STATISTICAL EVALUATION OF WASTE MANAGERMENT AND RECYCLING PRACTICES IN IREE COMMUNITY, NIGERIA.

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ABSTRACT

There have been ongoing search to reduce, reuse, recycle and recover waste management. The data obtained were mainly primary data sourced among residents of Iree Community in Boripe Local Government, Osun State, Nigeria, with a focus on identifying effective strategies for sustainable waste management. The study examined the relationship between demographic factors, awareness levels, and waste disposal methods using statistical tools such as Chi-square tests and ordinal logistic regression. Results revealed that while 56% of residents engage in sustainable waste disposal practices, a significant portion (44%) still relies on unsustainable methods such as burning and illegal dumping. Awareness of recycling programs was a significant predictor of sustainable practices ($p < 0.01$), highlighting the need for public education campaigns. Recycling programs (30%) and composting (28.5%) emerged as the most preferred waste management strategies. The study underscores the importance of increasing public awareness, improving access to waste management facilities, and fostering community-led initiatives to address the challenges of waste management. By identifying key factors that drive sustainable waste disposal, the findings provide actionable insights for policymakers and stakeholders aiming to enhance recycling rates and reduce landfill dependence in developing countries.

Keywords: Waste disposal, Recycling, Sustainable waste management, Logistic regression and Chi-square, Unsustainable waste management.

INTRODUCTION

Although initially developed in the 19th century, the logistic regression (LR) model has experienced a notable rise in application over the past two to three decades (Boateng and Abaye, 2019). Waste is defined as any item or material that must be discarded due to damage, contamination, deterioration, or loss of utility (Czekała, Drozdowski, and Łabiak, 2023). According to the State of Vermont's Department of Environmental Conservation, solid waste refers to any tangible, non-liquid material discarded as a result of human activity (Wan, Shen, and Choi, 2019).

Awareness plays a foundational role in the success of waste management systems and recycling programs. Studies have consistently shown that knowledge about the environmental and health impacts of poor waste disposal practices significantly influences public participation (Moqsud et al., 2021). According to Nigbur et al. (2010), individuals who are more informed about the benefits

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of recycling are more likely to separate and dispose of waste responsibly. In developing countries, including Nigeria, awareness campaigns are often limited, reducing community engagement and participation in waste reduction strategies (Ogwueleka, 2009).

Public understanding of waste disposal practices is critical in shaping both individual and collective waste management behaviors (Tian and Liu, 2022). This includes knowledge of waste classification, disposal methods, environmental impacts, relevant regulations, and safety protocols (Altikolatsi et al., 2021). As global environmental awareness continues to grow, sustainable practices such as recycling are increasingly adopted (Halkos and Matsiori, 2018). Moreover, Cultural beliefs and socioeconomic factors significantly influence waste disposal patterns, with traditional customs often intersecting with the modern challenges of waste generation (Ajani and Olutayo, 2021).

Composting presents a sustainable solution for decomposing organic waste, enriching soil, and promoting eco-friendly waste management (Wen et al., 2020). The widely endorsed "reduce, reuse, recycle" philosophy emphasizes minimizing waste at its source (Linda et al., 2021). Despite these efforts, illegal dumping continues to be prevalent, largely due to insufficient waste infrastructure, creating both environmental and health concerns (Grobler et al., 2022). In response, communities across Nigeria have implemented local waste initiatives to raise awareness and encourage responsible disposal practices (Sambo and Wetnwan, 2021). While recycling and waste reduction efforts are underway, their effectiveness varies based on regional implementation and the level of policy support.

Recycling behavior is influenced by a combination of personal attitudes, access to facilities, and perceived ease of participation. In urban centers like Lagos, where some waste management has been commercialized, incentives and structured programs have contributed to improved recycling outcomes (Babayemi and Dauda, 2020). However, in many Nigerian regions, recycling is still informal, often managed by unregulated scavengers without proper safety or efficiency protocols (Adebayo et al., 2022). This informal approach, while essential, lacks integration into the formal waste management framework and limits broader sustainability gains. Recycling programs, however, have shown success in reducing reliance on landfills while advancing environmental sustainability (Al-Khateeb and Al-Khateeb, 2017).

Empirical evidence shows that well-managed recycling programs can cut landfill-bound waste by as much as 50% (Zaman et al., 2017). composting initiatives have shown considerable

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effectiveness, with some achieving landfill waste reductions of 60–70% (Cerda et al., 2018). Cerda and colleagues, in particular, highlighted the significant impact of food waste composting in decreasing waste volumes. In the same vein, Ferronato and Torretta (2019) documented successful waste minimization practices that have led to reduced municipal waste generation across various global regions, especially in Europe.

Socio-economic factors, including income levels, education, and infrastructure, significantly impact the effectiveness of waste management systems. Studies suggest that lower-income households often lack the means to participate effectively in recycling programs due to limited access to information, infrastructure, or time (Wilson et al., 2012). Moreover, the absence of financial incentives or support mechanisms often discourages consistent participation among marginalized populations (Guerrero et al., 2013). In Nigeria, inadequate funding and institutional support further compound these challenges. Many local governments lack the resources to implement comprehensive waste collection, segregation, or recycling programs, leaving communities underserved and increasing landfill dependence (Zainu and Songip, 2017).

With the growing global emphasis on sustainable development, the adoption of integrated waste management strategies encompassing waste reduction, reuse, recycling, and safe disposal has become increasingly critical. As environmental awareness deepens, communities are urged to implement more sustainable waste handling practices. This paper contributes to the existing literature by assessing the effectiveness of various waste management strategies in reducing landfill reliance and enhancing recycling rates, with a particular emphasis on the specific challenges inherent in Nigeria’s waste management system.

MATERIALS AND METHODS

The data used in this study are mainly primary data, collected through a structured questionnaire. A total of 210 residents of Iree, located in Boripe Local Government Area of Osun State, were surveyed. Logistic regression and chi-square methods were employed for the analysis. A stratified sampling technique with uniform allocation was used to conduct the survey. Of the 210 questionnaires distributed, 202 were successfully retrieved, and the analysis was carried out using the R software package.

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CHI SQUARE TEST

The waste disposal practices among residents of the Iree community were classified into two categories: Sustainable and Unsustainable. Sustainable practices included public garbage collection, private waste management services, and composting, while Unsustainable practices comprised waste burning and illegal dumping. The independence of disposal methods from various factors such as educational level, age group, awareness of recycling programs, and occupation was then tested using the chi-square test.

Chi-square statistic is:

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

Where; O_i represents observed frequency, E_i represents expected frequency.

THE LOGIT (LOGISTIC) REGRESSION MODEL

In fact, the multinomial logistic regression (MLR) model is a fairly straightforward generalization of the binary model, and both models depend mainly on logit analysis or logistic regression. Logit analysis provides a ready alternative. For a response variable Y with two measurement levels (dichotomous) and explanatory variable X,

let: $\pi(x) = P(Y = 1 \mid X = x)) = 1 - P(Y = 0 \mid X = x)$, the logistic regression model has linear form for logit of these probabilities:

$$Logit[\pi(x)] = \log\left[\frac{\pi(x)}{1-\pi(x)}\right] = \alpha + \beta x, \quad where\ the\ odds = \frac{\pi(x)}{1-\pi(x)}$$

$$The\ odds = \exp(\alpha + \beta x), \qquad and\ the\ logarithm\ of\ the\ odds\ is\ called\ logit$$

So, $Logit[\pi(x)] = \log\left[\frac{\pi(x)}{1-\pi(x)}\right] = \log[\exp(\alpha + \beta x)] = \alpha + \beta x$

The logit has linear approximation relationship, and logit = logarithm of the odds. The parameter β is determined by the rate of increase or decrease of the S-shaped curve of π (x). The sign of β indicates whether curve ascends (β > 0) or descends (β < 0), and the rate of change increases as |β| increases.

MULTIPLE LOGISTIC REGRESSIONS

The logistic regression can be extending to models with multiple explanatory variables. Let k denotes number of predictors for a binary response Y by $x_1, x_2, \ldots, x_k$ the model for log odds is

$$Logit[P(Y = 1)] = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k$$

And the alternative formula, directly specifying$\pi(x)$, is

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$$\pi(x) = \frac{\exp(\alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k)}{1 + \exp(\alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k)}$$

The parameter β_i refers to the effect of x_i on the log odds that Y =1, controlling other x_j , for instance, $exp(\beta_i)$ is the multiplicative effect on the odds of a one-unit increase in x_i , at fixed levels of other x_j.

Given n independent observations with p explanatory variables and a qualitative response variable with k categories, constructing the logits for the multinomial case requires selecting one category as the base level, with all logits defined relative to it. Since there is no inherent ordering among the categories, any category can be chosen as the base; here, we select category k as the base level. Let πj represent the multinomial probability of an observation falling into the jth category. To find the relationship between these probabilities and the p explanatory variables, $x_1, x_2, \ldots, x_p$, the multiple logistic regression model is given as:

$$\log\left[\frac{\pi_j(x_i)}{\pi_k(x_i)}\right] = \alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \cdots + \beta_{pj}x_{pi}$$

$Where\ j = 1, 2, \ldots, (k-1),\ i = 1, 2, \ldots, n.$ Since all π′s add to unity reduces to

$$\log(\pi_j(x_i) = \frac{\exp(\alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \cdots + \beta_{pj}x_{pi})}{1 + \sum_{j=1}^{k-1} \exp \alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \cdots + \beta_{pj}x_{pi}}$$

For $j = 1, 2, \ldots, (k-1)$, the model parameters are estimated by the method of ML.

RESULTS OF ANALYSIS

Table 1: Distribution of the data collected

Parameters		Frequency (n)	Percentage
Age Group	Under 18	34	17%
	18 - 24	81	41%
	25 - 34	62	31%
	35 +	23	12%
Educational Level	ND/NCE	95	48%
	HND/BSc	105	53%
Gender	Female	126	63%
	Male	74	37%
Occupation	Unemployed	14	7%
	Student	95	48%
	Self Employed	41	21%
	Employed (Private Sector)	33	17%
	Employed (Public Sector)	17	9%

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Disposal Method	Unsustainable	87	44%
	Sustainable	113	56%
How often do you recycle?	Never	5	3%
	Rarely	18	9%
	Sometimes	41	21%
	Often	64	32%
	Always	72	36%
Waste Segregation Awareness	No	75	38%
	Somewhat	26	13%
	Yes	99	50%
Primary Reason for Recycling	Not Available	11	6%
	Lack of Awareness	31	16%
	Convenience	40	20%
	Inconvenience of facilities	6	3%
	Environmental concern	83	42%
	Financial incentives	29	14%
Effective Waste Management Strategy	Composting	57	28%
	Reducing waste at the source	34	17%
	Recycling programs	60	30%
	Waste-to-energy initiatives	49	25%
Awareness of recycling Initiatives	No	71	36%
	Maybe	22	11%
	Yes	107	54%

Table 1 above shows that most respondents are aged 18–24 (40.5%), with a majority being female (63%) and students (48%), While 56% practice sustainable waste disposal and 44% still use unsustainable methods. Recycling frequency is 36% always, 32% often, and 3% rarely, emphasizing the need for greater awareness and better infrastructure.

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GRAPHICAL REPRESENTATION OF DISTRIBUTION OF RESPONDENT

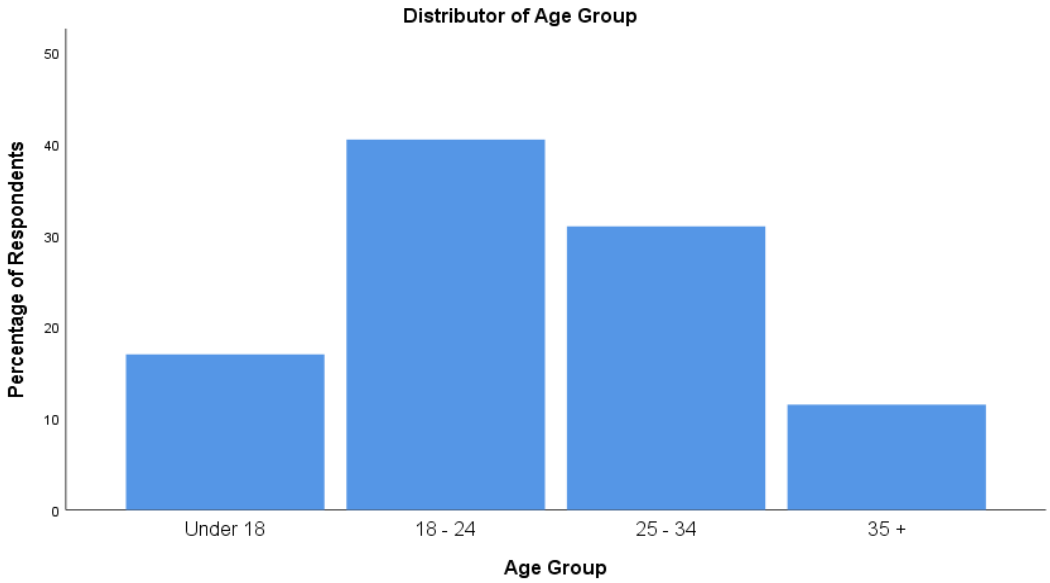

Figure1: Bar-chart of Distribution of Age group

Figure I illustrates the age distribution of respondents, with the majority aged 18–24 (40.5%) and the fewest aged 35 and above (11.5%).

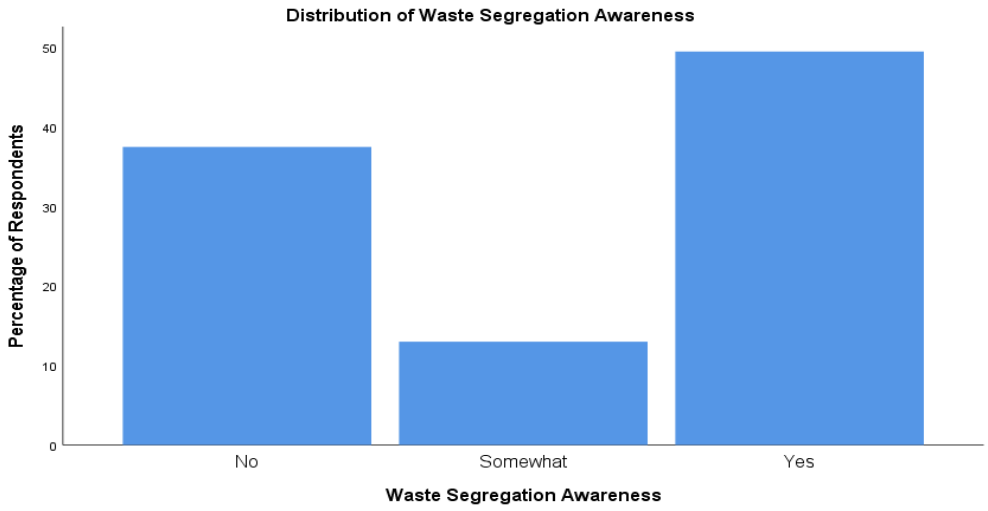

Figure II: Bar-chart of Distribution of Waste Segregation Awareness

Figure II reveals that around 50% (99) of respondents are aware of waste segregation before disposal, 37.5% (75) are unaware, and 13% (26) are somewhat aware. This suggests that over half of

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the Iree community is familiar with the practice.

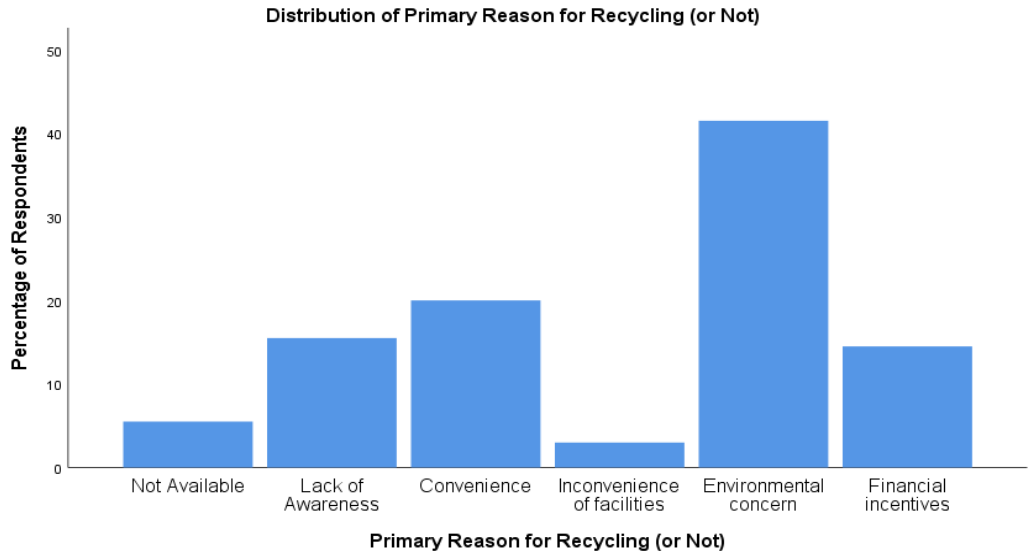

Figure III: Bar-chart of Distribution of Primary Reasons for Recycling

Figure III above shows that 41.5% of residents recycle because of Environmental concerns followed by Convenience (20%) and least of the residents as result of Inconvenience of facilities.

Figure IV: Bar-chart of Distribution of Most Effective Waste Management Strategy

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Figure IV shows that 54% of respondents are aware of recycling initiatives, while 36% are unaware and 11% are uncertain. Recycling is considered the most effective strategy (30%), followed by composting (28.5%), waste-to-energy (24.5%), and source reduction (17%). Although awareness is relatively high, there is still a need for greater public education and promotion of recycling programs.

RESULTS OF CHI-SQUARE TEST

Table II: Chi-Square Test Results for Model Coefficients

Parameters	χ^2	df	P-value	Result
Educational Level	0.0026	1	0.9601	Not Significant
Age Group	7.2543	3	0.0642	Not Significant
Awareness of recycling Program	14.338	2	0.0008	Significant
Occupation	15.451	4	0.0038	Significant

Table II shows that awareness of recycling programs and occupational status significantly affect sustainable waste disposal practices in the Iree community, while educational level and age group have no notable influence. This highlights the importance of targeted awareness campaigns to improve waste management behaviors.

ORDINAL LOGISTICS REGRESSION

An Ordinal logistic regression was used to formulate a model for the disposal practices among the residents of the Iree community. The model is formulated to predict dependent variables, disposal Practices (Sustainable and Unsustainable) using the independent variables which are Awareness (Awareness of Recycling Initiatives), Occupation, Age and Educational Level. The result of the analysis is as given below.

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Table III: Parameter Estimates from Ordinal Logistic Regression Models

Parameters	**Estimates**	**SE**	**Z value**	**Pr(>|z|)**
Intercept	1.50601	0.82038	1.836	0.06639
Awareness (Maybe)	-0.80405	0.61139	-1.315	0.18847
Awareness (Yes)	-1.90235	0.59866	-3.178	0.00148
Occupation (Students)	-2.46048	0.89905	-2.737	0.00621
Occupation (Self Employed)	-0.88896	0.56809	-1.565	0.11763
Occupation: Employed (Private Sector)	-0.08723	0.55216	-0.158	0.87447
Occupation: Employed (Public Sector)	-0.35184	0.72872	-0.483	0.62923
Age (18–24)	-0.06324	0.46551	-0.136	0.89193
Age (25–34)	0.44805	0.63879	0.701	0.48305
Age (35 +)	1.75860	0.54809	3.209	0.00133
Educational Level (ND/NCE)	-0.86564	0.39037	-2.217	0.02659

Table III indicates that awareness of recycling initiatives, occupation, age, and education significantly affect sustainable waste disposal. Students are more likely to adopt sustainable practices than the unemployed, and individuals aged 25–34 show higher engagement. Interestingly, higher education levels had a negative effect, implying that other socio-economic factors may play a more crucial role.

Model Formulation

The below Logistic model was formulated from the result of the analysis in Table III.

$$\log\left(\frac{P}{1-p}\right) = 1.50601 - 0.80405\ (Awareness\ Maybe) - 1.90235(Awareness{:}\ Yes) -$$

$$2.46048(Occupation{:}\ Student) - 0.88896(Occupation{:}\ Self-employed) -$$

$$0.08723(Occupation{:}\ Employed,\ Private\ Sector) -$$

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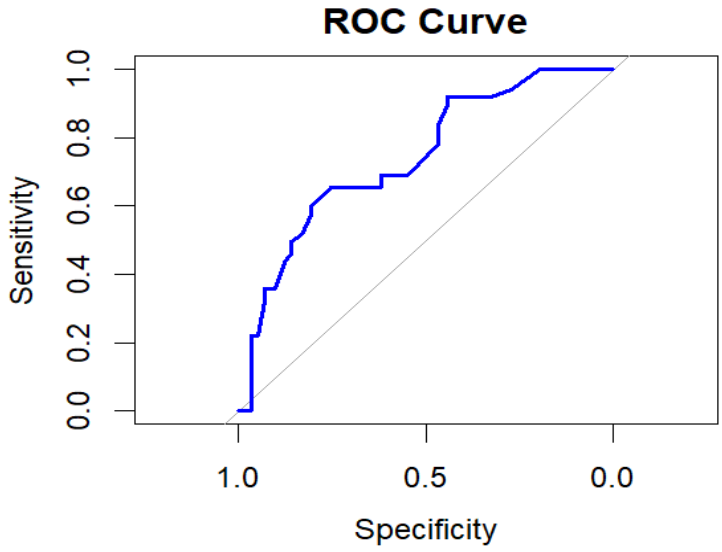
$0.35184(Occupation: Employed, Public Sector) - 0.06324(Age: 18-24) +$

$0.44805(Age: 25-34) + 1.75860(Age: 35+) - 0.86564(Education: ND/NCE)$

TEST FOR ASSUMPTIONS AND FITNESS OF THE MODEL USING RECEIVER OPERATING CHARACTERISTIC (ROC) CURVE

The ROC curve was plotted to assess the model's ability to distinguish between the two disposal methods (sustainable vs. unsustainable). It plots the true positive rate (sensitivity) against the false positive rate (1 - specificity) for various threshold values.



The curve appears well above the diagonal line, indicating good model performance. The closer the ROC curve approaches the top-left corner, the better the model distinguishes between the two classes.

DISCUSSION

The study examined waste disposal practices in the Iree community, focusing on demographic characteristics and their impact on waste management behaviors. Most respondents were aged 18–24 and exhibited moderate awareness of waste segregation, however, 37.5% lacked any awareness, indicating a need for educational initiatives to improve waste management knowledge.

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Environmental concerns were the primary motivator for recycling, cited by 41.5% of participants, while convenience and financial incentives also played a role. Burning was the most prevalent disposal method (32.5%), followed by public garbage collection. Composting was the least utilized, with only 6% adoption. Recycling programs were viewed as the most effective waste management strategy (30%), followed by composting at 28.5%.

A Chi-square test and logistic regression analysis identified awareness of recycling programs and occupational status as key factors influencing disposal behaviors. Older individuals and students were more likely to adopt sustainable practices. The logistic regression model demonstrated good predictive accuracy, suggesting that understanding these factors can guide future interventions and policy decisions to promote sustainability in the community.

CONCLUSION

This paper finds that although there is some awareness of waste segregation, a significant portion of the Iree community remains uninformed about sustainable waste management practices. While environmental concerns motivate recycling, unsustainable methods such as waste burning are still common. Awareness of recycling programs and occupational status significantly influence waste disposal decisions, with students and individuals aged 35 and above more likely to engage in sustainable practices.

The logistic regression model developed in this paper exhibited strong predictive accuracy, highlighting its potential for future use in assessing waste management behaviors and informing targeted interventions. To promote sustainable waste practices in Iree, policymakers and community leaders should prioritize awareness campaigns, improve access to recycling facilities, provide training and resources for professionals in relevant fields, collaborate with relevant stakeholders and address demographic barriers to encourage a more environmentally responsible future.

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