

Assessment of Current E-Waste Management Practices among Hotels in Naivasha Sub-County, Kenya

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ABSTRACT

The rapid growth of electrical and electronic waste (e-waste) has become a major environmental and public health concern, particularly in developing countries where inadequate recycling infrastructure and weak institutional capacity constrain sustainable management. Despite the hospitality industry's intensive use and frequent replacement of electrical and electronic equipment, empirical evidence on e-waste management practices among hotels in Sub-Saharan Africa remains limited. This study therefore assessed current e-waste management practices among classified hotels in Naivasha Sub-County, Kenya. An explanatory sequential mixed-methods design was employed, involving 69 stratified, randomly selected hotels and five purposively selected key informants from relevant environmental, public health, tourism, and regulatory institutions. Quantitative data were analyzed using descriptive statistics, Pearson's correlation, hierarchical multiple regression, and analysis of variance (ANOVA), while qualitative data were analyzed thematically and integrated through triangulation. Repairing electrical and electronic equipment was the most commonly reported practice (95.7%), followed by storage within hotel premises (84.1%). Other practices included disposal with general waste (59.4%), selling to e-waste collectors (46.4%), reuse (44.9%), and selling to scrap dealers (42.0%). Less common practices were refurbishing (23.2%), storage outside hotel premises (11.6%), donation to third parties (10.1%), and recycling (7.2%); with none of the hotels reporting burning or incineration. Current management practices were moderately and positively correlated with effective e-waste management ($r = .520$, $p < .01$) but were not significant predictors in either of the regression models ($\beta = .045$, $p = .733$; $\beta = -.051$, $p = .624$). The final hierarchical regression model explained 69.6% of the variance in effective e-waste management ($R^2 = .696$; adjusted $R^2 = .672$; $F(5,63) = 28.843$, $p < .001$), demonstrating substantial explanatory power. Qualitative findings corroborated these results, characterizing hotel e-waste management as fragmented, reactive, and predominantly informal. The study concludes that individual operational practices alone are insufficient to achieve effective e-waste management. Strengthening recycling infrastructure, improving access to licensed recyclers, enhancing regulatory enforcement, building organizational capacity through targeted training, and providing economic incentives as well as hotels aligning their organizational sustainability policies and operational procedures with national regulatory requirements are necessary to promote systematic e-waste management and advance circular economy initiatives within the hospitality sector.

Key Words: E-Waste, E-Waste Generation, E-Waste Management, Barriers, Naivasha Sub-County

INTRODUCTION

Electrical and electronic waste (e-waste) is among the fastest-growing solid waste streams globally, driven by rapid technological advancement, increasing consumption of electrical and electronic equipment (EEE), shorter product lifecycles, and accelerated technological obsolescence (Parajuly et al., 2019; Forti et al., 2020). E-waste comprises discarded electrical and electronic equipment containing circuitry or battery-powered components that have reached the end of their useful life. Although it contains valuable recoverable materials such as gold, silver, copper, aluminium, nickel, palladium and zinc (Roy 2023), its improper disposal releases hazardous

substances such as lead, cadmium, mercury, and persistent organic pollutants, posing significant environmental and public health risks (Dias et al., 2022).

Global e-waste generation continues to increase at an estimated annual rate of 3–5% and is projected to exceed 120 million metric tonnes by 2050 (Liu et al., 2023). However, formal collection and recycling systems remain inadequate in many developing countries, where e-waste is commonly managed through open dumping alongside other wastes, uncontrolled burning, and informal recycling, leading to environmental contamination and inefficient resource recovery (Maes & Preston-Whyte, 2022). Consequently, strengthening e-waste management has become central to sustainable development and circular economy initiatives aimed at minimizing pollution while promoting resource efficiency (Murthy & Ramakrishna, 2022). The hospitality industry is an important yet understudied contributor to this challenge. Hotels rely extensively on electrical and electronic equipment for accommodation, food production, communication, security, lighting, climate control, and digital service delivery. Continuous technological upgrades, smart building systems, energy-efficient technologies, and periodic renovations have increased both the volume and diversity of hotel-generated e-waste (Reijnders, 2024; Vishwakarma et al., 2023). Although sustainable management strategies such as recycling, refurbishment, repair, and Extended Producer Responsibility (EPR) are increasingly promoted worldwide, their implementation remains constrained in many developing countries by inadequate recycling infrastructure, weak regulatory enforcement, limited technical capacity, low stakeholder awareness, and high disposal costs (Shahabuddin et al., 2023; Wirtu et al., 2025).

Kenya faces similar challenges. The country generates approximately 53,000 metric tonnes of e-waste annually, increasing at an estimated rate of 8–12%, yet only about 5% enters formal recycling systems (Mungai & Maina, 2025). Hotels contribute substantially to this waste stream through the continual replacement of computers, televisions, refrigeration systems, lighting equipment, communication devices, and other electronic infrastructure required for quality service delivery (Karemeri et al., 2024). However, existing studies in Kenya have primarily focused on general environmental management in hotels, including solid waste, wastewater, procurement, and food waste management (Osiako & Kummitha, 2020; Chiro et al., 2020; Odeny et al., 2020; Ndung'u & Magaju, 2024), while e-waste research has largely been confined to households, universities, and healthcare facilities (Kamweru, 2019); Kiplagat et al., 2017; Getonto et al., 2021). Consequently, little is known about the existing e-waste management practices within Kenya's hospitality sector.

Naivasha Sub-County, one of Kenya's leading tourism destinations, has experienced rapid expansion of hotels and tourism infrastructure, increasing the use of electronic equipment and the potential generation of e-waste. Understanding the current management practices is particularly important for promoting sustainable tourism and supporting the transition towards a circular economy through increased reuse, repair, refurbishment, and material recovery. Accordingly, this study evaluated the current e-waste management practices among classified hotels in Naivasha Sub-County, Kenya. The findings provide sector-specific empirical evidence to guide policy and regulatory interventions and promote environmentally sound and sustainable e-waste management within the hospitality industry.

METHODOLOGY

Study area

The study was conducted in Naivasha Sub-county, Nakuru County. The County, one of the 47 Counties in Kenya, bordering 8 other counties: Laikipia to the North-East, Kericho to the West, Narok to the South-West, Kajiado and Kiambu to the South-East, Baringo to the North, Nyandarua to the East and Bomet to the West, covers an area of 7,504Km². It is divided into 11 Sub-counties and 55 electoral wards, located between Longitudes 35.41° East or 35° 24' 36" East and 36.6° East or 36° 36' 0" East and Latitude 0.23° North or 0° 13' 48" North and 1.16° South or 1° 9' 36" South. Naivasha Sub-county, covering an area of 1,685Km², is divided into 8 electoral wards: Biashara, Maiella, Mai Mahiu, Viwandani, Hells Gate, Olkaria, Naivasha East and Lake View Wards (Mekolela et al., 2025). The Sub-county, bordering Gilgil Sub-county to the west, Narok County to the South-West, Kajiado, and Kiambu Counties to the South-East, and Nyandarua County to the East, with a population of 355,383 (KNBS, 2019), is the biggest in Nakuru County, both by size and population.

Economic Drivers of the Study area

The export of horticulture, tourism and hospitality, energy, and fisheries sectors are the leading economic drivers of the Naivasha Sub-county economy in that order, earning and employing significantly more than their national share, within Naivasha Sub-county (Mengich et al., 2025). The Sub-county had 102 classified hotels as of the year 2024, defined by accommodation, food and beverage services (TRA, 2024). The key socio-economic activities of Naivasha Sub-county include; Agriculture and Horticulture, Tourism, Livestock Farming, Trade and Commerce, and Real Estate development (CGoN, 2023). The upper reaches of the Sub-county are characterized by smallholder farming involving the cultivation of maize, beans, and vegetables, while the mid reaches comprises of mixed farming, with large scale livestock ranches, and farming enterprises, culminating to the lowlands dominated by horticulture farming, especially around Lake Naivasha to a radius of approximately 50Km² (Onyango *et al.*, 2023).

Population of the Study

The population of the study was all the classified hotels within Naivasha Sub-county, offering at least accommodation, food and beverage services. An exhaustive list of 102 hotels and their bed capacities was obtained from the Tourism Regulatory Authority (TRA), comprising of 34 hotels along Moi South Lake Road, 47 within Naivasha Town, 6 at Kinamba area, 4 each along North Lake Road, Nairobi – Nakuru Highway, and at the Police Line area, and 1 each at Karai, South Lake Junction, and Karagita areas (TRA, 2024). Upon scrutiny, 16 facilities were excluded because they were either temporary camping sites, seasonal utilities like Airbnb, had been double-listed, or were not operational at the time of the study due to various reasons, leaving a total of 86 hotels making up the target population.

Research design

This study adopted an explanatory sequential mixed-methods design in which quantitative data were collected and analyzed first, followed by qualitative data to explain, contextualize, and enrich the quantitative findings. The design enabled the integration of numerical trends with participants' perspectives, providing a more comprehensive understanding of the current e-waste management practices in hotels (Leavy, 2022). Quantitative methods established the magnitude and relationships among the study variables, while qualitative interviews explored the underlying institutional, technical, economic, and behavioral factors shaping these relationships. The findings from both phases were integrated through triangulation to enhance the validity, depth, and interpretation of the results (Manzoor, 2020).

Sample size determination

The study adopted proportionate stratified random sampling, for sample size determination. The 86 classified hotels were stratified into five categories based on 100% bed capacity as provided by NEMA in the Eleventh Schedule of the Environmental Management and Coordination (Water Quality) Regulations, 2024 (NEMA, 2024). These categories are; Category 1 (≤ 25 Persons Bed Capacity), Category 2 ($\geq 26 \leq 50$ Persons Bed Capacity), Category 3 ($\geq 51 \leq 75$ Persons Bed Capacity), Category 4 ($\geq 76 \leq 100$ Persons Bed Capacity), and Category 5 (≥ 101 Persons Bed Capacity).

The choice of bed capacity for stratification was based on the fact that it is a reliable indicator for hotel size, operational complexity, resource consumption, and the volume of electrical and electronic equipment used, hence the potential e-waste generation. This stratification was targeted towards ensuring that the sample adequately captures the diversity of hotels, and improves the representativeness and precision of the study findings. For the stratified sample size determination, the researcher applied the Cochran's formula (finite population version).

$$n_0 = \frac{z^2 p (1-p)}{e^2} \text{ where;}$$

Z = Z-Score (1.96 for 95% confidence level),

$p =$ Estimated proportion of the population with the characteristic (assumed 0.5 for maximum variability),

$e =$ Margin of error (0.05 for $\pm 5\%$ error),

$N =$ Total number of hotels in the population.

$$n_0 = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = \frac{3.8416 \times 0.25}{0.0025} = \frac{0.9604}{0.0025} = 384.16$$

The value obtained was then applied for the finite population N , which in this case was 86, to get the final sample size.

$$n = \frac{n_0}{1 + \left[\frac{(n_0 - 1)}{N} \right]}$$

$$n = \frac{384.16}{1 + \left[\frac{(384.16 - 1)}{86} \right]} = \frac{384.16}{1 + \frac{383.16}{86}} = \frac{384.16}{(1 + 4.455)} = \frac{384.16}{5.455} = 70.4 \text{ (Approx. 70)}$$

Sampling technique

After the sample size determination, proportionate allocation was applied across the five strata using the proportional allocation formula for stratified random sampling $n_h = (N_h/N) \times n$ within each stratum to select the participating hotels (Lohr, 2021), Where;

n_h = Sample size for stratum h ,

N_h = Population size of stratum h ,

N = Total population, and,

n = Total Sample Size calculated above.

The results obtained were as shown in table 1 below;

Table 1: Table of Stratified Sample Size

Hotel Category	Hotels in Population	Sample size (n_h)
1 (≤ 25 Persons Bed Capacity)	17	14
2 ($\geq 26 \leq 50$ Persons Bed Capacity)	26	21
3 ($\geq 51 \leq 75$ Persons Bed Capacity)	12	10
4 ($\geq 76 \leq 100$ Persons Bed Capacity)	16	13
5 (≥ 101 Persons Bed Capacity)	15	12
Total	86	70

The calculation and distribution of the sample across hotel categories therefore yielded a target sample size of approximately 70 hotels. However, during the sampling and participation process, 69 hotels were successfully selected and included in the final study sample, representing 80.2% of the total population of 86 classified hotels. The achieved sample was therefore only one hotel below the calculated target and retained approximately 98.6% of the statistically calculated sample requirement. Given the small difference between the calculated target and the achieved sample, the final sample of 69 hotels was considered adequate for the study.

The purposively selected sample of key informants was; One (1) National Environment Management Authority (NEMA) Officer, One (1) County Government Environment Officer, One (1) Public Health Officer, One (1)

Information and Communication Technology (ICT) Officer, and One (1) Tourism Regulatory Authority (TRA) Officer. The quantitative analysis was based on the 69 hotel respondents while the qualitative analysis involved responses from the 5 key informants.

Operationalization of Variables

Table 2 presents the variables as operationalized, the measuring indicators and the measurement units.

Table 2: Variables, Measuring Indicators and Measurement Scale/Unit

Variable	Measuring Indicators	Measurement Scale/Unit
Current e-waste management practices (Independent Variable)	Storage of e-waste within the hotel; disposal with general solid waste; sale to e-waste collectors; use of licensed e-waste recyclers	Frequency (Number and Percentage of responses)
Effective e-waste management (Dependent Variable)	Presence of a hotel e-waste management policy; e-waste segregation; use of licensed e-waste recyclers; participation in take-back programmes	Frequency (Number and Percentage of responses)
Regulatory frameworks and hotel sustainability practices (Intervening Variables)	Awareness of Extended Producer Responsibility (EPR) Regulations; establishment of e-waste collection, recycling, and disposal systems; environmentally friendly procurement; e-waste inventory and tracking; guest engagement; reuse and refurbishment of electrical and electronic equipment	Frequency (Number and Percentage of responses)

Data collection procedure

Data collection followed a structured and technology-assisted procedure to ensure accuracy, completeness, and consistency. The sampled hotels were geo-referenced and mapped using **ArcGIS**, enabling verification of their spatial distribution across the study area and facilitating GPS-assisted navigation during fieldwork. This approach minimized location errors and ensured that data were collected exclusively from the selected hotels.

Quantitative data were collected using a structured questionnaire developed and deployed through **KoBo Toolbox**, a secure mobile data collection platform that supports real-time data capture, automated validation, and encrypted data storage. The digital platform minimized data entry errors, improved response completeness, and enhanced the overall quality and integrity of the dataset. Questionnaires were administered to management-level staff in the sampled hotels by the principal researcher, with assistance from a trained research assistant where necessary. Prior to data collection, respondents were informed of the study objectives, procedures, and their rights as participants, after which written informed consent was obtained. Qualitative data were collected through semi-structured interviews with purposively selected key informants representing relevant environmental, public health, tourism, and regulatory institutions. Interview appointments were scheduled in advance, and all interviews were conducted by the principal researcher following informed consent. The quantitative and qualitative data collection phases were implemented sequentially in accordance with the explanatory sequential mixed-methods design.

Data Analysis and Presentation

Data analysis followed a rigorous mixed-methods approach consistent with explanatory sequential design. Quantitative data were analyzed using IBM SPSS Statistics. The analysis began with data cleaning, coding, and screening for completeness, outliers, and consistency. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize the prevalence of various e-waste management practices across classified hotels. Inferential analysis was conducted in stages, with Pearson's correlation analysis being used to determine the direction and strength of relationships between current management practices and effective e-waste management. Hierarchical multiple regression analysis was then employed to determine the predictive

power of the independent variables, entered in blocks to assess incremental explanatory contribution. The first model included operational variables (nature of e-waste generated, current management practices and barriers to effective e-waste management), while the second model introduced institutional and policy-related variables (regulatory frameworks and hotel sustainability policies). Model fit was evaluated using R^2 , adjusted R^2 , F-statistics, and analysis of variance (ANOVA), with statistical significance set at $p < 0.05$.

Qualitative data from key informant interviews were transcribed verbatim, coded inductively, and analyzed thematically. Emerging themes were categorized into institutional, technical, economic, and behavioral dimensions. Triangulation was applied to integrate quantitative and qualitative findings, enhancing validity and providing a more comprehensive explanation of observed statistical patterns. Data were presented using a structured combination of tables, figures, and narrative descriptions. Quantitative findings were organized into three main categories: descriptive statistics on current e-waste management practices; correlation analysis results, and hierarchical regression outputs. Tables were used to present frequencies and percentages of identified practices, while regression coefficients, significance levels, and model summaries were systematically reported to support inferential interpretation.

Sample, Response Rate and Reliability of the Research Instrument

A total of 102 classified hotels in Naivasha Sub-county, as of 2024, were identified from records held by the Tourism Regulatory Authority, together with their bed capacities and specific locations. Upon scrutiny, 16 facilities were excluded because they were temporary camping sites, seasonal utilities such as Airbnb listings, double-listed, or not operational at the time of the study, leaving a target population of 86 hotels. Using Cochran's formula (finite population version) for stratified sample size determination, the target sample size was set at 70 respondents at a 5% margin of error and 95% confidence level. A total of 69 management-level hotel staff and 5 key informants provided valid entries for quantitative and qualitative analysis respectively, representing an effective quantitative response rate of 98.6%, as summarized in Table 3.

Table 3: Response Rate of Administered Questionnaires

Administered questionnaires	Questionnaires filled and valid	Response rate (%)
70	69	98.6

Data were collected through face-to-face interviews using a structured questionnaire and a key informant interview guide, supported by a trained research assistant who guided respondents where necessary. Response rates above 80% are considered exceptional and required for publication purposes (Taherdoost & Madanchian, 2024). The 98.6% rate achieved in this study was therefore satisfactory and robust. Prior to analysis, diagnostic checks were performed to confirm the completeness, consistency, and suitability of the datasets for statistical processing. The data were screened for missing values, entry errors, and outliers, ensuring that only high-quality responses were subjected to descriptive and inferential analysis in SPSS (Izah et al., 2024). To further guarantee accuracy and reliability, the questionnaire was pretested and refined, with internal consistency confirmed by a Cronbach's Alpha coefficient, with the help of the IBM Statistical Package for Social Sciences (SPSS) on the questionnaire, through a pilot study, involving 10 hotel managers and 3 key informants. The Cronbach's alpha

was computed using the formula: $\alpha = \frac{k}{k-1} \left(1 - \frac{\sum \sigma_i^2}{\sigma_T^2} \right)$, where: k is the number of items, $\sum \sigma_i^2$ is the sum of the item variances, and σ_T^2 is the variance of the total scores. A value of 0.7 – 0.9, if obtained indicates acceptable internal consistency hence reliability of the instrument being tested. An alpha coefficient of 0.76 was achieved for this study, indicating acceptable internal consistency hence reliability of the questionnaire.

Descriptive Analysis of the Current E-waste Management Practices in Hotels

The study evaluated the existing e-waste management practices among hotels in Naivasha Sub-county. To gather information regarding the current e-waste management practices, the study looked at the prevalence of various e-waste management practices; reusing, repairing, refurbishing, recycling, donation to third parties, selling to e-

waste collectors, selling to scrap dealers, burning, disposal with general waste, incineration, storing within and without the hotel premises as presented in Table 4 and Figure 1.

Table 4: Current E-Waste Management Practices in Hotels

Current Management Practice	No		Yes	
	n	Percentage (%)	n	Percentage (%)
Repairing	3	4.3	66	95.7
Storing within the hotel	11	15.9	58	84.1
Disposal with general waste	28	40.6	41	59.4
Selling to e-waste collectors	37	53.6	32	46.4
Reusing	38	55.1	31	44.9
Selling to scrap dealers	40	58	29	42
Refurbishing	53	76.8	16	23.2
Storing outside the hotel premises	61	88.4	8	11.6
Donation to third parties	62	89.9	7	10.1
Recycling	64	92.8	5	7.2
Burning	69	100	0	0
Incineration	69	100	0	0

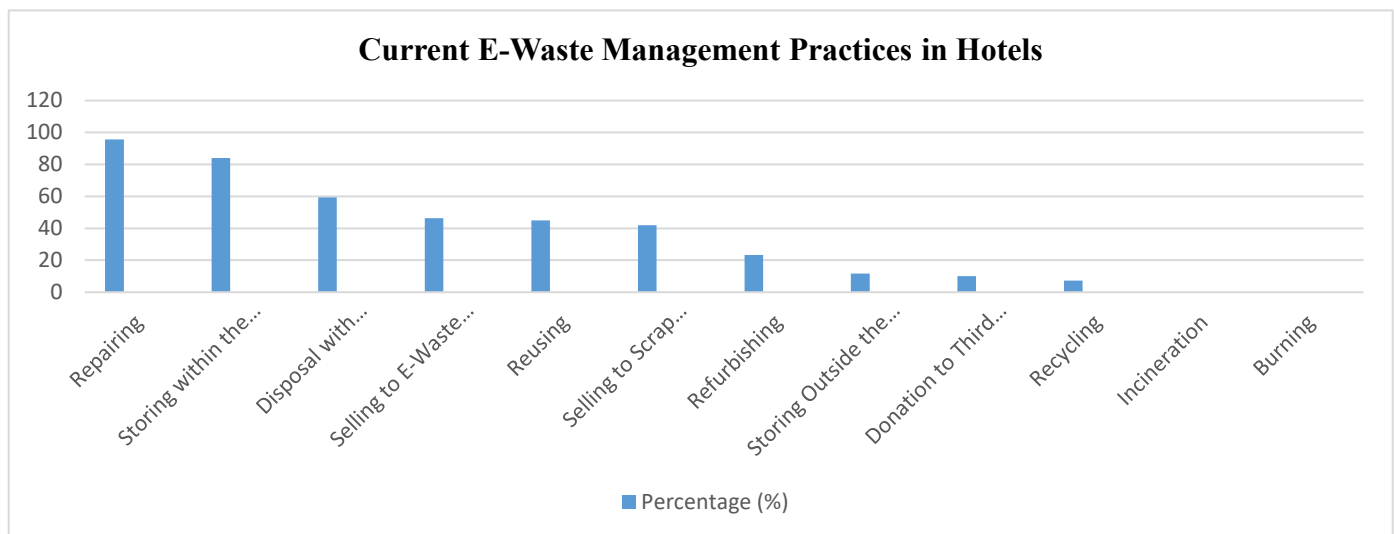


Figure 1: Current E-Waste Management Practices in Hotels

Use of Best Management Practices in E-Waste Management in Hotels

The study further evaluated the use of best management practices in e-waste management in hotels such as sorting, e-waste segregation from other wastes, use of environmentally-friendly procurement, number of fractions the waste is sorted into, use of licensed e-waste recyclers, regular e-waste collection, engaging clients on e-waste management, inventory and tracking of e-waste, and availability of hotel-level e-waste management policy. The results obtained are presented in Table 5 and Figure 2.

Table 5: Use of Best Practices in E-Waste Management in Hotels

Variable	Category	Frequency (n)	Percentage (%)
Sorting	Yes	45	65.2
	No	19	27.5
E-waste segregation from other wastes	Yes	41	59.4
	No	15	21.7
	Sometimes	13	18.8
Use of environmentally-friendly procurement	Yes	35	50.7
	No	34	49.3
No. of fractions sorted into (at least 3 fractions)	≥ 3	31	44.9
	2	19	27.5
Use of licensed e-waste recycler	No	46	66.7
	Yes	23	33.3
Regular e-waste collection (Weekly, Quarterly, Annually)	Yes	19	27.5
	Irregular	50	72.5
Engaging clients on e-waste management	Yes	9	13
	No	60	87
Inventory and tracking of e-waste	Yes	9	13
	No	60	87
Documented e-waste management policy	Yes	5	7.2
	No	64	92.8

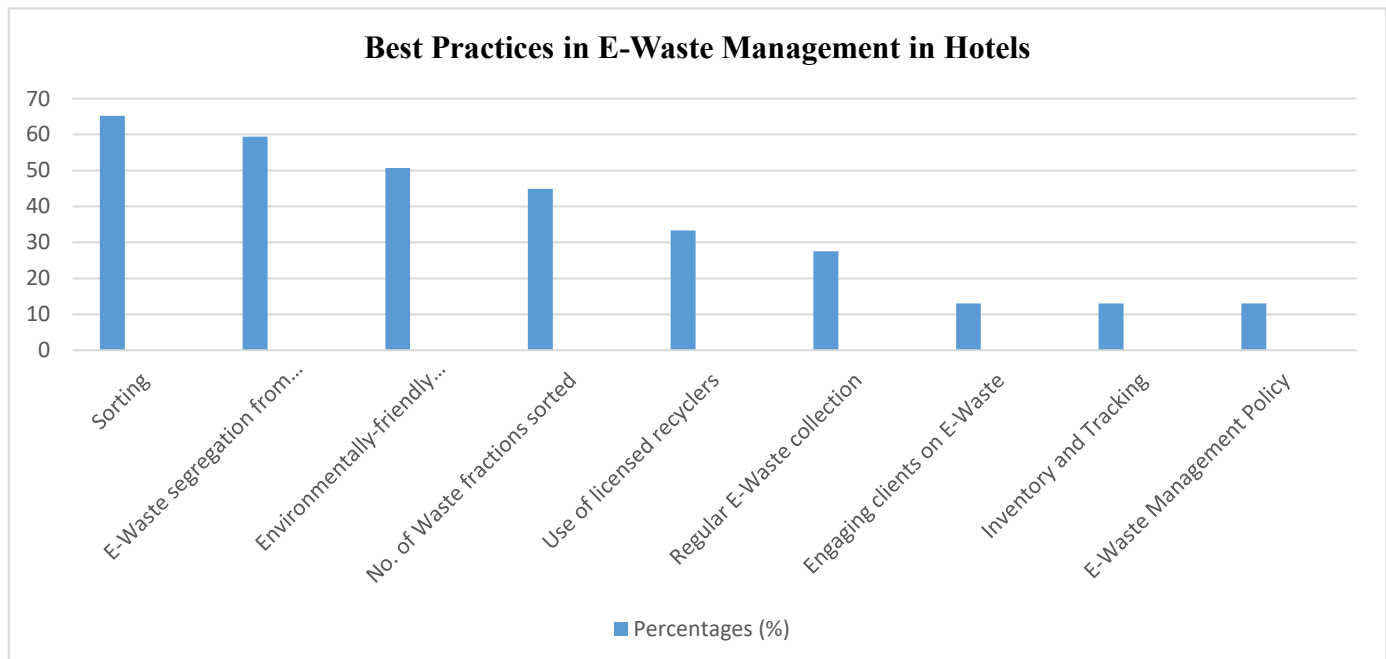


Figure 2: Best Practices in E-Waste Management in Hotels

Pearson's correlation analysis

The correlation analysis was conducted to examine the strength and direction of the linear relationships between the study variables. The analysis was considered appropriate for determining whether changes in one variable

were associated with corresponding changes in another variable, without implying a causal relationship. The results obtained are presented in Table 6.

Table 6: Pearson's Correlation Matrix for Independent, Dependent & Intervening Variables

Correlations							
		Nature of e-waste generated	Current e-waste management practices	Applicable regulatory frameworks	Barriers to effective e-waste management	Effective e-waste management	Hotels' sustainability policies
Nature of e-waste generated	Pearson correlation	---					
	N	69					
Current e-waste Management Practices	Pearson correlation	.464**					
	Sig. (2-tailed)	0					
	N	69	69				
Applicable Regulatory Frameworks	Pearson correlation	.458**	.581**				
	Sig. (2-tailed)	0	0				
	N	69	69	69			
Barriers to effective e-waste management	Pearson correlation	-0.184	-.638**	-.576**			
	Sig. (2-tailed)	0.13	0	0			
	N	69	69	69	69		
Effective e-waste management	Pearson correlation	.453**	.520**	.800**	-.589**		
	Sig. (2-tailed)	0	0	0	0		
	N	69	69	69	69	69	
Hotels sustainability policies	Pearson correlation	.578**	.311**	.547**	-0.222	.558**	
	Sig. (2-tailed)	0	0.009	0	0.067	0	
	N	69	69	69	69	69	69

**** Correlation is significant at the 0.01 level (2-tailed)**

Hierarchical multiple regression analysis

Hierarchical multiple regression analysis was performed to examine the extent to which the study variables predicted effective e-waste management among classified hotels. Variables were entered sequentially to evaluate their independent and incremental contributions to the explained variance in the dependent variable. In Model 1, the predictor variables comprised the operational variables (nature of e-waste generated, current e-waste management practices, and barriers to effective e-waste management) while Model 2 incorporated the institutional and policy-related variables (applicable regulatory frameworks and hotels' sustainability policies) to determine whether they significantly improved the explanatory power of the model beyond that of the primary predictors.

Regression model summary

The regression model summaries are presented in Table 7. Model 1 was statistically significant, $F(3, 65) = 19.22$, $p < 0.001$, explaining 47.0% of the variance in effective e-waste management ($R^2 = 0.470$; Adjusted $R^2 = 0.452$). This indicates that the combined effects of the nature of e-waste generated, current management practices, and barriers to effective e-waste management provided a moderate level of explanatory power. The inclusion of applicable regulatory frameworks and hotels' sustainability policies in Model 2 significantly improved the model's explanatory capacity. The final model was statistically significant, $F(5, 63) = 28.84$, $p < 0.001$, and accounted for 69.6% of the variance in effective e-waste management ($R^2 = 0.696$; Adjusted $R^2 = 0.672$). Compared with Model 1, the increase in explained variance demonstrates that regulatory and organizational factors contribute substantially to understanding effective e-waste management beyond the influence of operational factors alone. These findings underscore the importance of incorporating institutional and policy-related variables when modelling e-waste management performance in the hospitality sector.

Table 7: Summary of Multiple Regression Analysis Models

Model	R	R square	Adjusted R square	Std. Error of the Estimate
1	.686 ^a	0.47	0.446	0.20462
2	.834 ^b	0.696	0.672	0.15742

- Predictors: (Constant), Barriers to effective e-waste management, Nature of e-waste generated, current e-waste management practices.
- Predictors: (Constant), Barriers to effective e-waste management, Nature of e-waste generated, current e-waste management practices, hotels' sustainability policies, applicable regulatory frameworks.

Analysis of Variance (ANOVA)

The ANOVA results confirm that both regression models provide statistically significant prediction of the dependent variable. Model 1 was significant, $F(3, 65) = 19.215$, $p < 0.001$, indicating that the set of three independent variables collectively predicts effective e-waste management. Model 2 was highly significant, $F(5, 63) = 28.843$, $p < 0.001$, confirming that the addition of the two intervening variables strengthens the overall prediction. In both models, at least one predictor has a statistically significant effect on the outcome variable, as shown in Table 8.

Table 8: Model-Comparison ANOVA Analysis

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.414	3	0.805	19.215	.000 ^a
	Residual	2.722	65	0.042		
	Total	5.135	68			
2	Regression	3.574	5	0.715	28.843	.000 ^b
	Residual	1.561	63	0.025		
	Total	5.135	68			

- Dependent Variable: Effective E-Waste Management,
- Predictors: (Constant): Barriers to Effective E-Waste Management, Nature of E-Waste Generated, & Current E-Waste Management Practices.
- Predictors: (Constant): Barriers to Effective E-Waste Management, Nature of E-Waste Generated, Current E-Waste Management Practices, Hotels' Sustainability Policies, And Applicable Regulatory Frameworks.

Regression coefficients analysis

The standardized regression coefficients for the hierarchical models are presented in Table 9. In the first model, current e-waste management practices did not significantly predict effective e-waste management ($p = 0.733$). Following the inclusion of the intervening variables in Model 2, applicable regulatory frameworks emerged as the strongest positive predictor of effective e-waste management ($\beta = 0.561, p < 0.001$), indicating that stronger regulatory support was associated with improved management outcomes. Hotels' sustainability policies exhibited a positive but non-significant association with effective e-waste management ($\beta = 0.168, p = 0.077$).

Table 9: Coefficients Analysis

Coefficients ^a								
		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
		B	Std. Error	Beta (β)	t	Sig.	Lower Bound	Upper Bound
Model								
1	(Constant)	0.872	0.242		3.607	0.001	0.389	1.355
	Nature of e-waste generated	0.564	0.171	0.34	3.292	0.002	0.222	0.906
	Current e-waste management practices	0.072	0.212	0.045	0.342	0.733	-0.35	0.495
	Barriers to effective e-waste management	-0.959	0.229	-0.497	-4.183	0	-1.417	-0.501
2	(Constant)	0.509	0.193		2.628	0.011	0.122	0.895
	Nature of e-waste generated	0.127	0.156	0.076	0.811	0.421	-0.185	0.438
	Current e-waste management practices	-0.082	0.167	-0.051	-0.492	0.624	-0.415	0.251
	Barriers to effective e-waste management	-0.476	0.192	-0.247	-2.487	0.016	-0.859	-0.094
	Applicable Regulatory Frameworks	0.573	0.107	0.561	5.378	0	0.36	0.786
	Hotels' sustainability policies	0.161	0.089	0.168	1.8	0.077	-0.018	0.339

a. Dependent Variable: effective e-waste management

RESULTS

Descriptive Analysis Results of Current E-waste Management Practices in Hotels

The findings presented in Table 3 and Figure 1 indicate that repairing electronic equipment was the most common practice (95.7%). Other commonly reported practices were: storing e-waste within hotel premises (84.1%), disposal together with general waste (59.4%), selling to e-waste collectors (46.4%), reusing equipment (44.9%), and selling to scrap dealers (42.0%). Less frequently practiced methods included refurbishing (23.2%), storage outside hotel premises (11.6%), donation (10.1%), and recycling (7.2%). None of the hotels reported burning or incinerating the e-waste. These findings suggest that hotels primarily rely on repair and temporary storage, while formal recycling remains very limited despite being marginally higher than the national average of 5%. The results presented in Table 4 and Figure 2 indicate varying adoption of best practices in waste. The most common best practices included: overall waste sorting (65.2%), e-waste segregation (59.4%), environmentally-friendly procurement (50.7%) while the less commonly practiced were: sorting into at least three fractions (44.9%), use of licensed recyclers (33.3%), regular e-waste collection (27.5%), guest engagement (13.0%), inventory and tracking systems (13.0%) and having documented e-waste management policies (7.2%).

These findings suggest that while operational practices such as sorting are relatively common, institutional management systems remain poorly developed.

Inferential analysis results

The correlation analysis results presented in Table 6 showed a moderate positive significant relationship between current e-waste management practices and effective e-waste management ($r = .520$, $p < .01$). This suggests that improved operational practices are associated with improved e-waste management outcomes. However, the multiple regression analysis results, showed that despite the positive correlation, current management practices were not statistically significant predictors of effective e-waste management in either Model 1 ($\beta = .045$, $p = .733$) or Model 2 ($\beta = -.051$, $p = .624$). These findings indicate that current practices alone are insufficient to explain variations in effective e-waste management once other organizational and institutional factors are considered.

Through coefficients analysis of the first model (Table 8), current e-waste management practices exhibited a positive but statistically insignificant effect on effective e-waste management ($\beta = 0.045$, $t = 0.342$, $p = 0.733$). The small standardized coefficient indicates that the contribution of existing management practices to explaining effective e-waste management is negligible after accounting for the other predictors. Similarly, the unstandardized coefficient ($\beta = 0.072$) is very small, while the 95% confidence interval (-0.350 to 0.495) includes zero, confirming that the effect is not statistically significant. This finding suggests that although hotels reported implementing various e-waste management practices such as repairing, storage, reuse, and disposal, these practices do not independently translate into significantly improved e-waste management outcomes. The result implies that the practices may be inconsistently implemented, inadequately coordinated, or insufficiently aligned with environmentally sound e-waste management standards.

In the second model, the variable (current e-waste management practices) remained statistically insignificant in the expanded model ($\beta = -0.051$, $t = -0.492$, $p = 0.624$). The coefficient changed from a weak positive value in Model 1 to a weak negative value in Model 2, but the effect remained negligible and statistically insignificant. The confidence interval (-0.415 to 0.251) which includes zero, confirmed that current management practices do not independently explain effective e-waste management once other variables are considered. This finding reinforces the conclusion that the existing practices implemented by hotels are insufficient on their own to produce meaningful improvements in e-waste management effectiveness without supportive institutional and regulatory conditions.

Qualitative analysis results

The qualitative findings presented in Table 10 indicate that e-waste management within hotels remains largely fragmented, reactive and predominantly informal. Although respondents identified several methods currently employed by hotels, none reflected a comprehensive or structured e-waste management system. The most frequently reported practice involved the disposal of small electronic waste together with municipal solid waste. Informants explained that bulbs, chargers, switches, sockets and printer cartridges are routinely mixed with ordinary waste before being transported to municipal dumpsites. This practice reflects limited segregation of hazardous waste at source and exposes the environment to potentially hazardous substances contained in electronic products. Conversely, larger electronic equipment such as televisions, printers, refrigerators and photocopiers is commonly stored within hotel premises rather than immediately discarded. Respondents attributed this practice to expectations of future resale opportunities, uncertainty regarding appropriate disposal mechanisms and the high costs associated with formal recycling. The prolonged storage of obsolete equipment consequently creates substantial accumulations of dormant e-waste within hotels. Another widely reported management practice involves selling obsolete equipment to scrap dealers and informal waste collectors. According to respondents, these actors recover reusable components and valuable metals for resale despite operating largely outside formal regulatory systems. A limited number of hotels reportedly engage licensed recyclers or authorized waste service providers, although such practices remain relatively uncommon due to inadequate accessibility and associated disposal costs. Additionally, some respondents noted that obsolete but still functional equipment is occasionally donated to employees, schools, prisons or charitable organizations, thereby extending product life before eventual disposal.

Despite these multiple disposal pathways, respondents consistently emphasized that most hotels lack formal e-waste management systems, including documented procedures, inventory systems, scheduled collection programmes and formal contractual arrangements with licensed recyclers. Consequently, e-waste management decisions are generally driven by convenience, storage capacity and immediate financial considerations rather than environmental sustainability or regulatory compliance. These qualitative findings reinforce the quantitative results which showed that repairing equipment, storing obsolete electronics and selling waste to informal collectors were considerably more common than environmentally preferred practices such as recycling, segregation and engagement with licensed recyclers. Together, the findings characterize hotel e-waste management as predominantly reactive rather than preventive or circular.

Table 10: Current E-waste Management Practices in Hotels

Management Practice	Evidence from KIIs	Source (KII)
Disposal at Municipal Dumpsite	Small e-waste (bulbs, chargers, switches, sockets, cartridges) mixed with general waste and dumped at the municipal dumpsite	K1, K3, K4, K5
On-site Storage	Large items (TVs, fridges, photocopiers, printers) stored within hotel premises, often awaiting sale	K1, K2, K3, K5
Sale to Scrap Dealers	E-waste sold in bulk to scrap dealers or informal collectors who salvage reusable parts or sell as scrap	K1, K2, K3, K5
Donation / Redistribution	Some functional but obsolete equipment donated to staff, orphanages, schools, or prisons	K2
Licensed Recyclers (Limited)	A small number of hotels engage licensed recyclers; solid waste service providers recover some materials (wires, metals, plastics)	K2
No Formal System	Most hotels lack a structured e-waste management system	K1, K3, K4

DISCUSSION

The findings indicate that although hotels have adopted several e-waste management practices, these practices remain fragmented, inconsistent, and largely reactive rather than systematic. The quantitative findings revealed that repair, temporary storage within hotel premises, sorting, and reuse were relatively common, commanding 95.7%, 84.1%, 65.2%, and 44.9% respectively, whereas environmentally preferred practices such as, engagement of licensed e-waste recyclers, inventory management, formal recycling, and documented hotel-level environmental policies, were poorly implemented showing 33.3%, 13%, and 7.2% respectively. Qualitative findings reinforced this pattern by revealing that no informant described a structured hotel-wide e-waste management system. Instead, hotels relied on a combination of municipal disposal, prolonged on-site storage, sale to informal scrap dealers, and only occasional engagement with licensed recyclers.

The convergence between the quantitative and qualitative findings on this account demonstrates that hotel e-waste management is characterized by isolated operational practices rather than an integrated environmental management system. This finding is consistent with Gohoungodji & Chembessi (2026), who also found that, although individual hotels undertake certain environmentally desirable activities, their actions mainly occur

without coordinated institutional policies, standardized procedures, or effective regulatory oversight. Consequently, the findings suggest that e-waste management within hotels remains predominantly driven by operational convenience and financial considerations instead of circular economy principles or environmental sustainability.

Repair represents the most Dominant Waste Minimization Strategy in Hotels

Repairing EEE emerged as the most widely adopted management practice, with 95.7% of hotels indicating that malfunctioning equipment is repaired before replacement or disposal. This demonstrates that hotels recognize the economic value of extending the useful life of electrical and electronic equipment. Given the substantial investment required to acquire guest room appliances, kitchen equipment, ICT infrastructure, and entertainment

systems, repair minimizes replacement costs while ensuring uninterrupted service delivery. The qualitative findings indirectly support this conclusion by showing that hotels retain large appliances such as refrigerators, televisions, photocopiers, and freezers on-site rather than disposing of them immediately. Such storage often reflects attempts to repair, refurbish, or recover some value before final disposal.

This finding aligns closely with the waste hierarchy and circular economy framework, which prioritize product maintenance and repair above disposal as they reduce demand for new products, conserve raw materials, and minimize waste generation (Awino & Apitz, 2024). Similarly, Baldé *et al.* (2024), Sundar *et al.* (2023) and Awasthi & Pandey (2026), separately held that repair has become an important sustainability strategy among commercial organizations seeking to maximize asset utilization. However, the findings also demonstrate the limitations of relying primarily on repair, which although postponing waste generation, it cannot eliminate it, as electronic equipment inevitably reach their end of functional or economic life, requiring environmentally sound disposal. Due to this consideration, repair should be regarded as an important upstream waste prevention strategy rather than a complete e-waste management solution.

Extensive Storage reflects deferred Disposal rather than Active Management

The finding that 84.1% of hotels stored obsolete EEE within their premises for varying periods of time represents one of the most significant management practices identified by the study. While temporary storage is generally considered an acceptable practice when organizations await collection by licensed recyclers or to accumulate sufficient quantities for transport, the qualitative findings indicate that storage in the case of this study often represents indefinite accumulation rather than planned resource recovery. Interview participants consistently reported that bulky equipment such as refrigerators, freezers, photocopiers, televisions, and other large appliances remained stored within hotel premises because there was no clearly established formal disposal mechanism. The informants further indicated that hotels lacked structured procedures governing when, how, or through whom these stored materials should eventually be disposed.

The qualitative findings therefore provide important contextual explanation for the quantitative results. Rather than representing proactive environmental management, prolonged storage appears to reflect uncertainty regarding disposal options and the absence of accessible formal recycling systems (Mishra *et al.*, 2026). These findings are consistent with earlier finding by Forti *et al.* (2020), who observed that substantial quantities of institutional e-waste remain stockpiled for prolonged periods because organizations face limited recycling infrastructure, uncertainty regarding disposal procedures, data security concerns, and insufficient collection services. Baričević *et al.* (2024), similarly found that commercial organizations frequently accumulate obsolete equipment while waiting for economically viable disposal opportunities to arise.

The implications of prolonged storage are significant. Besides occupying valuable operational space, long-term storage increases the likelihood of equipment deterioration, reducing opportunities for refurbishment and material recovery. Hazardous substances contained in batteries, fluorescent lamps, and damaged electronic components may also leak during the prolonged storage, increasing environmental and occupational risks. In this case, the finding suggests that extended storage may be a symptom of weak downstream waste management systems rather than an environmentally desirable management practice by the hotels.

Disposal with General Waste Demonstrates Weak End-of-Life Management

One of the most concerning findings of the study is that 59.4% of hotels reported disposing of electronic waste together with general solid waste, a fact strongly reinforced by the qualitative findings. The key informants consistently stated that small electronic items such as chargers, bulbs, switches, sockets, cables, cartridges, and similar equipment were routinely discarded at the municipal dumpsites alongside ordinary solid waste. The strong agreement between the quantitative and qualitative findings demonstrates that co-disposal is an established management practice within many hotels. This practice directly contradicts internationally accepted e-waste management principles and Kenya's regulatory requirements, requiring electronic waste to be segregated from ordinary waste because of its hazardous constituents (Mugendi *et al.*, 2024).

The findings however, correspond with those of Owonikoko & Alimba (2024), and Mwalugeni *et al.* (2025), who documented widespread co-disposal of e-waste with municipal waste throughout sub-Saharan Africa. Similarly, Eze *et al.* (2024), emphasized that electronic waste contains hazardous substances including lead, mercury, cadmium, chromium, and brominated flame retardants that pose substantial risks to human health and ecosystems when disposed of in uncontrolled landfill environments. The coexistence of extensive repair and widespread disposal with general waste reveals an important contradiction within hotel waste management. Hotels appear to prioritize maximizing equipment value during its useful life, yet many fail to implement environmentally sound practices once the equipment reach their end-of-life. This inconsistency suggests that economic considerations dominate equipment management decisions while environmental considerations become secondary during disposal.

Informal Recovery systems Dominate End-of-Life Management

The quantitative findings revealed that approximately half of the hotels sold obsolete equipment to e-waste collectors (46.4%), reused equipment internally (44.9%), or sold materials to scrap dealers (42.0%), whereas refurbishment (23.2%) and donation (10.1%) remained relatively uncommon. The qualitative findings provide deeper insight into these disposal pathways, with informants consistently describing the sale of bulky equipment to informal scrap dealers as one of the principal methods used to remove obsolete electronics from hotel premises. At the same time, respondents indicated that these transactions occurred outside any recognized regulatory framework and without assurance that environmentally sound recycling practices would subsequently be applied by the up-takers.

These findings suggest that although hotels attempt to recover economic value from obsolete equipment, much of this recovery occurs through informal recycling networks rather than licensed facilities. This observation agrees with Derks *et al.* (2024), who reported that informal recycling dominates electronic waste management throughout many African countries because formal collection systems remain underdeveloped. Similarly, Lepawsky (2018) argued that developing countries continue to depend heavily upon informal waste actors due to the limited implementation of formal producer responsibility systems. Although informal recovery contributes to material reuse and income generation, it often involves unsafe dismantling techniques, uncontrolled burning, and environmentally hazardous recovery methods (Quinto *et al.*, 2025). Consequently, the findings suggest that current value recovery practices only partially support circular economy objectives because environmental protection remains inadequately addressed.

Formal recycling remains extremely limited

Perhaps the most important quantitative finding is that only 7.2% of hotels reported recycling their e-waste through formal systems. This extremely low recycling rate, though slightly higher than the national average of 5%, indicates that environmentally sound material recovery remains largely absent within the hotel sector. The qualitative findings reinforce this conclusion by revealing that only limited engagement with licensed recyclers occurred, while several key informants indicated that no clearly established formal disposal mechanisms existed for hotels. The respondents repeatedly emphasized that hotels were generally unaware of accessible formal e-waste management systems, resulting in dependence upon storage, municipal disposal, or informal scrap dealers.

The qualitative evidence therefore explains why formal recycling rates remained exceptionally low despite widespread awareness that electronic waste requires specialized handling. These findings are consistent with Baldé *et al.* (2024), who found that formal global recycling rates remain substantially lower than overall e-waste generation, particularly within developing countries where recycling infrastructure has not kept pace with the rapid growth of electronic consumption. The findings also support the quantitative analysis of barriers presented elsewhere in the study. Limited access to licensed recyclers, inadequate infrastructure, and high disposal costs appear to constrain formal recycling opportunities regardless of hotels' willingness to participate. As a result, the low recycling rate reflects structural deficiencies within the national e-waste management system rather than simple managerial negligence.

Preventive Management Practices show a growing Environmental Awareness

The quantitative findings indicate that hotels have begun adopting several preventive management practices consistent with sustainable waste management principles. Approximately two-thirds of hotels reported sorting e-waste (65.2%), while more than half practiced segregation (59.4%) and environmentally preferable procurement (50.7%). These practices represent important elements of integrated waste management because they improve material recovery, reduce contamination, facilitate recycling, and encourage procurement of more durable and repairable products. However, the qualitative findings suggest that these operational activities occur without formal organizational structures. The informants consistently indicated that hotels lacked standardized management systems governing collection, segregation, documentation, transportation, or disposal. As a result, sorting and segregation appear to depend primarily upon individual operational practices rather than institutionalized environmental management programmes. These findings are consistent with Chachage *et al.* (2024), who held that although awareness of preventive e-waste management has increased across several sectors in most developing countries, organizational systems necessary to sustain these practices remain underdeveloped.

Institutionalization of E-Waste Management Remains Weak in Hotels

One of the clearest indicators of institutional weakness is the limited adoption of documented e-waste management policies (13.0%), inventory systems, monitoring procedures, regular collection schedules (27.5%), and engagement with licensed recyclers (33.3%), with qualitative findings strongly reinforcing this conclusion. The informants consistently reported that there was no known formal or standardized hotel-wide system for managing e-waste. Decisions regarding storage, disposal, or sale of obsolete equipment were largely made on an ad hoc basis without documented procedures or regulatory guidance. This convergence between quantitative and qualitative findings demonstrates that hotels have not yet institutionalized e-waste management as a routine component of organizational environmental management systems. Documented policies, inventories, monitoring systems, and standard operating procedures are widely recognized as essential for ensuring regulatory compliance, accountability, and continuous improvement (Baldini & Cerutti, 2026). Their absence therefore limits the hotels' ability to manage increasingly diverse e-waste streams effectively.

Absence of Open Burning is a Positive Environmental Progress

An encouraging finding is that none of the surveyed hotels reported open burning or incineration of e-waste at source. Although the qualitative interviews did not specifically identify open burning as a management practice, respondents instead described municipal disposal, storage, and informal sales as the predominant management pathways. The absence of open burning suggests that hotels generally avoid one of the most environmentally destructive disposal methods frequently associated with informal e-waste recycling. This finding may reflect increasing environmental awareness among hotel managers and greater recognition of the health risks associated with uncontrolled combustion of electronic waste specifically and also other wastes generally. Nevertheless, avoiding open burning alone cannot compensate for continued disposal through municipal waste streams or informal recycling networks, both of which continue to present significant environmental challenges as already observed by Andeobu *et al.* (2023).

Inferential findings Demonstrate that Operational Practices alone are Insufficient

The inferential analysis provides important insight into the effectiveness of current management practices. Pearson's correlation demonstrated a moderate positive relationship between current e-waste management practices and effective e-waste management ($r = 0.520$, $p < 0.01$), indicating that hotels implementing better operational practices generally reported better management outcomes. The qualitative findings support this relationship because hotels that described repair, segregation, storage, and selective recovery appeared to demonstrate greater awareness of e-waste issues than those relying exclusively on municipal disposal. However, hierarchical regression analysis revealed that current management practices were not statistically significant independent predictors of effective e-waste management ($\beta = 0.045$, $p = 0.733$), and they remained non-significant after regulatory frameworks and sustainability policies were introduced into the model ($\beta = -0.051$, $p = 0.624$).

These findings suggest that operational practices alone cannot overcome systemic institutional deficiencies as already found by Boateng *et al.* (2026). Repair, sorting, temporary storage, and reuse may improve day-to-day waste handling, but their effectiveness depends fundamentally upon the existence of accessible recycling infrastructure, regulatory enforcement, licensed recycling facilities, and organizational governance. This interpretation is reinforced by the broader regression findings in which applicable regulatory frameworks emerged as the strongest predictor of effective e-waste management ($\beta = 0.561, p < 0.001$), while barriers remained significant negative predictors ($\beta = -0.247, p = 0.016$). Collectively, these results indicate that effective e-waste management is primarily determined by the enabling institutional environment within which hotel practices operate (Erdiaw-Kwasie *et al.*, 2024).

Implications for Sustainable Hotel E-Waste Management

Taken holistically, the quantitative and qualitative findings reveal that hotels have embraced several positive operational practices, particularly repair, reuse, sorting, and segregation, demonstrating growing awareness of resource efficiency and circular economy principles. Nevertheless, these practices coexist with environmentally unsustainable approaches including prolonged storage, disposal with municipal waste, dependence on informal scrap dealers, and extremely limited formal recycling. The qualitative evidence adds considerable explanatory depth by demonstrating that these practices arise largely because hotels lack formal institutional systems, standardized procedures, and accessible regulatory support rather than because of unwillingness to manage e-waste responsibly. Informants consistently highlighted the absence of structured hotel-wide management systems and formal disposal pathways, confirming that current practices are largely improvised responses to systemic governance gaps.

CONCLUSION

The study concludes that, despite the existence of a range of e-waste management practices in hotels, and varying levels of adoption of best waste management practices, the practices, do not have a statistically significant influence on effective e-waste management. This suggests that the practices may be inconsistently implemented, inadequately coordinated, or insufficiently aligned with environmentally sound e-waste management standards. It further concludes that operational practices alone are insufficient to improve e-waste management outcomes without supportive institutional and regulatory conditions.

RECOMMENDATION

Prioritize strengthening of regulatory and institutional environment for improved e-waste management among classified hotels in Naivasha Sub-County. This can be achieved through strengthened implementation and enforcement of e-waste regulatory requirements by both National and County Governments, establishment of clearer hotel-specific guidance for e-waste management, improved access to licensed e-waste collection and recycling systems, integration of e-waste compliance into routine hotel environmental inspections, strengthened institutional coordination and capacity building, as well as improved hotel-level implementation of regulatory requirements. Further, hotel management should align organizational sustainability policies and operational procedures with national regulatory requirements by developing and implementing formal hotel-level e-waste management policies, maintaining e-waste inventories and tracking systems, allocating adequate financial and human resources, conducting regular staff training, integrating environmentally preferable procurement practices, and establishing partnerships with licensed e-waste recyclers. These measures will improve the consistency and effectiveness of e-waste management practices within hotels.

ETHICAL CONSIDERATIONS

Ethical approval

Ethical approval for this study was obtained from the Kabarak University Ethics Review Committee (KUREC) in accordance with the national research ethics guidelines. Research authorization was subsequently granted by the National Commission for Science, Technology and Innovation (NACOSTI) under license number

NACOSTI/P/26/4186063, covering the administration of survey-based questionnaires involving human participants, within Naivasha Sub-county.

Conflict of Interest

The authors affirm their complete impartiality, declaring that no conflicts of interest exist, thereby reinforcing the credibility, transparency, and integrity of the research findings.

Data availability

The datasets generated and analyzed during this study are available from the corresponding authors upon reasonable request.

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