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Comparative analysis of hazardous waste disposal at landfill sites in O.R. Tambo District Municipalities, South Africa

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Abstract

Waste management remains a significant environmental challenge, particularly with regard to hazardous waste, which poses considerable threats to public health and ecological systems. This research examines the types and volumes of hazardous waste disposed of at O.R. Tambo landfill sites. Data collection involved distributing 60 questionnaires to waste pickers, conducting direct observations, and systematically identifying, sorting, and weighing hazardous waste on a weekly basis over a six-week period. The results reveal a statistically significant difference in the type and amount of hazardous waste found in the two landfill sites. Medical waste was found to be more prevalent in Mthatha in comparison to Port St Johns, whereas electronic waste exhibited a significantly higher presence in Port St Johns relative to Mthatha. This study concludes that there are gaps in waste management practices in both local municipalities, particularly in the regulation and disposal of hazardous waste. Consequently, the research recommends implementing tougher regulations, utilizing technology for oversight, and ensuring corporate responsibility. These actions could help minimize environmental damage, safeguard public health, and adhere to international standards.

Keywords: Hazardous Waste; Landfill Sites; Municipalities; Environmental Challenges; Waste Pickers

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1. Introduction

The illegal disposal of hazardous waste poses a serious and growing global environmental and public health crisis. Although properly managed landfill sites are an essential part of waste management systems, they are often misused for the unlawful dumping of hazardous, corrosive, and reactive materials (Knežiček et al., 2023; Mane, 2020; Siddiqua et al., 2022). This practice, motivated by financial gain and insufficient enforcement measures, circumvents established methods for proper treatment and disposal. This results in a series of adverse effects on soil, water, and air quality. The unregulated discharge of harmful substances, including heavy metals, long-lasting organic pollutants, and carcinogens, from these concealed waste sources presents enduring dangers, including the contamination of groundwater supplies and the accumulation of toxins in nearby ecosystems. Additionally, hazardous waste in landfill sites poses risks, especially to vulnerable communities exposed to toxic materials (Anand et al., 2021; Ravina et al., 2020). For example, waste pickers frequently work without protective equipment largely due to cost constraints and lack of access or training (Akyen et al., 2025; Amosu & Tella, 2021; Dada et al., 2023; Yusuf et al., 2022) and encounter dangerous items like medical waste, industrial chemicals, and electronic scrap.

This research has explored the negative health impacts associated with living near waste disposal sites, highlighting an increased risk of congenital anomalies, respiratory illnesses, and various types of cancer (Fazzo et al., 2023; Gumede & Gumede, 2025). Nevertheless, there is a significant gap in scientific knowledge regarding the specific types and makeup of hazardous waste that is illegally dumped in general landfill sites. Most studies tend to concentrate on legacy sites or locations recognised for organised illegal dumping, rather than the covert activities taking place within approved facilities. This limitation complicates the development of effective prevention and remediation strategies.

This study seeks to address the knowledge gap regarding illegally disposed hazardous waste found in landfill sites. Through a systematic sampling strategy, we seek to quantify the types, volumes, and potential sources of these materials. The findings will provide essential evidence concerning the nature of this environmental crime. Ultimately, this research will contribute to the development of more effective and data-driven protocols for preventing the illegal disposal of hazardous waste, thereby mitigating its severe and widespread threats to environmental sustainability and public health.

2. Materials and methods

2.1. Study area

This study was conducted in two local municipalities of O.R. Tambo District Municipality, Eastern Cape, South Africa (Figure 1). The boundaries of the O.R. Tambo district are delineated by KwaZulu-Natal and the districts of Amatole, Chris Hani, Ukhahlamba, and Alfred Nzo (Nkamisa et al., 2022). The geographical coordinates defining the O.R. Tambo District Municipality are 32°46’31’’ S and 21°23’29’’ E (Mlanjeni, 2014; Nkamisa et al., 2022). The O.R. Tambo District Municipality is notable for its rich natural resources and fertile agricultural

land, establishing it as one of the most agriculturally productive areas in South Africa. Moreover, O.R. Tambo constitutes one of the Eastern Cape's four Integrated Rural Development Programme (ISRDP) nodes. The O.R. Tambo region encompasses moderate and high precipitation zones, primarily along its sub-tropical coastline and isolated mountainous terrains (Nkamisa et al., 2022).

The ORTDM ranks as the second most populous district in the Eastern Cape, following Amatole, contributing to 26.2% of the provincial population. However, it occupies only 9.52% of the province's land area, making it one of the most densely populated districts, with an approximate density of 108 individuals per square kilometer, second only to the metropolitan area. Despite its considerable population, the urbanisation rate remains low at 9.24%. O.R. Tambo is designated as one of the most destitute districts in South Africa (Ngumbela et al., 2020).

The O.R. Tambo District Municipality faces considerable difficulties in waste management, characterised by insufficient waste disposal practices and unlicensed landfill sites. Out of the eleven operational landfill sites, only four are equipped with the necessary licenses, specifically: Ingquza Hill Local Municipality (Flagstaff and Lusikisiki), Nyandeni Local Municipality (Libode and Ngqeleni), and King Sabatha Dalindyebo Local Municipality (Mthatha). Despite their existence, the problem of illegal dumping remains an ongoing issue. Although the district has formulated an Integrated Waste Management Plan (IWMP) to promote sustainable development and enhance service delivery, waste management has historically been given lower priority, resulting in systemic inefficiencies. The responsibility for managing leachate arising from landfill sites is delegated to local municipalities; however, Port St Johns Local Municipality is the only entity that actively engages in the monitoring and testing of its landfill leachate, as recorded in the IDP for the years 2017-2022 of the O.R. Tambo District Municipality.

2.2. Data collection

This research utilised both primary and secondary methods to gather data on the management of hazardous waste at landfill sites in Mthatha and Port St. Johns. The primary data collection techniques included systematic sorting and weighing, direct observations, photographic documentation, structured interviews, and questionnaire surveys. The researcher conducted weekly visits to the landfill sites for six weeks (July- August) to identify, sort, and measure the hazardous waste present. To avoid duplication, the researcher, in collaboration with landfill personnel, made sure that the waste was sorted, weighed, and stored separately throughout the study. In Mthatha, the waste is promptly covered with soil using a bulldozer. The systematic sorting and weighing provided firsthand information on the types and quantities of hazardous waste, which facilitated objective classification and comparative analysis. A calibrated weighing scale was used to quantify the waste, thereby ensuring precision. Photographs acted as visual corroboration, substantiating observational findings and augmenting the study's credibility. The visual representations also facilitated discourse with stakeholders, including policymakers and waste management authorities, regarding regulatory and legal implications.

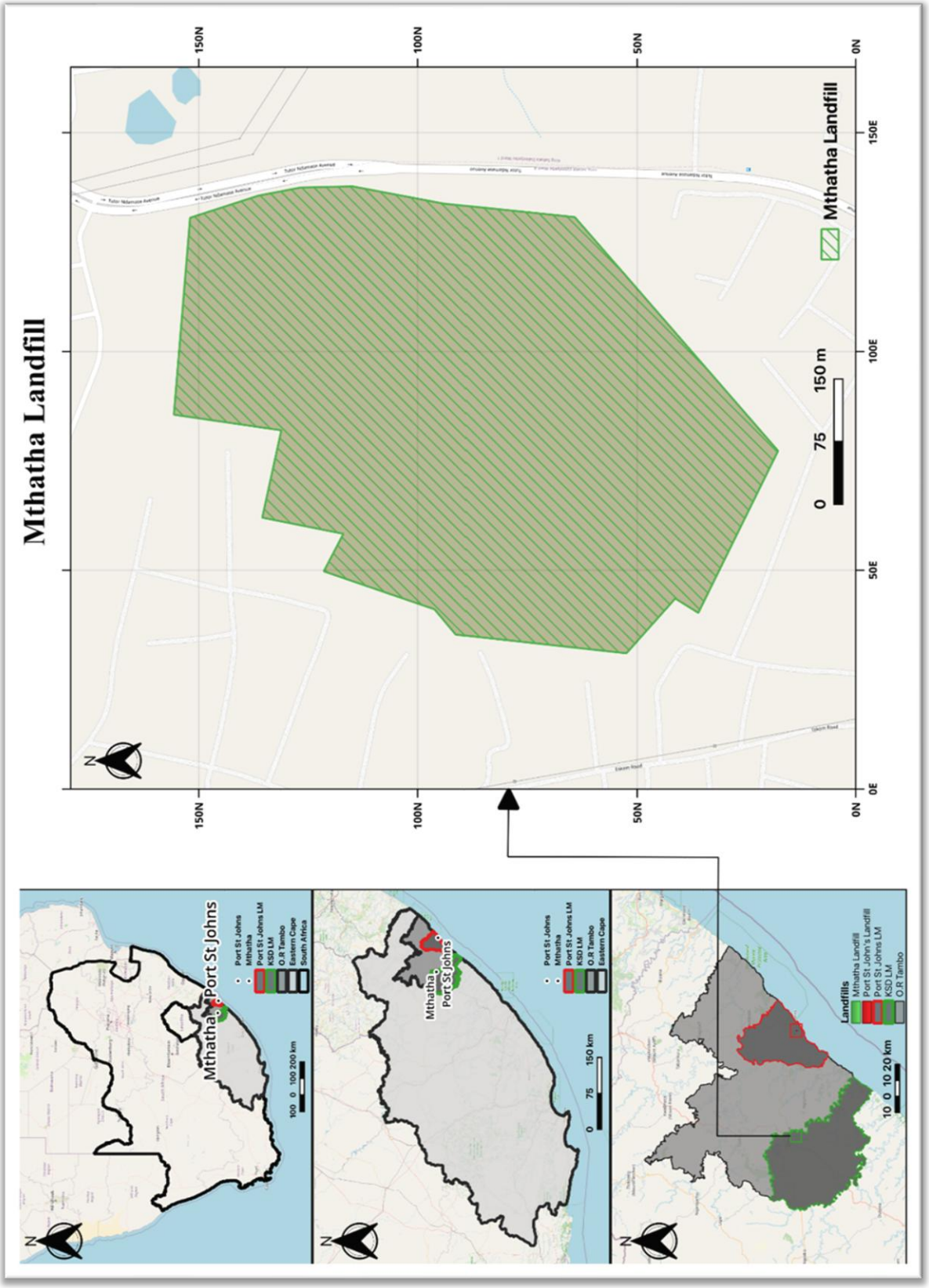


Figure 1. Map showing the location of KSD local Municipality and Port St Johns local municipality – (a) Mathatha Landfill (Source: Author's creation)

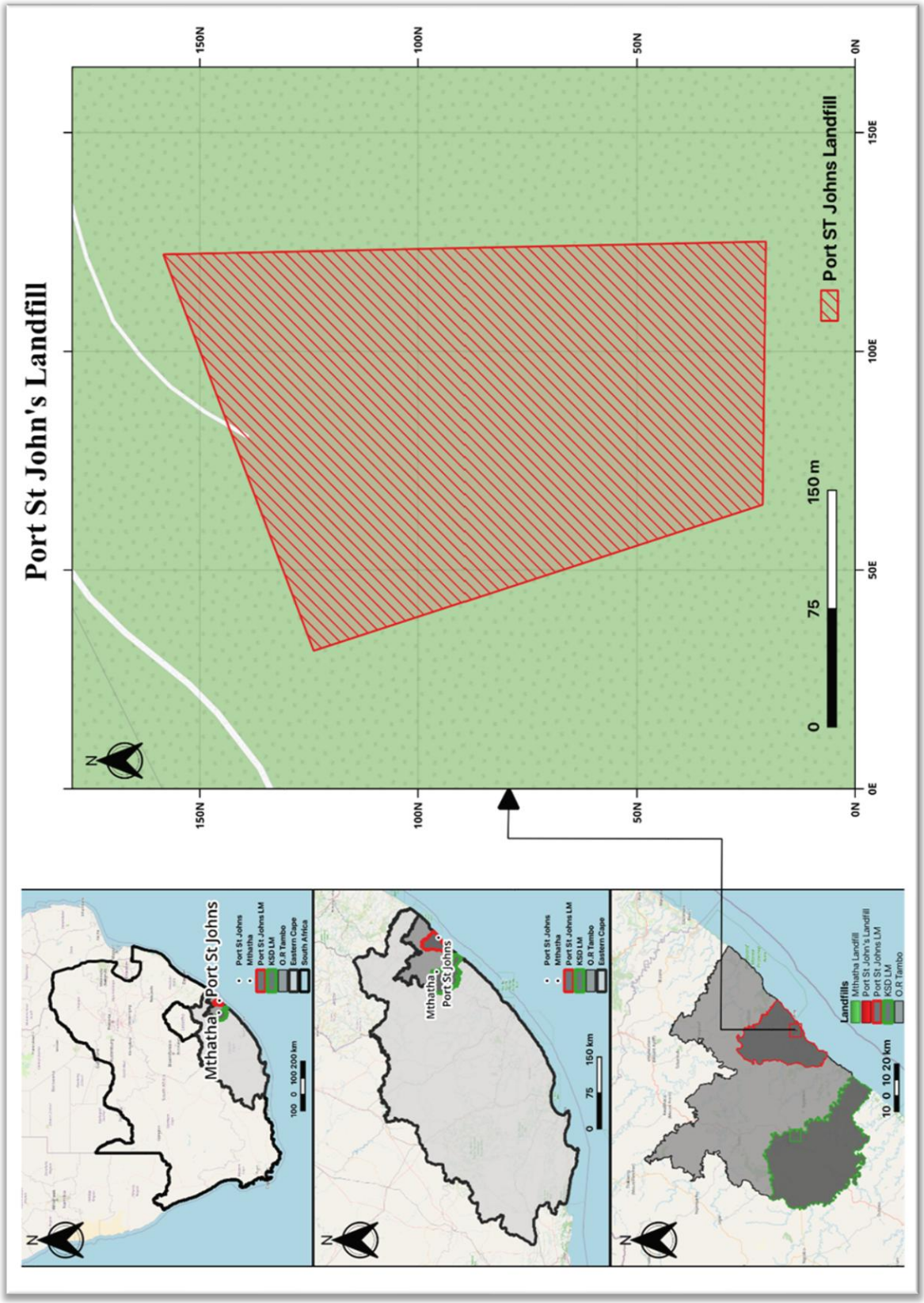


Figure 2. Map showing the location of KSD local Municipality and Port St Johns local municipality – (b) Port St Johns' location (Source: Author's creation)

A total of 60 questionnaires (30 in Mthatha and 30 in Port St. Johns) were self-administered to solid waste pickers at landfill sites. The questionnaire, comprising both open-ended and closed-ended questions, was a pivotal component in understanding the impact of hazardous waste disposal on waste pickers and assessing levels of awareness and compliance. The on-site execution of data collection ensured the validity of responses while maintaining ethical considerations through the obtaining of informed consent. The survey was systematically conducted in phases across both localities to ensure uniformity. Furthermore, structured interviews with municipal authorities yielded expert perspectives on hazardous waste management practices, compliance status, and challenges related to enforcement. These interviews addressed critical research objectives, facilitating a nuanced comparison of waste management practices between Mthatha and Port St Johns. The discussions covered topics such as unlawful waste disposal, strategies for prevention and detection, as well as the repercussions, challenges, and systemic issues encountered by municipalities.

2.3. Data analysis

Research data analysis constitutes a methodological process that researchers employ to distill data into a coherent narrative and interpret it to extract insights. The data analysis procedure helps distil extensive datasets into more manageable components. Data can be leveraged to address inquiries and bolster decision-making in various ways. Identifying the most effective approach to analyse one's data can enhance understanding of the four categories of data analysis: descriptive, diagnostic, prescriptive, and predictive (Akshara & Jain, 2024; Gudivada, 2017).

Descriptive analysis encapsulated and presented data accrued through direct observation, visual evidence, and questionnaires. The study rendered a comprehensive overview of the nature and magnitude of illegal hazardous waste disposal by categorising diverse types of hazardous waste (e.g., medical waste, E-waste, aerosols, and tires). This methodology also illuminated waste management practices, compliance rates, and deficiencies in landfill management. Diagnostic analysis within this study was pivotal in identifying the underlying causes of illegal hazardous waste disposal and evaluating the efficacy of waste management practices. It facilitated the revelation of inefficiencies in landfill operations, deficiencies in regulatory enforcement, and factors contributing to non-compliance. By scrutinising waste types, quantities, and regulatory inadequacies, the study ascertained whether the issues originated from inadequate infrastructure, feeble enforcement, or a lack of awareness. This approach yielded insights into the motivations behind hazardous waste mismanagement and informed evidence-based recommendations for enhancing compliance and mitigating illegal dumping.

The research employed thematic analysis to discern principal patterns in hazardous waste management strategies, waste categorization, and compliance levels in Mthatha and Port St Johns. This analytical technique enabled the researcher to organize qualitative data into significant themes, highlighting prevalent challenges, regulatory deficiencies, and trends in waste disposal practices. Through a systematic examination of responses, observations, and photographic documentation, the investigation furnished a coherent understanding of hazardous waste dilemmas, thereby allowing for a more precise interpretation of the data and bolstering the formulation of targeted recommendations to enhance waste management protocols and compliance adherence.

To address quantitative data analysis, the study employed the Chi-Square test to compare the frequency of hazardous waste between the two landfill sites. The test assessed whether a statistically significant disparity existed between the two sites by quantifying the frequency of various hazardous waste classifications. The null hypothesis posited that no significant difference was present in the frequency of hazardous waste between the sites, whereas the alternative hypothesis proposed a discernible variation. This analytical approach yielded empirical evidence to substantiate conclusions regarding waste patterns and management inconsistencies between the two locales.

3. Results

The Pearson Chi-square test (X^2 = 63.082, df = 3, p = 0.001) confirms a statistically significant difference in the types of hazardous waste disposed of between the Mthatha and Port St Johns landfill sites. Consequently, the study rejects the null hypothesis, which states that there is no significant association between the amount and type of hazardous waste present at the landfill sites in Mthatha and Port St Johns. Instead, it accepts the alternate hypothesis, which states that there is a significant association between the amount and type of hazardous waste present at the landfill sites in Mthatha and Port St Johns.

The research found that the actual amount of medical waste in Mthatha (33) exceeds the expected amount (21.6), resulting in a positive residual of 11.4. In contrast, the observed count in Port St Johns is 14, while the expected count is 25.4, resulting in a negative residual of -11.4. The study on electronic waste shows that in Mthatha, the expected count is 28, with an actual count of 7, resulting in a negative residual of -21. The discrepancy between the expected and actual counts is likely due to factors such as data collection methods, sample size, and other variables. In Port St. Johns, the observed count for e-waste is 54, while the expected count is 33, resulting in a positive residual of 21. In this case, the expected count is 33, not 3.7. Regarding aerosols, Mthatha has an observed count of 2, and Port St Johns has 4, with expected counts of 2.8 and 3.2, respectively. The standardized residuals are -0.5 for Mthatha and 0.4 for Port St Johns. Lastly, for tires, Mthatha exhibits a higher count of 19, which is expected to be 8.7, with a strong positive residual of 3.5. Conversely, Port St Johns has no tires at its landfill, despite an expected count of 10.3, resulting in a negative residual of -3.2 (refer to Table 1 for details).

The results of the study indicate that medical waste accounts for 36.26% of the overall hazardous waste at the Port St Johns landfill and 33.33% of the total hazardous waste at the Mthatha landfill. Electronic waste is the most prevalent type of hazardous waste found at the Port St. Johns landfill site, making up 59.34% of the total. In comparison, electronic waste accounts for 16.67% of the hazardous waste in the Mthatha landfill site. Additionally, aerosols represent 4.396% of the overall hazardous waste in Port St. Johns, while in Mthatha, they account for 4.762%. Lastly, tires comprise 45.24% of the hazardous waste found at the Mthatha landfill site, whereas no tires were found at the Port St. Johns site.

The research reveals significant socio-economic difficulties that waste pickers encounter at landfill sites, noting that most waste pickers are women (76.7%), while men make up 23.3%. The respondents come from large families, with 60% having between 6 to 10 members, indicating a high dependency ratio. Notably, female respondents, especially those aged 35-50, constitute the largest group of unemployed individuals, reflecting that many women are responsible for supporting their families. Furthermore, the study reveals that 93.33%

of participants have never received Personal Protective Equipment (PPE) from local authorities. Waste segregation and sorting are identified as crucial practices in waste management at landfill sites.

Table 1. Crosstabulation of hazardous waste types identified, collected, and weighed in Mthatha and Port St Johns landfill sites.

Hazardous Waste Type		Mthatha	Port St Johns	Total
Medical waste	Count	33	14	47
	Expected Count	21.6	35.4	47.0
	% within the Waste type	70.2%	29.8%	100%
	% of Total	**24.8%**	**10.5%**	**35.3%**
	Standardized Residual	2.5	-2.3	
E-waste	Count	7	54	61
	Expected Count	28.0	33.0	61.0
	% within the Waste type	11.5%	88.5%	100%
	% of Total	**5.3%**	**40.6%**	**45.9%**
	Standardized Residual	-4.0	3.7	
Aerosols	Count	2	4	6
	Expected Count	2.8	3.2	6.0
	% within the Waste type	33.3%	66.7%	100%
	% of Total	**1.5%**	**3.0%**	**4.5%**
	Standardized Residual	-.5	.4	
Tires	Count	19	0	19
	Expected Count	8.7	10.3	19.0
	% within the Waste type	100%	0.0%	100%
	% of Total	**14.3%**	**0.0%**	**14.3%**
	Standardized Residual	3.5	-3.2	
Total	Count	61	72	133
	Expected Count	61.0	72.0	133.0
	% within the Waste type	45.9%	54.1%	100%
	% of Total	**45.9%**	**54.1%**	**100%**

4. Discussion

4.1. Characterisation of illegally disposed hazardous waste

The study shows that both landfill sites examined contain hazardous waste. However, the Mthatha landfill site had a notably greater amount of medical waste than the Port St Johns landfill site. This disparity may be attributed to the greater number of healthcare facilities in Mthatha, which include two public hospitals, three private hospitals, and several private clinics, whereas Port St Johns has only one public hospital. The presence of numerous healthcare facilities contributes to the generation of significant medical waste, which ultimately ends up in landfill sites. Hazardous waste can end up in landfills when regulations are weak or not properly enforced (Walters & Loureiro, 2020). Additionally, the Mthatha landfill site reported more waste tires than the

Port St Johns landfill site. This discrepancy might be due to Mthatha's status as the economic hub of the O.R. Tambo region, which attracts numerous auto mechanics who may illegally discard their unusable tires to save money. Furthermore, population density plays a crucial role in waste production. Specifically, a greater population substantially impacts the amount of waste generated, as waste production tends to increase with population size (Rusni, 2025; Voukkali et al., 2023). Thus, the high levels of hazardous waste in Mthatha can be attributed to its larger population, which leads to increased demand for medical services and, consequently, a rise in waste output from healthcare facilities. In contrast, Port St Johns had a notably greater quantity of electronic waste (e-waste) than Mthatha. The higher levels of e-waste at the Port St. Johns landfill can be attributed to the fact that waste pickers in Mthatha are actively gathering e-waste to sell, whereas those in Port St. Johns primarily concentrate on collecting paper and cardboard. The increased focus on e-waste in Mthatha is likely due to a more accessible market for metal waste in that area compared to Port St Johns. Lastly, the results indicate that the aerosols are evenly distributed across the two landfill sites examined. This balanced distribution between Mthatha and Port St Johns implies that the primary sources of these aerosols are likely domestic and common household products rather than industrial activities. Given the common use of items such as deodorants, insecticides, and cleaning sprays in both areas, their disposal patterns appear to be similar.

4.2. Risk and vulnerabilities of hazardous waste to waste pickers

The unlawful disposal of medical waste at landfill sites presents serious health effects to waste pickers. Workers, who often lack proper protective gear, face numerous risks associated with the mishandling of medical waste. Medical waste often contains potentially hazardous substances (PHS), including arsenic, cadmium, lead, and mercury. These toxic elements, present in items such as plastics, syringes, and various medical supplies, can cause environmental harm if disposed of improperly, posing a threat to the health of waste collectors (Bolan et al., 2023). Waste pickers face a significant risk of developing infections due to improperly disposed medical waste, including hepatitis, tuberculosis, and skin infections (Geyer & van Lille, 2024; Khan & Raza, 2011; Omokaro et al., 2024; Oyedele & Oyedele, 2017). This risk arises from contact with harmful substances found in medical waste, which can result in respiratory problems, gastrointestinal illnesses, and other serious health complications (Fulwani et al., 2024).

The study reveals significant challenges in managing hazardous waste at the investigated landfill sites, particularly in terms of non-compliance with health and safety regulations. A major finding is that landfill personnel lack awareness about hazardous waste disposal and handling procedures. Approximately 76.7% of respondents reported being unfamiliar with these essential practices. The low awareness, combined with a widespread lack of access to personal protective equipment (PPE), with 92% of workers inadequately equipped, poses serious health and safety risks. Furthermore, the open burning of waste at these sites exacerbates health hazards by exposing workers to harmful fumes and pollutants. These findings align with a study conducted among individuals aged 15 to 40 in Nigeria, South Africa, and Kenya, indicating that Nigeria and several other African nations struggle with low awareness regarding hazardous waste management (Akpan & Olukanni, 2020). The study highlights the urgent need for comprehensive training and awareness programs for landfill personnel, as well as the provision of appropriate safety equipment, to reduce occupational health risks. It also underlines significant deficiencies in landfill operations, including inadequate staffing, insufficient infrastructure, and non-compliance with relevant environmental legislation. Similarly, a 2016 study conducted by the eThekwini Municipality noted that local municipalities face challenges related to

a lack of infrastructure and manpower, particularly in the waste management sector. As a result, municipalities are unable to effectively provide waste management services to all areas.

This study found that more than 53% of waste pickers do not have the necessary authorisation for their work. This issue is linked to insufficient access control at landfill sites, as well as problems such as damaged fencing, among other reasons. For instance, the Mthatha landfill site has many unauthorised entry points due to vandalised fences. The lack of proper access control, combined with a damaged fence, exacerbates waste management problems by allowing unauthorised access, which contributes to increased illegal dumping and further complicates the already challenging task of managing solid waste in landfill sites (Owusu-Sekyere, 2020).

The study observed open waste burning at the Mthatha landfill site, which presents considerable health risks. Waste pickers burn electric sockets to extract the copper for sale to metal waste recyclers. Fires at landfill sites pose an immediate and long-lasting danger to human health. They can lead to respiratory issues and skin problems and may even result in more severe health consequences, including cancer (Jakhar et al., 2023). The study also found that these landfill sites face operational challenges, including a lack of yellow plants for covering waste. As a result, the waste remains uncovered for more than a week without being compacted and covered with a layer of soil, which leads to further health concerns. Such a situation contravenes the Environmental Conservation Act (ECA) (Act No. 73 of 1989). The operational difficulties in these landfill sites stem from financial limitations. For instance, equipment is available at the Mthatha landfill site, but it frequently remains non-operational due to fuel shortages resulting from an inadequate budget.

5. Conclusion

The research discovered a notable difference in the types of hazardous waste found between the Mthatha and Port St Johns landfill sites. Consequently, the study rejects the null hypothesis and supports the alternative hypothesis, confirming that there is a significant difference in both the type and quantity of hazardous waste found in these landfill sites. The Mthatha landfill site had notably larger quantities of medical waste and tires, while the Port St Johns site exhibited a considerably greater amount of e-waste. Conversely, there was no significant difference in the amount of aerosols found between the two landfill sites.

The research highlights the influence of population size and healthcare facilities on the generation of hazardous waste at the Mthatha and Port St Johns landfill sites. Mthatha, with its larger population and improved medical services, produces higher amounts of medical waste and tires compared to Port St Johns, which has fewer healthcare resources. These results emphasise the need for customised waste management strategies that address variations in population and healthcare capabilities to improve disposal methods. The study found that compliance with hazardous waste management regulations was largely inadequate, with many waste management practices failing to meet national standards. Structured interviews with local authorities indicated a significant need for better monitoring, enforcement, and education on hazardous waste management. To address the unlawful dumping of hazardous waste in landfills and enhance hazardous waste management, there is a need for more rigorous enforcement, improved monitoring, and harsher penalties within the legal framework for waste disposal. Additionally, the hazardous waste crisis necessitates a technology-based monitoring system that incorporates accountability measures, including the installation of high-resolution cameras equipped with deep learning algorithms to automatically identify suspicious activities,

such as trucks transporting and unloading hazardous waste. The study also recommends implementing regular mandatory on-site inspections and audits of waste loads, particularly from high-risk industries, conducted by landfill operators, along with unannounced audit programs by environmental authorities. Such interventions can help minimise environmental damage, safeguard public health, and adhere to global best practices

Conflict of interest

The authors declare that they have no conflict of interest.

Data availability

All information used in the study is included in this article.

Consent to participate

All participants provided informed consent prior to the collection of data.

Ethics approval

The study was approved by the Faculty of Natural Sciences Research Ethics Committee.

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References

Akpan, V.E. and Olukanni, D.O. (2020), "Hazardous waste management: An African overview", *Recycling,* Vol. 5 No. 3, p. 15. https://doi.org/10.3390/recycling5030015

Akshara, R. and Jain, A. (2024), "Data to decisions: Optimizing e-commerce sales potential with analytics", *International Research Journal on Advanced Engineering Hub,* Vol. 2 No. 4, 1087-1093. https://doi.org/10.47392/IRJAEH.2024.0150

Akyen, D., Agyemang, E. and Forkuor, J. (2025), "Determinants of Occupational Health and Safety Practices of Informal Waste Pickers", *International Journal of Occupational Safety and Ergonomics*, Vol. 31 No. 12, pp. 486-493. https://doi.org/10.1080/10803548.2025.2452753

Amosu, A. and Tella, A. (2021), "An assessment of perception of waste-pickers and risk-protective behaviour from selected dumpsites in Ogun State Nigeria", *Open Journal of Environmental Research,* Vol. 2 No. 2, pp. 47-57. https://doi.org/10.52417/ojer.v2i2.266

Anand, U., Reddy, B., Singh, V., Singh, A., Kesari, K., Tripathi, P., Kumar, P., Tripathi, V. and Simal-Gándara, J. (2021), "Potential Environmental and Human Health Risks Caused by Antibiotic-Resistant Bacteria (ARB), Antibiotic Resistance Genes (ARGs) and Emerging Contaminants (ECs) from Municipal Solid Waste (MSW) Landfill", *Antibiotics*, Vol. 10 No. 4, pp. 1-27. https://doi.org/10.3390/antibiotics10040374

Bolan, S., Padhye, L., Kumar, M., Antoniadis, V., Sridharan, S., Tang, Y., Singh, N., Hewawasam, C., Vithanage, M., Singh, L., Rinklebe, J., Song, H., Siddique, K., Kirkham, M., Wang, H. and Bolan, N. (2023), "Review on distribution, fate, and management of potentially toxic elements in incinerated medical wastes", *Environmental pollution*, Vol. 321, pp. 1-18. https://doi.org/10.1016/j.envpol.2023.121080

Dada, O., Faniran, G., Ojo, D. and Taiwo, A. (2023), "Waste pickers' perception of occupational hazards and well-being in a Nigerian megacity", *International Journal of Environmental Studies*, Vol. 80 No. 4, pp. 933-947. https://doi.org/10.1080/00207233.2022.2055344

Fazzo, L., Manno, V., Iavarone, I., Minelli, G.D.E., Santis, M., Beccaloni, E., Scaini, F., Miotto, E., Airoma, D. and Comba, P. (2023), "The health impact of hazardous waste landfills and illegal dumps contaminated sites: An epidemiological study at ecological level in Italian Region", *Frontiers in Public Health,* Vol. 11**,** pp. 1-18. https://doi.org/10.3389/fpubh.2023.996960

Fulwani, D., Gupta, S.K., Chandel, P. and Chandel, D. (2024), "Biomonitoring of Serum Markers as a Measurement of Occupational Exposure in Personnel at Landfill Site", *Toxicology International*, Vol. 31 No. 3, pp. 457-465. https://doi.org/10.18311/ti/2024/v31i3/35803

Geyer, H.S. and van Lille, G. (2024), "The medicalisation of solid waste: Coordination challenges of domestic biomedical risk waste in illegal dumping sites in informal settlements in Cape Town", *Habitat International*, Vol. 146, pp. 1-10. https://doi.org/10.1016/j.habitatint.2024.103042

Gudivada, V. N. (2017). "Data analytics: fundamentals", In: Chowdhury, M., Apon, A. and Dey, K. (Ed.s), *Data analytics for intelligent transportation systems*, Elsevier, pp. 31-67. https://doi.org/10.1016/B978-0-12-809715-1.00002-X

Gumede, P.R, and Gumede, D. (2025), "Air quality, and health risks of residents living near a landfill site in Durban, South Africa", *Journal of Public Health Africa*. Vol. 16 No 1. https://doi.org/10.4102/jphia.v16i1.1274

Jakhar, R., Samek, L. and Styszko, K. (2023), "A Comprehensive Study of the Impact of Waste Fires on the Environment and Health", *Sustainability*, Vol. 15 No. 19, p. 14241. https://doi.org/10.3390/su151914241

Knežiček, T., Osmanović, D. and Sinanović Ćatibušić, S. (2023), "Locally characterised repetitive illegal landfills classification", *Journal of Faculty of Mining, Geology and Civil Engineering*. https://doi.org/10.51558/2303-5161.2023.11.11.1

Khan, M.R. and Raza, Z. (2011), "Socio-Economic Impact of Improper Hospital Waste Management on Waste Disposal Employees", *Pakistan Journal of Medical Research*, Vol. 50, No. 4, pp 130-132.

Mane, M. (2020), "A study on the illegal waste dumping influences on the environment", *Journal of the Gujarat Research Society*, Vol. 22 No 1, pp. 148–153.

Mlanjeni, N.L. (2014), "Identification and documentation of ethnobiological methods used by rural farmers to control stalk borers on maize in the Eastern Cape province of South Africa", Masters thesis, University of Fort Hare, Alice.

Ngumbela, X.G., Khalema, E.N. and Nzimakwe, T.I. (2020), "Local worlds: Vulnerability and food insecurity in the Eastern Cape province of South Africa", *Jàmbá: Journal of Disaster Risk Studies,* Vol. 12 No. 1. https://doi.org/10.4102/jamba.v12i1.830

Nkamisa, M., Ndhleve, S., Nakin, V.M., Mngeni, A. and Kabiti, H.M. (2022), "Analysis of trends, recurrences, severity and frequency of droughts using standardised precipitation index: Case of OR Tambo District Municipality, Eastern Cape, South Africa", *Jàmbá: Journal of Disaster Risk Studies,* Vol. 14 No. 1. https://doi.org/10.4102/jamba.v14i1.1147

Omokaro, G.O., Michael, I. and Evgenievich, P.V. (2024), "Assessing the Environmental and Health Implications of Waste Disposal: A Case Study of Africa's Largest Dumping Site", *Journal of Geography, Environment and Earth Science International*, Vol. 28 No. 5, pp. 16-30. https://doi.org/10.9734/jgeesi/2024/v28i5767

Owusu-Sekyere, E. (2020), "Altered urban landscape: Shedding light on conflicts in a landfill community in Ghana", *African Journal of Science, Technology, Innovation and Development*, Vol. 14 No. 1, pp. 1-10. https://doi.org/10.1080/20421338.2020.1811928

Oyedele, O.A. and Oyedele, A.O. (2017), "Impacts of Waste Dumps on the Health of Neighbours: A Case Study of Olusosun Waste Dump, Ojota, Lagos State, Nigeria", *Journal of Civil, Construction and Environmental Engineering*, Vol. 2 No.1, pp. 27-33.

Ravina, M., Facelli, A. and Zanetti, M. (2020), "Halocarbon Emissions from Hazardous Waste Landfills: Analysis of Sources and Risks", *Atmosphere*, Vol. 11 No. 4, p. 375. https://doi.org/10.3390/atmos11040375

Rusni, N. (2025), "Spatial planning based on urban waste-generating: A streetscape design perspective", *Journal of Placemaking and Streetscape Design*, Vol. 2 No. 2. https://doi.org/10.61511/jpstd.v2i2.2025.1133

Siddiqua, A., Hahladakis, J. and Al-Attiya, W. (2022), "An overview of the environmental pollution and health effects associated with waste landfilling and open dumping", *Environmental Science and Pollution Research International*, Vol. 29, 58514-58536. https://doi.org/10.1007/s11356-022-21578-z

Walters, R. and Loureiro, M. (2020), "Waste Crime and the Global Transference of Hazardous Substances: A Southern Green Perspective", *Critical Criminology*, Vol. 28, pp. 463-480. https://doi.org/10.1007/s10612-020-09522-4

Voukkali, I., Papamichael, I., Loizia, P. and Zorpas, A. (2023), "Urbanization and solid waste production: prospects and challenges", *Environmental Science and Pollution Research*, Vol. 31, pp. 17678-17689. https://doi.org/10.1007/s11356-023-27670-2

Yusuf, F., Ali, A. and Buba, L. (2022), "Waste-pickers' knowledge of occupational hazards and utilisation of personal protective equipment: A case study of Bauchi City, Nigeria", *Dutse Journal of Pure and Applied Sciences*, Vol. 8 No. 1b, pp. 58-68. https://doi.org/10.4314/dujopas.v8i1b.8