeg0631.

Chukwuma, E.C., Okafor, G. & Abdul Rasheed. (2021). Fuzzy-based risk assessment of abattoir operation and treatment facility. A case study of Onitsha North and South LGAs, Anambra State, Nigeria. Elsevier journal of food and bio-product processing. Doi: 10.1016/j.fbp.2019.10.012.

Elenwo, E. I. (2010). Socio-economic impact of the Greater Port Harcourt Development project on the residents of the affected area. *Open journal of social science 2015 No. 3 82-93. Doi. 10.4236/JSS2015/31010.*

Food and Agriculture Organisation (FAO,1991). Animal Production and Health Paper 91. Guidelines for slaughtering of meat, cutting, and other processing. ISBN92-5-1029210. FAO,1991.


Article DOI: 10.52589/AJENSR-G5G9PTF9
DOI URL: https://doi.org/10.52589/AJENSR-G5G9PTF9

Food and Agriculture Organisation (FAO,1985). Manual for Slaughtering of Small Ruminant in Developing Countries, Section 3-5. ISBN92-5-102271-2.FAO,1985.

Fearon, J., Mensah, S.B. & Boateng, V. (2014). Abattoir operation, waste generation and management in Tamale metropolis, Ghana: Case study of the Tamale Slaughterhouse. Journal of Public Health and Epidemiology,6(1),14-19. Doi:10-5897/JPHE2013.0574.

Federal Ministry of Environment of Nigeria: National Environmental Sanitation Policy (Regulation 2005). Policy guideline on market and abattoir sanitation. Section 6(4)1-13.

Francis, R.A. & Chadwick. (2013). Urban Ecosystem: Understanding the Human Environment, Routledge. ISBN 9780415698030.

Gali, A.U., Abdullahi, H.A., Umaru, G.A., Zailani, S.A., Adamu, S.G., Hamza, I.M. & Jibrin, M.S (2020). Assessment of operational facilities and sanitary practices in Zangon Shanu Abattoir, Sabon Gari Local Government Area, Kaduna State, Nigeria. Journal of Veterinary Medicine and Animal Health, 12(2),36-47. Doi: 10.5897/JVMAH.

Lawal, M.O., Obiniyi, A.A. and Junaidu, S. B. (2017), Fuzzy Logic Concept for Safety Driven Vehicular – Pedestrian Interaction. International Journal of Computer Application. (0975-8887). Vol. 167, No. 1. Doi: 10.5120/ijca2017914058.

Mehuru, K. Y. (2019). Environmental Implications of Abattoir Waste in Ethiopia. Research article on environmental analysis and ecology studies. ISSN 2578-0336. Doi:31031 IRAES 2019. Vol. 6 Issue 3.

Mor, S. & Ravindra K. (2023). Municipal solid waste landfills in lower- and middle-income countries: Environmental impacts, challenges and sustainable practices. process safety and environmental protection, 174, 510-530. Doi: 10: 1016/j.psep.2023.04.014.

Ogeleka Doris Forwe, Emegha Mildred, and Okiemien Felix (2021). Ecotoxicological Risk Assessment of Surface Water Receiving Abattoir Effluent. Science Journal of Chemistry. 9(1):14. Doi: 10.11648/j.sjs.20210901.13.

Omole, D. & Longe, E. (2008). An Assessment of the impact of abattoir effluents on River illo, Ota, Nigeria. journal of environmental science and technology. 1(2). Doi:10.3923/jest.2008.56.64.

Omotosho, O., Olalekan, J., Olalere, O. & Emikpe, B. (2016). Pig Slaughtering in Southwestern Nigeria: A peculiar animal welfare concern and public health. African Journal of Infectious Diseases. 10(2):146-153. Doi:10.21010/ajid. v10.2.11.

## APPENDIX

### Appendix 1

**Field Data Collection Form**

1. Impact of smoke ? --- ------ (a) Unnoticed (b)Negligible (c) Moderate d) Severe (e) Very severe.

2. Odour Impact ? ------ ------- (a) Unnoticed b)Negligible c) Moderate d) Severe e) Very severe.

3. Site Visual Quality ?-------- (a) Excellent ( b) good (c) Moderate (d) Bad (e) very Bad

4. Solid waste disposal method ?---- ( a) Waste Conversion-Excellent (b) Incinerator- good(c) off-site disposal - moderate (d)Burning- Bad(e) Burying/ littering- Very Bad

5 Liquid waste disposal method ? ---- (a) Waste Conversion- Excellent (b)Physical Evacuation good (c)Neutralization - oderate (d) Discharge- Bad (e) Ground infiltration Very Bad

6 Vulnerability to Flooding ?-----(a) No flooding- Unnoticed (b) Sporadic Flooding - Negligible (c) Seasonal Flooding- moderate(d)Constant Flooding - severe (e) Immediate\Continuous Flooding- Very severe.

7 Availability of abattoir facilities ? ----- (a) Excellent (b) good (c) moderate (d) Bad (e) Very bad.

8 Availability of Personal Protection Equipments ?--- a) Excellent b) good c) moderate (d) Bad e)Very Bad

9 Access to potable water supply ?-- (a) Excellent (b) good (c) moderate (d) Bad (e) Very Bad

10.Local acceptability ? ----- (a) Excellent (b) good (c) moderate (d) Bad e) Very bad

11 Level of Awareness?--- (a) Excellent (b) Good (c) moderate (d) Bad (e) Very Bad.

12 Availability of Regulatory body? ----(a) Actively Available b) Passively available c)Not Available (d) Not in Existence

**13** Attraction/ effect of pest and scavengers? --- (a) Unnoticed (b)Negligible (c) Moderate (d) Severe (e) Very severe.


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**Appendix 2: Table Showing Names of the Abattoir Locations and Geographical Coordinates**

| S/N | Code | Name of Abattoir Location | Geographical Coordinates |
|---|---|---|---|
| 1 | Wo | Woji Waterside Market Abattoir | 04°48'57" N, 07°03'00" E |
| 2 | El | Elelenwo Abattoir | 04°50'32" N, 07°04'13" E |
| 3 | Ez | Eliozu Market Abattoir | 04°51'37" N, 07°01'28" E |
| 4 | Rs 1 | Rumuokwurusi 1 Abattoir | 04°51'01" N, 07°03'39" E |
| 5 | Rk | Okoro/Odomanya Market Abattoir | 04°52'11" N, 06°59'57" E |
| 6 | Rh | Rumuagholu/Anya Waterside Abattoir | 04°52'59" N, 06°59'11" E |
| 7 | Rs 2 | Rumuokwurusi 2 Abattoir | 04°51'46" N, 07°03'38" E |
| 8 | Rd | Rumunduru/Ewhara Abattoir | 04°51'37" N, 07°01'27" E |
| 9 | Ir | Iriebe Abattoir | 04°52'07" N, 07°06'11" E |
| 10 | Ak | Akpajo Abattoir | 04°48'28" N, 07°05'58" E |
| 11 | Iw | Iwofe Abattoir | 04°48'28" N, 06°56'09" E |
| 12 | Cb | Choba River Waterside Abattoir | 04°53'46" N, 06°52'45" E |
| 13 | Og | Ogbogoro Abattoir | 04°50'08" N, 06°56'59" E |
| 14 | Ro | Rumuosi/Ekini Abattoir | 04°52'48" N, 06°56'41" E |
| 15 | Mb | Mgbuosimiri Waterside Abattoir | 04°48'05" N, 06°58'15" E |
| 16 | Al | Aluu Abattoir | 04°55'55" N, 06°50'19" E |
| 17 | Ru | Rumukpoku/SAS Road Abattoir | 04°53'45" N, 06°59'16" E |
| 18 | Mg | Mgbuoba/Mgbaraja Abattoir | 04°50'56" N, 06°57'32" E |
| 19 | Ep | Elipranwo/Aka Market Abattoir | 04°48'59" N, 06°56'50" E |
| 20 | Chk | Chokocho Abattoir | 04°59'38" N, 07°03'28" E |
| 21 | M3 | Mile 3 Market Abattoir | 04°48'23" N, 06°59'39" E |
| 22 | Oy 1 | Oyigbo 1 Abattoir | 04°53'09" N, 07°08'39" E |
| 23 | Oy 2 | Oyigbo 2 Abattoir | 04°52'37" N, 07°09'22" E |
| 24 | M1 | Mile 1 Emenike Abattoir | 04°47'08" N, 06°59'24" E |
| 25 | Ok | Okuruama Waterside Abattoir | 04°47'26" N, 07°03'17" E |
| 26 | Ig | Igwuruta Abattoir | 04°58'09" N, 07°02'03" E |
| 27 | Ei | Iluabuchi/Eagle Island Abattoir | 04°47'16" N, 06°59'06" E |
| 28 | OC | Ozuoba/Choba Abattoir | 04°53'18" N, 06°53'54" E |
| 29 | Ad 1 | Amadi Slaughter 1 | 04°48'09" N, 07°02'59" E |
| 30 | Ad 2 | Amadi Slaughter 2 | 04°48'06" N, 07°02'58" E |

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