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Sustainable Waste Management in Cross River State: Assessing the Impacts of Recycling and Composting on Employment and Revenue Generation

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Abstract

Waste management issues in Nigeria, particularly in Cross River State, endanger public health and the environment. Inadequate waste practices result in waste buildup in both urban and rural areas. Sustainable methods like recycling and composting can offer economic benefits, create jobs, and alleviate poverty. This study seeks to explore the potential of sustainable waste management practices, particularly recycling and composting, to not only mitigate the waste crisis but also to drive employment and revenue generation. This research adopted a survey research design, employing questionnaires to assess the impact of sustainable waste management practices on socio-economic development. The study targeted 336 respondents from diverse sectors and used multiple regression analysis to evaluate the relationship between waste management practices and socio-economic development. Data analysis considered the significance of coefficients and tested for multicollinearity. The study revealed that waste recycling, waste reuse, reclaimed waste, recycling business activity, and recycled products collectively have a significant impact on socio-economic development. Recycling business activity demonstrated the most significant contribution, while waste reuse showed the least. The results suggest that sustainable waste management practices play a crucial role in enhancing employment and revenue generation in Cross River State. This study underscores the positive impact of waste recycling and composting in Cross River State, Nigeria. It emphasizes the role of waste pickers, recycling's effectiveness, and composting's economic and environmental benefits. These practices reduce waste, create jobs, and promote sustainability, highlighting the need for sustainable waste management in Cross River State.

Keywords*: Sustainable waste management, recycling, composting, employment, revenue generation*

Introduction

Waste management practices in Nigeria, like those in many developing nations, often involve the generation, collection, and indiscriminate dumping of mixed waste materials into designated dumpsites. This alarming situation has become a global concern, particularly for scholars, as it poses significant challenges to public health and the environment in these regions (Omole, Isiorho, S. A., & Ndambuki, 2016; Coker, Sangodoyin, Sridhar, Booth, Olomolaiye, & Hammond, 2009; Etim, Ndem, Inyang, & Ada, 2023). The compounding factors of urban migration, industrialization, and shifting consumer patterns have led to a substantial increase in waste generation, outstripping the capacity of waste management agencies to effectively handle this mounting challenge. In Nigeria, it is estimated that an average citizen generates approximately 0.49 kilograms of unwanted waste, with a quarter of this waste being haphazardly discarded on streets, open spaces, and highways, creating severe health hazards. What exacerbates this problem is that, in many urban centers and rural communities across Nigeria, the focus is primarily on receiving effective waste services, with less regard for environmental cleanliness. This has led to the unfortunate practice of discharging waste materials indiscriminately in unauthorized areas (Tiku, Isokon, & Enamhe, 2019; Ada, & Angioha, 2021). Despite the earnest

efforts made by waste agencies in Nigeria to rid streets and neighborhoods of indiscriminate waste disposal, success in this endeavor has remained elusive (Ada, & Akan, 2019; Ogwueleka, 2021; Ada, & Ada, 2013; Afolabi, Agbabiaka, Afon, Akinbinu, & Adefisoye, 2017).

Urban areas such as Calabar Metropolis, Ugep, Ikom, Ogoja, and Obudu in Cross River State face the repercussions of this mismanagement, generating vast quantities of municipal waste that often go uncollected (Bassey, Brooks, Asikong, & Andy, 2015; Oyedepo, 2014; Ingwe, Ada, & Angiating, 2014; Ingwe, Ada, & Adalikwu, 2015; Enamhe, Tangban, Ojong-Ejoh, Kenneth, Agba, & Ejoh, 2022). These accumulating heaps of waste lead to blocked drains and gutters, creating ideal breeding grounds for pests and, in turn, giving rise to a myriad of health problems. Waste management planners and experts in Nigeria have traditionally focused on waste management with a primary goal of safeguarding public health and enhancing environmental aesthetics. However, these practices have been underutilized as potential sources of revenue generation, employment opportunities, poverty alleviation, improved standards of living, enhanced environmental aesthetics, and health development.

It is against this backdrop that this research endeavors to investigate the multifaceted effects of waste management practices on the socioeconomic development of Cross River State, Nigeria. This study seeks to explore the potential of sustainable waste management practices, particularly recycling and composting, to not only mitigate the waste crisis but also to drive employment and revenue generation, ultimately enhancing the well-being of the state's residents.

Materials and Methods

Design

This study employed a survey research design, a subset of the ex post facto research method, utilizing questionnaires to analyze the significant relationships among variables. The non-manipulable independent and dependent variables, combined with aspects of exploratory research, were used to assess the impact of sustainable waste management practices on employment and revenue generatione. This design facilitated data collection through questionnaires and aided in addressing questions, solving problems, setting goals, and assessing needs. The study setting, Cross River State, located in the South-South geopolitical region of Nigeria, consists of three political zones with a total of eighteen local government areas.

Sampling

The study's total population consisted of 2,095 individuals, comprising various entities: the Ministry of Environment (808), Calabar Band Development Authority (212), Ugep Urban Development Authority (215), Ikom Urban Development Authority (286), Ogoja Urban Development Authority (283), Obudu Development Authority (279), and the private sector (12). A sample size of 336 was selected from this population using Taro Yamane's sample size determination technique. Stratified and simple random sampling methods were employed to select the sample.

The population was stratified into seven categories: Ministry of Environment (Stratum 1), Calabar Urban Development Authority (Stratum 2), Ugep Urban Development Authority (Stratum 3), Ikom Urban Development Authority (Stratum 4), Ogoja Urban Development Authority (Stratum 5), Obudu Urban Development Authority (Stratum 6), and the private sector (Stratum 7). Within each stratum, respondents were chosen using simple random sampling. The Hat and Draw method were used, involving pieces of paper with "YES" and "NO" written on them, which were shuffled in a hat. Respondents selecting "YES" were included in the study and given a questionnaire to complete. This process was repeated for all strata, resulting in a final sample size of 336 individuals.

Method of Data Analysis

The study will employ multiple regression analysis to examine the impact of waste recycling and composting on employment and revenue generation in Cross River State, utilizing data collected from various sources. This analysis involves data cleaning, transformation, and standardization, followed by a statistical software application for regression modeling. The results will be interpreted by assessing the significance of coefficients, p-values, and R-squared values to determine the extent of the effects of waste management practices on economic outcomes, building on established research methodologies in the field.

Findings

Demographic information of respondents

Table 1 provides an overview of the respondent distribution based on various demographic items. For Item 1, out of the total 316 respondents surveyed, 156 (49.3%) were male, while 160 (50.7%) were female. In Item 2, the age distribution reveals that among the surveyed respondents, 36 (11.4%) were in the 16-20 age bracket, 102 (32.3%) were in the 21-25 age bracket, 101 (32.0%) fell in the 26-30 age bracket, and 63 (19.9%) were aged 31 or above. Moving on to Item 3, the qualifications of the respondents show a diverse educational background. Among the 316 respondents, 25 (7.9%) had no formal education, 166 (52.5%) possessed primary education, 34 (10.8%) had secondary education, 28 (8.9%) had tertiary education, and 49 (15.5%) had other educational qualifications. For Item 4, the marital status of the respondents varied. Of the 316 participants, 58 (18.4%) were single, 88 (27.8%) were married, 79 (25.0%) were divorced, and 82 (25.9%) were widowed. Lastly, Item 5 illustrates the occupational status of the respondents. Out of the total respondents, 159 (50.3%) were in senior staff positions, 114 (36.1%) held junior staff roles, and 15 (4.7%) worked as ad hoc staff. Distribution of responses by demographic data.

Table 1: demographic data of respondents

S/N			Frequency	Percent	Valid Percent	Cumulative Percent
		Male	156	49.3	49.3	49.3
1	Gender	Female	160	50.7	50.7	100.0
		Total	316	100.0	100.0	
		16-20	36	11,4	H.9	11.9
		2L25	102	32.3	33.8	45.7
		26-30	101	32.0	33.4	79.1
2	Age Bracket	31 or above	63	19.9	20,9	100.0
		Total	302	95.6	100.0	
		Missing	14	4.4		
		Total	316	100.0		
		No formal	25	7.9	8.3	8.3
		Primary education	166	52.5	55.0	63.2
		Secondary education	34	10.8	11.3	74.5
		Tertiary education	28	8.9	9.3	83.8
3	Qualifications	Others	49	15.5	16.2	100.0
		Total	302	95.6	100.0	
		Missing	14	4.4		
		Total	316	100.0		
		Single	58	18.4	18,9	18,9

		Married	88	27.8	28.7	47.6
		Divorced	79	25.0	25.7	73.3
4		Widowed	82	25.9	26.7	100.0
	Marital Status	Total	307	97.2	100.0	
		Missing	9	2.8		
		Total	316	100.0		
		Senior staff	159	50.3	55,2	55,2
		Junior staff	114	36,1	39.6	94.8
S	Occupational	ad hoc staff	15	4.7	5.2	100.0
	Status	Total	288	91.1	100.0	
		Missing	28	8.9		
		Total	316	100.0		

Presentation of Results

Hypothesis one

There is no significant effect of waste recycling on socio-economic development.

Table 2: Model Summary showing the effect of waste recycling on socio-economic development

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,338[a]	.114	.100	5.10838

a. Predictors: (Constant), waste recycling, waste reuse, reclaimed waste, recycling business activity, recycled products.

Table 3: ANOVA showing the effect of waste recycling on socio-economic development

Model		Sum of Squares	Df	Mean Square	P	Sig.
1	Regression	1001.301	5	200.260	7.674	.000[b]
	Residual	7750.369	297	26.096		
	Total	8751,670	302			

a. Dependent Variable: Socio-economic Development
b. Predictors: (Constant), waste recycling, waste reuse, reclaimed waste, recycling business activity, recycled products

Table 4:Coefficients® showing the effect of waste recycling on socio-economic development

Model	Unstandardized Coefficients		Standard Coefficients	t	Sig.	Co-Linearity Statistics	
		Std. Error	Beta			Tolerance	VIF
1 (Constant)	B 9.128	1.799		5.073	.000		
Waste reuse	0.234	.356	0.03734998	0.659	.511	0.92746	1.07822
Waste recycling	-0-303	.554	-0.0442806	-0.547	.585	0.4545	2.20024
Reclaimed waste	0.560	.464	0.08644229	1.209	.228	0.58287	1.71564

Recycling business activity	1.567	.391	0.30549588	4.005	.000	0.51247	1.95132
Recycled products	0.287	.348	0.05741098	0.827	-409	0.61808	1.61791

a. Dependent Variable: Socio-economic Development

The results of the multiple regression analysis conducted to test Hypothesis 1 are presented in Tables 2, 3, and 4. The findings suggest that waste recycling, waste reuse, reclaimed waste, recycling business activity, and recycled products collectively have a significant impact on socio-economic development in Cross River State. The respective regression coefficients (B1 = -0.234, B2 = -0.303, B3 = 0.560, B4 = 1.567, B5 = 0.287) and their associated p-values were reported. Notably, recycling business activity (B4) had the strongest unique contribution (Beta = 0.3055) to explaining the dependent variable, followed by the practice of waste recycling (Beta = 0.08644), while waste reuse made the smallest contribution (Beta = 0.0373), confirming its insignificance.

Additionally, Tables 4.7 and 4.8 demonstrate a significant F statistic, indicating the model's predictive strength ($R2 = 11.4\%$, $F = 7.674$, $p < 0.05$). This implies that approximately 11.4% of the variation in socio-economic development can be jointly attributed to waste recycling, waste reuse, reclaimed waste, recycling business activity, and recycled products.

To address concerns of multicollinearity, the tolerance values and VIFs (Variance Inflation Factors) were examined. The high tolerance values, greater than 0.8, indicated that less than 55% to 8% of the variance in each predictor was explained by the other predictors. Additionally, VIFs less than 5 suggested that there were no significant issues with multicollinearity in the model.

In summary, the findings reject Hypothesis 1 and highlight the collective influence of various waste-related factors on socio-economic development in Cross River State, with recycling business activity playing a particularly significant role. The regression analysis and assessment of multicollinearity ensure the robustness of these results.

Hypothesis Two

There is no significant effect of waste composting on socio-economic development in Cross River State.

Table 5

Ode Summary showing the effect of waste composting on socio-economic development Model R R Square Adjusted R Square Std. Error of the Estimate

1 .391" .153 .139 5.02484

a. Predictors: (Constant), waste reduction, composting biodegradable waste material, waste reuse, composting organic and inorganic waste material, composting for agricultural purposes.

Table 6: ANOVA[a] showing the effect of waste composting on socio-economic development

Model	Sum of Squares	•Df	Mean Square	F	Sig-
1	Regression 1351.829	5	270.366	10.08	.000°
	Residual 7473.711	296	25.249		
	Total 8825.540	301			

a. Dependent Variable: Socio-economic Development:

b. Predictors: (Constant), Waste reduction, composting biodegradable waste material, waste reuse, composting organic and inorganic waste material, composting for agricultural purposes.

TABLE 7: Coefficients showing the effect of waste composting on socio-economic development

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	
1 (Constant)	8.746	1.316		6.645	.000		
Composting biodegradable material	0.223	.335	0.0413675	0.667	.505	0.74361	1.3448
Waste reuse	0.723	.392	0.13623408	1.843	.066	0.52369	1.90951
Composting organic and inorganic waste material	.381 0.040		- 0.0073344	-0.105	.917	0.5831	1.71496
Waste reduction	0.627	.421	0.11054377	1.489	.138	0.51899	1.92683
Composting for agricultural purposes	0.994	.348	0.20655357	2.858	.005	0.54788	1.82523

a. Dependent Variable: Socio-economic Development

Tables 5,6,7 report the results of the multiple regression analysis carried out to test Hypothesis 2. The results show that waste reduction, composting biodegradable waste material, waste reuse, composting organic and inorganic waste material, and composting for agricultural purposes jointly have a significant effect on socio-economic development in Gross River State. (Bl = 0.223, $p > 0.05$; B2 = 0.723, $p > 0.05$; B3 = 0.040, $p > 0.05$; B4 = 0.627, $p > 0.05$; B5 = 0.994, $p < 0.05$). Tables 4.11 and 4.8 further reports a significant F statistic, indicating the model's prediction strength ($R^2 = 15.3\%$, $F = 10.708$, $p < 0.05$). Therefore, Hypothesis 2 was rejected. The R^2 of 15.3 per cent implies that for every unit change in socio-economic development, 15.3 per cent of such variation is jointly attributed to or explained by waste reduction, composting biodegradable waste material, waste reuse, composting organic and inorganic waste material, composting for agricultural purposes. For comparison purpose, we look closely at the Beta column (table 7) for the independent variable with high beta values. It is seen that composting for agricultural purposes has made the strongest contribution to explaining the dependent variable (Beta = 0.2065), when the variance explained by all other variables in the model is controlled for. The Beta value for composting organic and inorganic waste material was the lowest (Beta = 0.0073), indicating that it made the least contribution in explaining the dependent variable, at the same time confirming its insignificance. In addressing multicollinearity concerns, we look at the tolerance column which shows the percentage of the variance in a given predictor that cannot be explained by the other predictors. Thus, the high tolerances show that only less than 49% - 36% of the variance in a given predictor can be explained by the other predictors, and, with VIFs less than 5, it implied that there were no problems with multicollinearity.

Discussion of Findings

The study's findings underscore the significant effect of waste recycling on the socioeconomic development of Cross River State, Nigeria. This conclusion aligns with previous research by Scheinberg and Anchutz (2010), which highlighted the essential role of waste pickers in the informal economy, particularly in their vital contributions to social, ecological, and economic services in developing countries. It also resonates with the findings of Mohammed Kenneth and Emad (2015), who emphasized the importance of waste pickers in informal waste management, particularly in terms of waste reduction, minimization, and material recovery. Importantly, the

study affirms that scavengers' material contributes significantly to making recycling a profitable business for those in need, especially in poverty-stricken areas. Moreover, this research is in agreement with the work of Aljadin, Pesson, and Al-tawi (2011), which focused on the effect of waste recycling on employment generation in Nigeria. Their findings indicate that waste pickers, often from impoverished backgrounds, engage in recycling activities to make a living from recycled materials. Wilson (2007) also supports this, highlighting that waste scavenging can lead to grassroots development, poverty alleviation, and environmental protection. Additionally, it reduces the time and money spent by businesses on waste sorting, collection, and transportation. The recognition of waste recycling's effectiveness in managing waste and creating employment opportunities is growing in Nigeria. It not only reduces the cost of the formal waste management system but also turns scavenging into a profitable business. Scavenging is viewed as an avenue to improve resource efficiency, with commonly collected materials including aluminum, plastic, paper, cardboard, glass, copper, and iron. Organic waste predominates in the waste stream, aligning with Nigeria's status as a developing country with a significant agricultural waste component. The recycling business has become lucrative, especially given the rising costs of natural resources globally. This practice benefits not only economically but also environmentally, reducing overall environmental damage, global warming, and safeguarding human lives and aesthetics. In addition, waste recycling leads to increased production scales and sustains lower prices for recycled products, mitigating price fluctuations.

Furthermore, the study corroborates the observations of Van Benkaing (2011) that waste recycling extends the lifespan of products and services derived from waste materials, making them more readily available. Nigel, Dogmas, Garvin, and Mcgrath (2010) also assert that waste recycling creates employment opportunities and generates household income and tax revenue for the government in many developing countries. In the study area, commercial scavenging has emerged as a profitable business, preventing the disposal, burning, or burial of valuable materials. It emphasizes the potential of segregating waste components to serve as raw materials for cottage industries, generate employment, and eliminate refuse in Cross River State.

The study also underscores the significantly positive impact of waste composting on the socioeconomic development of Cross River State, Nigeria. This finding aligns with the work of Tobore (2013), who emphasized that composting solid waste into compost manure can reduce the demand for chemical fertilizers, conserve foreign exchange, and enhance economic productivity in developing countries. Additionally, it resonates with Aftab (2013), who suggested that using compost manure as a substitute for chemical fertilizers can lower production costs, improve farmers' income, reduce poverty, and create employment opportunities in developing nations.

Furthermore, the study supports the assertion of Adamu, Rozilah, and Bala (2015), indicating that composting and manufacturing processes generate a chain of economic activities, engaging labor in production, sales, transportation, and other related sectors, thereby creating employment and generating revenue. Additionally, waste composting significantly reduces the volume of solid waste, particularly in urban and rural areas in developing countries like Nigeria. It aligns with Sahari, Mir, Basri, Begum, and Mahmood (2012), who noted that composting organic waste materials reduces the loss of waste and carbon dioxide, leading to volume reduction. Moreover, waste composting can lower operating costs associated with waste collection and transportation, representing a substantial fraction of the total waste management cost. In Cross River State, organic waste, such as banana peels, leaves, and maize cobs, is composted and used as organic fertilizer in farming. This approach has not only improved soil physiochemical properties but also reduced environmental pollution. Waste composting has gained acceptance as a method of waste disposal in many communities in the study area, reducing the burden of waste disposal. In conclusion, the study highlights the crucial roles of waste recycling and composting in driving socioeconomic development in Cross River State. These practices reduce waste, create

employment opportunities, and contribute to environmental sustainability, ultimately improving the overall well-being of the region.

Conclusion and Recommendations

The study's outcomes underscore the profound and positive influence of waste recycling and composting on the socioeconomic development of Cross River State, Nigeria. These findings resonate with prior research and emphasize the pivotal role of waste pickers in facilitating effective waste management while also creating valuable employment opportunities. Furthermore, the conversion of solid waste into compost manure is shown to be economically and environmentally advantageous. These sustainable practices not only reduce waste but also bolster job prospects and enhance environmental sustainability, contributing holistically to the region's well-being.

Based on this, it is imperative to empower waste pickers with training, safety gear, and support. Upgrade recycling infrastructure through public-private partnerships and incentives. Promote grassroots composting for sustainable waste reduction. Integrate informal waste pickers into formal systems, ensuring fair compensation. Raise public awareness for responsible waste management and environmental preservation.

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