International Journal of Education, Management Sciences and Professional Studies (IJEMPS)
Vol. 3 Issue 2, 2026 PRINT *ISSN:3115-5065* || E-ISSN:3115-5545
URL: https://journals.iempsglobal.org/index.php/IJEMPS

WASTE RECYCLING PRACTICES, RESOURCE CONSERVATION, AND OPERATIONAL COST REDUCTION IN NIGERIAN PRINTING PRESS ORGANISATIONS: EMPIRICAL EVIDENCE FROM LAGOS STATE

Ohallem Nneka Vivian
Department of Business Administration,
University of Lagos, Akoka, Yaba, Lagos State, Nigeria

Prof. Patrick Sunday Okonji
Department of Business Administration,
University of Lagos, Akoka, Yaba, Lagos State, Nigeria
sokonji@unilag.edu.ng +2348035789583

Assoc. prof. Peter O. Olayiwola
Department of Business Administration,
University of Lagos, Akoka, Yaba, Lagos State, Nigeria
polayiwola@unilag.edu.ng +2348023005464

Abstract

The generation of industrial wastes is increasingly becoming a problem from an environmental and economic perspective in the Global South, but the impact of the recycling practices of organisations on the performance of resource-poor small and medium enterprises (SMEs) in developing economies is still largely under-researched. This study examines the relationship between sustainable waste recycling practice (WRP) and two organisational performance outcomes (resource conservation (RC) and operational cost reduction (CR) in printing press organisations in Lagos State, Nigeria. A positivist cross-sectional survey design was used, with the Natural Resource-Based View (Hart, 1995) and institutional theory (DiMaggio & Powell, 1983) as the theoretical underpinning for this study, a structured questionnaire was administered to 188 supervisory and managerial employees who were purposively sampled from registered printing establishments in Shomolu and Ikeja Local Government Areas. Reliability assessment showed that the internal consistency of the five measurement scales was acceptable to good (Cronbach's α: .696 - .855). Descriptive findings revealed a bifurcated adoption pattern: basic paper recycling practices were broadly institutionalised (M range: 4.04–4.12), while technically advanced systems — solvent recovery, wastewater treatment, VOC minimisation, remained largely absent (M range: 2.14–2.23). Ordinary least squares regression analyses found that WRP did not significantly predict RC ($\beta = .111$, $p = .128$, $R^2 = .012$) or CR ($\beta = .080$, $p = .278$, $R^2 = .006$), retaining both null hypotheses. The findings challenge the universality of the circular economy win-win hypothesis under developing-economy institutional conditions, extend the Natural Resource-Based View by demonstrating that capability depth and institutional embeddedness, not mere adoption, determine performance returns, and provide original empirical documentation of the bifurcated recycling *adoption pattern characteristic of Sub-Saharan African printing SMEs. Implications for theory, practice, and policy are systematically discussed.*

Keywords: waste recycling practices; resource conservation; cost reduction; circular economy; Natural Resource-Based View; printing industry; SMEs; Nigeria; Sub-Saharan Africa

Introduction

Industrial production systems worldwide generate substantial waste volumes that impose serious environmental and economic burdens on societies, ecosystems, and productive enterprises. Production strategies based on recycling, material recovery and resource efficiency have consequently garnered increasing attention in the literature, at regulatory and management levels, and in various industry sectors (Geissdoerfer et al., 2017; Kirchherr et al., 2023; Velenturf & Purnell, 2021). At the heart of these approaches is the circular economy (CE) concept that considers industrial production as a closed cycle of material flows, in which waste from one process is used as input for another, with waste permanently removed and natural capital continuously renewed (Ellen MacArthur Foundation, 2013; De Angelis et al., 2018). The printing industry provides an important context for examining these sustainability challenges because its production activities involve the continuous use of paper, inks, solvents, chemicals, water, energy, and other production materials. Different stages of the printing process can generate several categories of waste, including paper trimmings, rejected printed materials, ink residues, solvents, wastewater, packaging materials, and chemical residues. Consequently, the environmental implications of printing extend beyond paper disposal to include the management of chemical, liquid, and gaseous waste streams (Pivnenko et al., 2019; Gavrilescu et al., 2020). Previous studies on industrial recycling and CE have focused mainly on manufacturing, electronics and construction industries in high-income countries and have tended to prioritize technological solutions over an analysis of whether organisational recycling practices available to SMEs can offer the same performance benefits (Geissdoerfer et al., 2017; Kirchherr et al., 2023; Dereli & Baykasoglu, 2019). This study tackles a fundamental theoretical tension: the CE "win-win" hypothesis suggests that material loops can have positive environmental and economic effects, while the Natural Resource-Based View (Hart, 1995) suggests that environmental capabilities create economic advantage when they are sufficiently developed and institutionally embedded. These predictions require testing in developing countries where recycling infrastructure, technical capacity, scale economies and supportive policy mechanisms are limited. With this background, the study has two research questions: RQ_1: What is the association between sustainable waste recycling practices and resource conservation among printing press organisations in Lagos State, Nigeria? RQ_2: Is there any relationship between sustainable waste recycling and cost reduction of the printing press organisations in Lagos State, Nigeria? The questions are operationalised in the form of two formal hypotheses which are tested with Pearson correlation and ordinary least squares (OLS) regression analysis on a sample of 188 respondents. The study contributes by offering empirical evidence from printing organisations in Sub-Saharan Africa, testing the CE win-win hypothesis under institutional scarcity, extending the NRBV through attention to capability depth and institutional embeddedness, and documenting bifurcated recycling adoption in developing-economy printing SMEs.

Literature Review

Waste Generation in the Printing Industry

The waste products of industrial printing processes include a variety of waste streams such as solid materials, paper offcuts, used plates, spent cartridges, and chemical effluents including ink residues, volatile organic chemicals (VOCs) and solvent-laden wastewater (Pivnenko et al., 2019; Ferronato & Torretta, 2019). According to Gavrilescu et al. (2020), waste from printing processes represents a considerable part of the urban industrial solid waste, while Pivnenko et al. (2019) show that the chemical composition of the printing waste is very complex and makes the recovery process very difficult. Corresponding to this, more and more studies report recycling measures implemented by printing companies, such as waste minimisation, paper recycling, chemical recycling and procurement of eco-materials (Zhu et al., 2019; Khan et al., 2020). Hayta and Oktav (2023) warn, however, that having sustainable options does not necessarily mean that they will be adopted, as some organisations might not have the technical know-how, financial capability or regulatory pressure to change.

Sustainable Waste Recycling Practices

Sustainable waste recycling practices (WRP) are considered as systematic methods for recovering, processing, and reusing waste materials to lower the need for virgin resources, decrease the amount of waste sent for disposal, and enhance the efficient use of resources (Kirchherr et al., 2023; Velenturf & Purnell, 2021). This definition differentiates recycling from incineration because incineration is not considered a form of recycling due to the loss of material value and concerns about hazardous by-products (Makarichi et al., 2018; Aiguobarueghian et al., 2024). In the case of printing, recycling processes range from low capital paper management systems to high capital solvent recovery, wastewater treatment, and formal take-back systems (Pivnenko et al., 2019).

The Technology Bias in Printing Sustainability Research

A critical appraisal of the printing sustainability literature reveals a systematic bias toward technological solutions over organisational practices. Digital printing, computer-to-plate systems, UV-curable inks, AI-driven waste sorting, and dry defibration technologies have attracted the overwhelming majority of scholarly attention (Dereli & Baykasoglu, 2019; Silva et al., 2020; Ragaert et al., 2017). This technological orientation produces a body of evidence that speaks almost exclusively to large, capital-rich firms in developed economies and is largely silent on the performance implications of lower-capital organisational recycling practices available to developing-economy SMEs. These practices, paper segregation, solvent recovery routines, chemical take-back participation, eco-material procurement, require organisational routines and managerial commitment rather than capital-intensive equipment, making them the realistic sustainability entry point for most Lagos printing enterprises.

Circular Economy Principles and Resource Conservation

The circular economy has emerged as the dominant framework for sustainable industrial production (Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2017), rejecting the linear take-make-dispose model in favour of closed-loop systems characterised by continuous material reuse, repair, remanufacture, and recycling (Kirchherr et al., 2023). Resource conservation, defined by Foo (2016) as the awareness and application of practices that preserve and manage natural resources for current and future generations — is both a goal and a measure of CE effectiveness. Empirical support for the CE-resource conservation relationship is substantial across diverse industrial sectors, predominantly in high-income contexts: Merli, Preziosi, and Acampora (2018), in a systematic review of 127 CE empirical studies, confirm that CE adoption is positively associated with material efficiency and environmental performance across manufacturing sectors, though they note that evidence from low-income institutional contexts remains sparse. De Angelis et al. (2018) prove that circular supply chain configurations lead to a decrease in material consumption per unit; Arora et al. (2023) find that the principles of CE are a catalyst for process innovation and an increase in resource productivity; and Udo et al. (2024) verify that circular practices increase resource efficiency by optimising material use throughout the product life cycle. The question of whether or not these effects are reproduced in Sub-Saharan African institutional voids is precisely what H_1 tests. Given the theory and evidence:

H_1: There is a significant positive association between Sustainable waste recycling practices and Resource conservation among printing press organisations in Lagos State, Nigeria.

Recycling Practices and Operational Cost Reduction

The CE win-win hypothesis suggests that CE can create mutual benefits for both the environment and the economy, including the substitution of recycled materials for virgin materials to reduce raw material procurement costs, diversion of materials from landfill to reduce landfill disposal costs, reduction in energy intensity of secondary material processing, and increase in operational efficiency through systematic management of materials (Zhu & Sarkis, 2004; Khan et al., 2020; Igbinenikaro & Adewusi, 2024). In high-income settings, there is a significant amount of empirical evidence (Cucchiella et al., 2016; Gavrilescu et al., 2020; Singh & Ordóñez, 2021). But there is a lot more debate about the economic argument in the developing economy setting. Aliu Adekunle et al. (2022) show that recycling is costly in terms of operation in a situation of low technology and infrastructural support. Ngan et al. (2019) note that the circular transition is often accompanied by a loss of performance in the initial period, followed by an improvement in efficiency, which can be a time lag that can be extended under developing-economy conditions. In the context of small-scale industrial recyclers, Adegbite et al. (2023), in a directly relevant African manufacturing context, report that small-scale industrial recyclers often face a net loss in early adoption stages. The results indicate that the economic arm of the win-win hypothesis does not always work, but is dependent on institutional enabling factors:

H_2: There will be no significant reduction in the operational costs of printing press organisations in Lagos State, Nigeria, by implementing sustainable waste recycling practices, and perhaps it would increase the operational costs of the printing press organisations, due to the institutional and infrastructural conditions of a developing-economy context.

The Natural Resource-Based View: Framework and Critical Evaluation

The Natural Resource-Based View (Hart, 1995) builds on the resource-based view (Barney, 1991) and adds the natural environment as a boundary condition on firm strategy and includes three interrelated environmental capabilities: pollution prevention, product stewardship and sustainable development. The operationally embedded routine of pollution prevention is the main focus of this study, and this is equated with WRP. The NRBV anticipates that pollution prevention will yield not only resource conservation benefits, but ultimately, cost benefits as well, in terms of less resources used and less disposal expense. But it is important to approach the NRBV in a critical manner and not as a received authority. Aragón-Correa and Sharma (2003) provide empirical evidence that the link between proactive environmental strategy and performance is highly dependent on the institutional dynamism, munificence and complexity which are systematically less favourable in developing economies.

In the case of printing, Krystosiak et al. (2024) discover that environmental efficiency is influenced by process optimisation and material management infrastructure, which are the most limiting factors in the Lagos printing sector. These critical perspectives result in a theoretically coherent, and empirically testable, proposition: the two performance parts of the win-win hypothesis do not have equal accessibility under all institutional circumstances.

Research Methodology

Research Design and Philosophical Positioning

The research design used in this study was quantitative cross-sectional research with a positivist epistemological approach. According to the positivist perspective, social reality can be objectively known through systematic empirical observation and scientific inquiry should be based on verifiable and quantifiable evidence (Saunders et al., 2019; Creswell, 2014).

Population, Sampling, and Data Collection

The study population consisted of supervisory and managerial staff of printing establishments in Shomolu and Ikeja Local Government Areas of Lagos State. The population was estimated at 369 employees across registered printing establishments. Using Krejcie and Morgan (1970), a sample size of 191 was obtained. The final dataset contained 188 valid responses, representing a 98.4% response rate. Purposive sampling was used to ensure that respondents had sufficient operational knowledge of recycling practices.

Measurement Instrument

The questionnaire had 4 sections. Demographic data was obtained in Section A. Section B assessed waste recycling practices for 16 items under three sub scales: Basic Recycling Practices (BRP, 6 items), Process and Material Efficiency (PME, 5 items) and Advanced Technical Recycling Systems (ATR, 5 items). There were 8 items measuring resource conservation (RC) and 8 items measuring cost reduction (CR) in Section C and D, respectively. A 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) was used on all Likert items. The scales were developed based on existing instruments by Kirchherr et al. (2019), Zhu and Sarkis (2004) and Foo (2016) and were adapted to the printing industry context by expert review and pilot testing with five printing industry practitioners

Data Analysis

IBM SPSS Statistics (v.27) was used to analyse the data. The internal consistency was calculated by Cronbach's alpha coefficients, which was suggested by Nunnally (1978) as the value of $\alpha \geq .70$. Convergent validity evidence was provided by calculating alpha and composite reliability (CR) of each construct; the alpha ranged from .71 to .87 (all above the .70 threshold; Hair et al., 2010) and AVE ranged from .38 to .54. The PME subscale AVE (.38) is slightly lower than the cut-off value of .50 (Fornell & Larcker, 1981), which is known as a validity boundary condition, and this is consistent with the alpha attenuation reported for this subscale.

Results

Results are reported in five steps: the profile of the respondents, the reliability of the measurement instrument, descriptive statistics of all scale items, bivariate correlation between the study variables and hypothesis testing using OLS regression. This sequence is based on the analytical thinking of verifying data quality, descriptive characterisation and inferential testing.

Respondent Profile

Table 1 *Demographic profile of respondents (n = 188)*

Characteristic	Category	n	%
Gender	Male	105	55.9
	Female	83	44.1
Age	18–25 years	35	18.6
	26–35 years	55	29.3
	36–45 years	57	30.3
	46 years and above	41	21.8
Educational qualification	Secondary School Certificate	17	9.0
	OND/NCE	31	16.5
	HND/B.Sc.	88	46.8
	Postgraduate Degree	52	27.7

Work experience	Less than 5 years	35	18.6
	5–10 years	65	34.6
	11–15 years	51	27.1
	Above 15 years	37	19.7
Department	Production	57	30.3
	Administration	36	19.1
	Environmental/Safety Unit	23	12.2
	Quality Control	44	23.4
	Others	28	14.9

Source: Survey 2026

Table 1 presents the demographic profile of the sample. Males constituted 55.9% (n = 105) and females 44.1% (n = 83), reflecting the moderately male-skewed workforce composition typical of Nigerian industrial SMEs (Okafor & Nwosu, 2021). The age distribution was concentrated in the 26–45 years range, with the 36–45 years cohort constituting the largest group (30.3%, n = 57), followed by the 26–35 years cohort (29.3%, n = 55). This concentration in the economically active mid-career age range implies a workforce with sufficient occupational experience to provide contextually informed responses on recycling practices and their perceived outcomes. Educationally, HND/B.Sc. holders constituted the largest group (46.8%, n = 88), and 74.5% of the total sample (n = 140) held tertiary qualifications, consistent with the minimum supervisory-grade eligibility criterion and with evidence that educational attainment is positively associated with environmental awareness (Mensah, 2019). Work experience was distributed across all four categories, with 81.4% of respondents reporting five or more years of industry experience — a pattern that validates the purposive eligibility criterion and ensures that responses reflect substantive operational familiarity with recycling practices rather than surface-level awareness.

Table 2 *Reliability statistics for study scales*

Scale	Items (k)	Α	Verdict	Threshold
Basic Recycling Practices (BRP)	6	.769	Acceptable	≥ .70
Process & Material Efficiency (PME)	5	.696	Borderlinea	≥ .70

Advanced Technical Recycling (ATR)	5	.810	Good	≥ .70
Resource Conservation (RC)	8	.805	Good	≥ .70
Cost Reduction (CR)	8	.855	Good	≥ .70

Source: Survey 2026

Reliability Assessment

Table 2 shows Cronbach's alpha coefficients for the five scales. Four scales achieved acceptable to good internal consistency (BRP, ATR, RC, and CR), while PME had $\alpha = .696$, a value considered acceptable in exploratory research. Overall, the reliability evidence was sufficient to support subsequent analysis.

Descriptive Statistics

Table 3 *Descriptive statistics for all scale items (n = 188)*

Item	M	SD	Level
Subscale A: Basic Recycling Practices (BRP)			
Active paper waste recycling (Q1)	4.07	1.15	High
Paper waste segregation at source (Q6)	4.05	1.07	High
Paper waste dispatched for recycling (Q7)	4.12	1.11	High
Recycled/sustainable paper procurement (Q11)	4.08	1.07	High
Internal recycling training (Q15)	4.11	1.15	High
Environmental management goals (Q16)	4.04	1.14	High
Subscale B: Process & Material Efficiency (PME)			
Excess ink recovery (Q9)	2.49	1.30	Low
Eco-friendly ink alternatives (Q10)	3.40	1.29	Moderate
Recycled-content substrate use (Q13)	3.41	1.34	Moderate

Waste monitoring/reporting system (Q14)	3.40	1.29	Moderate
Formal integration into production (Q5)	3.38	1.29	Moderate
Subscale C: Advanced Technical Recycling (ATR)			
Ink/solvent recovery system (Q2)	2.20	1.09	Low
Wastewater treatment and reuse (Q3)	2.19	1.09	Low
VOC emissions minimisation (Q4)	2.22	1.11	Low
Ink/cartridge take-back programmes (Q8)	2.14	1.14	Low
Cleaning solvent recovery (Q12)	2.23	1.09	Low
Section C: Resource Conservation (RC)			
Recycling reduced raw material wastage (RC1)	3.86	1.22	Moderate
Improved efficient utilisation of resources (RC2)	3.85	1.22	Moderate
Conserves paper and printing materials (RC3)	3.85	1.20	Moderate
Improved operational sustainability (RC4)	3.76	1.16	Moderate
Reduced excessive consumption of materials (RC5)	3.88	1.27	Moderate
Reuse improved production efficiency (RC6)	3.84	1.22	Moderate
Energy conserved through recycling (RC7)	3.92	1.20	Moderate
Contributes to environmental sustainability (RC8)	3.87	1.22	Moderate
Section D: Cost Reduction (CR)			

Reduced cost of raw material procurement (CR1)	3.74	1.31	Moderate
Minimised operational expenses (CR2)	3.81	1.29	Moderate
Reuse contributed to cost savings (CR3)	3.76	1.34	Moderate
Reduced waste disposal costs (CR4)	3.71	1.29	Moderate
Improved organisational profitability (CR5)	3.72	1.31	Moderate
Reduced expenditure on production inputs (CR6)	3.74	1.26	Moderate
Improved financial efficiency (CR7)	3.76	1.24	Moderate
Economic benefits through recycling (CR8)	3.71	1.27	Moderate

Note. *M = mean; SD = standard deviation. Level classification applied: Low = M < 2.50; Moderate = 2.50 ≤ M < 3.50; High = M ≥ 3.50. Five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).*

Table 3 reveals the study's central descriptive finding: a three-tier stratification of recycling adoption. The BRP subscale items, covering paper segregation, dispatch for recycling, sustainable procurement, internal training, and environmental target-setting, recorded uniformly high means, ranging from 4.04 (SD = 1.14; environmental management goals) to 4.12 (SD = 1.11; paper waste dispatched for recycling). The PME subscale exhibited a bifurcation within itself. Four of five items recorded moderate means: eco-friendly ink alternatives (M = 3.40, SD = 1.29), recycled-content substrate use (M = 3.41, SD = 1.34), waste monitoring (M = 3.40, SD = 1.29), and formal process integration (M = 3.38, SD = 1.29). The exception was excess ink recovery (M = 2.49, SD = 1.30), which scored below the Moderate threshold, indicating that ink reclamation technology, despite its material recovery potential, remains largely underdeveloped even among organisations that have partially adopted other process efficiency measures. This item's low mean corroborates its weak item-total correlation and reflects the capital-intensity of ink reclamation infrastructure relative to the financial capacity of Lagos printing SMEs (Eze et al., 2022). Most importantly, all five ATR items fell below the Low threshold (M range: 2.14 to 2.23) with take-back programmes having the lowest score (M = 2.14, SD = 1.14) and cleaning solvent recovery having the highest score (M = 2.23, SD = 1.09) within the subscale. The values are close to the minimum, suggesting that the technically advanced recycling systems, such as solvent recovery, wastewater treatment, VOC minimisation and cartridge take-back, are not currently in place in the sampled organisations. This discovery directly confirms Nwosu et al. (2023) that gaps in the regulation and infrastructural shortcomings are structural challenges to implementing such systems in Sub-Saharan African printing industries. All the items related to resource conservation were grouped around the Moderate level (M range: 3.76 – 3.92), with energy conservation through recycling activities having the highest mean (M = 3.92, SD = 1.20) and improved operational sustainability having the lowest (M = 3.76, SD = 1.16). The mean points for the RC items were quite similar and the spread was relatively small (0.16 mean points), indicating internally consistent moderate perceptions of the resource conservation benefits of recycling. Cost reduction items were also squeezed at the Moderate level (M range: 3.71–3.81), with minimised operational expenses getting the highest score and reduced waste disposal costs and economic benefits through recycling getting the lowest score.

The near-parallel distributions of RC and CR means are analytically important: They indicate that respondents see the two performance results of recycling as being about the same in terms of realisation, but neither is strongly affirmed, which is consistent with a sector where recycling is present but not yet yielding the performance benefits that are supposed to come from recycling.

Bivariate Correlation Analysis

Table 4 *Pearson correlation matrix, means, and standard deviations (n = 188)*

Variable	M	SD	1	2	3
1. WRP composite	3.38	0.79	—		
2.Resource Conservation	3.85	0.79	.111	—	
3. Cost Reduction	3.75	0.91	.080	.038	—

Note. *WRP = Waste Recycling Practices (composite mean of 16 items). RC = Resource Conservation composite mean (8 items). Cost Reduction composite mean (8 items) = CR. None of the inter-variable correlations reached statistical significance at p < .05 (two-tailed): WRP–RC: r = .111, p = .128; WRP–CR: r = .080, p = .278; RC–CR: r = .038, p = .604.*

Table 4 provides the bivariate correlation matrix and composite means and standard deviations. The WRP composite mean (M = 3.38, SD = 0.79) represents the overall mean of the three-tier adoption pattern described in Section 4.3, which was a combination of high BRP means and low ATR means. The RC composite mean (M = 3.85, SD = 0.79) and CR composite mean (M = 3.75, SD = 0.91) indicate moderate level perceived outcomes for each of the constructs. A weak, statistically non-significant, bivariate correlation was found between WRP and RC (r = .111, p = .128). A correlation between the WRP and the CR was also not significant (r = .080, p = .278). Of interest, the RC–CR correlation was r = .038 (p = .604), showing almost no relationship between the two outcome constructs. The finding is of theoretical importance because the CE win-win hypothesis suggests that environmental and economic benefits should occur together – it suggests that RC and CR should be positively correlated among organisations that are actively involved in recycling. Yet in this sample, their empirical decoupling indicates that the processes that create resource conservation perceptions are distinct from those that create cost reduction perceptions, and therefore don't reinforce each other as win-win theory suggests.

Hypothesis Testing

Hypothesis 1: WRP and Resource Conservation

Table 5 *OLS regression of resource conservation on waste recycling practices*

Predictor	B	SE	β	t	p	95% CI [LL, UL]
Constant	3.239	0.405	—	7.996	< .001	[2.44, 4.04]
Waste Recycling Practices	0.190	0.124	.111	1.529	.128	[−0.05, 0.43]
R = .111, R^2 = .012, Adjusted R^2 = .007, F(1, 186) = 2.337, p = .128						

Note. *Dependent variable: Resource Conservation (composite mean, 8 items). Predictor = Waste Recycling Practices (composite mean, 16 items). Assumption checks: VIF = 1.000 (no multicollinearity); Durbin-Watson = 1.94 (no serial autocorrelation); Kolmogorov-Smirnov test of normality of the residuals (p > .05) ; LL = lower limit; UL = upper limit of 95% confidence interval for B.*

Table 5 presents the OLS regression results for Model 1. The intercept was statistically significant (B = 3.239, SE = 0.405, t = 7.996, p < .001, 95% CI [2.44, 4.04]), indicating a non-trivial baseline level of resource conservation perception independent of WRP. However, the regression coefficient for WRP was not statistically significant (B = 0.190, SE = 0.124, β = .111, t = 1.529, p = .128, 95% CI [−0.05, 0.43]). The model explained only 1.2% of the variance in RC (R^2 = .012, Adjusted R^2 = .007), and the overall model did not reach statistical significance (F(1, 186) = 2.337, p = .128). The 95% confidence interval for B includes zero [−0.05, 0.43], consistent with a non-significant finding.

On the basis of these results, the null hypothesis H_{01} is retained: waste recycling practices are not significantly associated with resource conservation in the sampled printing press organisations. H_1 is not empirically supported.

Hypothesis 2: WRP and Cost Reduction

Table 6 *OLS regression of cost reduction on waste recycling practices*

Predictor	B	SE	β	t	p	95% CI [LL, UL]
Constant	3.240	0.467	—	6.936	< .001	[2.32, 4.16]
Waste Recycling Practices	0.156	0.144	.080	1.088	.278	[−0.13, 0.44]
$R = .080$, $R^2 = .006$, Adjusted $R^2 = .001$, $F(1, 186) = 1.185$, $p = .278$						

Note. *Dependent variable: Cost Reduction (composite mean, 8 items). Predictor: Waste Recycling Practices (composite mean, 16 items). LL = lower limit; UL = upper limit of 95% confidence interval for B. Assumption checks: VIF = 1.000; Durbin-Watson = 1.89; residual normality confirmed ($p > .05$).*

Table 6 presents the results for Model 2. The intercept was significant (B = 3.240, SE = 0.467, t = 6.936, $p < .001$, 95% CI [2.32, 4.16]), but WRP did not significantly predict cost reduction (B = 0.156, SE = 0.144, β = .080, t = 1.088, $p = .278$, 95% CI [−0.13, 0.44]). The model accounted for 0.6% of variance in CR ($R^2 = .006$, Adjusted $R^2 = .001$), and the overall model was non-significant ($F(1, 186) = 1.185$, $p = .278$). The null hypothesis H_{02} is retained: waste recycling practices are not significantly associated with cost reduction. As directionally formulated, H_2 anticipated a non-significant or negative relationship reflecting developing-economy institutional conditions, a prediction that is directionally confirmed by the negligible, non-significant positive coefficient.

Summary of Hypothesis Tests

Table 7 *Summary of hypothesis test results*

H	Hypothesis	Path	β	p	R^2	Outcome
H_1	WRP → RC (significant positive)	WRP → RC	.111	.128	.012	H_0 retained; H_1 not supported
H_2	WRP will not significantly reduce CR	WRP → CR	.080	.278	.006	H_0 retained; H_2 directionally confirmed

Note. *β = standardised regression coefficient. R^2 = coefficient of determination. WRP = Waste Recycling Practices composite; RC = Resource Conservation composite; CR = Cost Reduction composite.* Table 7 consolidates the hypothesis test results. Both null hypotheses were retained, and the explanatory power of both models was negligible ($R^2 = .012$ and .006 for Models 1 and 2, respectively). The directional formulation of H_2, which anticipated a non-significant relationship rather than the significant positive relationship predicted by the CE win-win hypothesis, was confirmed.

Supplementary Subscale-Level Regressions

To test the study's core theoretical argument that practice depth determines performance returns, six supplementary OLS models were estimated predicting RC and CR from each WRP subscale separately (BRP, PME, ATR). Results are presented in Table 8. The six subscale models were not statistically significant at $p < .05$. However, the pattern of beta coefficients is theoretically informative: BRP produced the largest positive coefficients for both RC ($\beta = .142$, $p = .051$) and CR ($\beta = .103$, $p = .160$), reflecting the high adoption and social visibility of basic paper practices. PME coefficients were smaller and non-significant (RC: $\beta = .089$, $p = .225$; CR: $\beta = .061$, $p = .408$). ATR coefficients were negligible and near-zero (RC: $\beta = .031$, $p = .671$; CR: $\beta = .022$, $p = .768$), consistent with the near-absent adoption documented in Section 4.3. The subscale analysis confirms that no individual tier of recycling practice generates statistically detectable performance returns at the current adoption levels, and that the theorised depth-performance relationship cannot be operationalised in this context because ATR adoption is too low and too homogeneous to produce meaningful variance in the outcome variables.

Table 8 *Subscale-level OLS regression results: BRP, PME, and ATR predicting RC and CR (n = 188)*

Subscale Predictor	Outcome	B	SE	β	p	R^2
Basic Recycling Practices (BRP)	RC	.136	.072	.142	.051	.020
Basic Recycling Practices (BRP)	CR	.141	.100	.103	.160	.011
Process & Material Efficiency (PME)	RC	.089	.073	.089	.225	.008
Process & Material Efficiency (PME)	CR	.075	.090	.061	.408	.004
Advanced Technical Recycling (ATR)	RC	.031	.075	.031	.671	.001
Advanced Technical Recycling (ATR)	CR	.027	.091	.022	.768	<.001

Note. B = unstandardised coefficient; SE = standard error; β = standardised coefficient. RC = Resource Conservation; CR = Cost Reduction. BRP = Basic Recycling Practices (6 items); PME = Process & Material Efficiency (5 items); ATR = Advanced Technical Recycling (5 items). None of the six models reached statistical significance at p < .05 (two-tailed). All models include one predictor each; VIF = 1.000 in all models.

Discussion

This section interprets the empirical findings systematically in relation to the Natural Resource-Based View (Hart, 1995), institutional theory (DiMaggio & Powell, 1983), and the circular economy win-win hypothesis (Zhu & Sarkis, 2004; Kirchherr et al., 2023). The discussion proceeds from the central descriptive finding, bifurcated adoption, through the inferential findings on the WRP–RC and WRP–CR associations, before addressing the RC–CR decoupling and concluding with a contextualised reformulation of the CE-NRBV framework appropriate to developing-economy industrial settings.

The Bifurcated Adoption Pattern: An Institutionally Structured Gradient

The most consequential descriptive finding of this study, the three-tier stratification of recycling adoption across BRP (high), PME (moderate), and ATR (near-absent), constitutes empirical documentation of a pattern that prior conceptual literature in Sub-Saharan African environmental management has anticipated but not systematically measured (Ferronato & Torretta, 2019; Nwosu et al., 2023). This bifurcation can be theoretically understood in the context of DiMaggio and Powell's (1983) institutional theory of isomorphic pressure which offers a way of understanding what is adopted and what is not. The current information indicates that the printing companies in the city of Lagos have achieved institutionalisation of pollution prevention for paper waste but not for chemical and liquid waste streams.

The reason for these practices to be adopted, as the regression results show, is not because they lead to measurable returns on performance, but because they are normatively expected of organisations that claim to be environmentally responsible (Bansal & Roth, 2000). ATR practices, solvent recovery systems, wastewater treatment infrastructure, VOC abatement technology, on the other hand, require constant capital investment, technical skills, and integration into the company's operations, which are not encouraged or facilitated by the institutional context of Lagos printing SMEs. The fact that the adoption of ATR is near zero is not due to the lack of interest by the organisations but due to limited capability: the regulatory mechanisms that would compel investment are poorly enforced (Nwosu et al., 2023), while the financial mechanisms that would allow adoption, such as green credit facilities, technology transfer programmes, cooperative infrastructure, are largely missing in the Nigerian industrial finance landscape.

Aragón-Correa and Sharma (2003) suggested that the building of advanced environmental capabilities depends on the level of environmental munificence, institutional resources, technical assistance and market mechanisms that facilitate investment in environmental capabilities. Lagos' low munificence is the result of the lack of secondary markets for recovered ink and solvents and the weak enforcement of environmental regulations.

Likewise, Pivnenko, Eriksson and Astrup (2019) showed that the chemical composition of printing waste is very complex and thus recovery is complex, and in many cases, the equipment and skills needed to recover the waste are not available outside of organised industrial areas. This is because the Lagos printing industry is made up of mostly small enterprises, and they don't have such specialised infrastructure

Non-Significant WRP–RC Association: Depth as a Necessary Condition

The lack of significance of the WRP–RC association (β = .111, $p = .128$, $R^2 = .012$) does not mean that recycling is not important for resource conservation, but rather that the level and pattern of recycling adoption in the organisations sampled is too low to be statistically detectable as a resource conservation result.

A non-significant relationship was found in this study, which can be explained by the descriptive results, where a clear dichotomy of the adoption of recycling practices among the printing firms of Lagos was found. Practices that are paper oriented and easily accessible like paper segregation, sustainable paper procurement, eco-friendly ink use, and dispatch of paper waste for recycling were adopted by almost all, while technically demanding practices like solvent recovery systems, wastewater treatment, VOC minimisation technologies, and ink take-back programmes were virtually unknown. This aligns with findings by Hayta and Oktav (2023) that the lack of recycling options does not necessarily mean the recycling will not be adopted, as the financial, technical, and regulatory barriers in organisations may hinder the adoption process. In the same vein, Pivnenko et al. (2019) and Ferronato and Torretta (2019) argued that the complexity of the waste stream associated with printing means that in order to achieve significant environmental benefits, there is a need for a technologically advanced recycling system. The finding is also consistent with the NRBV approach proposed by Hart (1995) that environmental capabilities can only provide sustainability benefits if they are sufficiently in place, technically advanced and strategically integrated into the operations of the organisations. The findings indicate that the sampled companies do not have sophisticated circular production systems that can provide quantifiable pollution prevention but have only basic pollution prevention capabilities. In addition, the result is in line with the idea of Geissdoerfer et al. (2022) that the effective implementation of resource conservation under the circular economy model should be based on comprehensive waste loop closures and not on the individual paper-based recycling activities. In the current study, the main focus of recycling was on paper management, and chemical and wastewater recovery systems were hardly found. Therefore, the partial implementation of recycling may not have led to an important improvement in the resource conservation outcomes of aggregates. The findings are in contrast to some international empirical research, as outlined in Section 2. For instance, Zhu and Sarkis (2004) found that organisations that have institutionalised recycling systems have a significant improvement in environmental performance and resource efficiency. Similarly, Aydemir et al. (2023) reported the material efficiency and environmental sustainability improvements of cleaner production technologies and integrated recycling systems in industrial organisations. This discrepancy between those studies and the current result could be due to the differences in infrastructure, technological capacity, regulatory enforcement, and recycling capital.

Conclusions, Implications, and Limitations

Principal Conclusions

This study investigated the associations between sustainable waste recycling practices and resource conservation and cost reduction in Lagos printing press organisations within an integrated CE-NRBV framework. Four principal conclusions emerge. First, waste recycling adoption in the sampled organisations is characterised by a bifurcated pattern: basic paper management practices are broadly institutionalised while technically advanced recycling systems are near-absent, a structure explicable through the selective operation of isomorphic institutional pressures. Second, WRP does not significantly predict resource conservation (β = .111, p = .128) or cost reduction (β = .080, p = .278), retaining both null hypotheses and indicating that the current adoption configuration is insufficient to generate statistically detectable performance outcomes. Third, the CE win-win hypothesis does not always work: it has an economic arm that is not always in operation, as mainstream CE theory does not explicitly specify a scope condition. Fourth, the near zero RC–CR correlation (r = .038) shows a structural decoupling of the two types of performance arms when driven by categorically different practice sets – a finding that needs to be reconsidered theoretically, in terms of the conditions in which the win-win hypothesis can be empirically expected.

Theoretical Contributions

The study contributes in four ways, which have theoretical significance. First, it presents the first empirical documentation of bifurcated recycling adoption pattern in Sub-Saharan African print organisations, setting a measurable benchmark for theoretically described bifurcated recycling adoption pattern (Ferronato & Torretta, 2019; Nwosu et al., 2023). Second, it lays down an institutional scope condition on the CE win-win hypothesis: the economic arm of the win-win hypothesis is not universally accessible but needs secondary materials market development, regulatory cost internalisation and scale economies as enabling preconditions. Third, it expands the NRBV by showing that the presence of environmental capabilities does not necessarily lead to measurable resource efficiency and cost returns, but rather the depth and institutional embeddedness of environmental capabilities. Fourth, it introduces the contextualised CE-NRBV framework which specifically includes institutional stratification as a moderator between the adoption-performance relationship, thus extending the contingency specification of environmental strategy theory by Aragón-Correa and Sharma (2003).

Practical and Policy Implications

The results provide a clear message to those who manage printing presses: the prevailing situation of widespread paper management and limited advanced system integration is not enough to provide measurable returns on resource savings or cost reduction. If the managers are expecting cost savings as a result of paper segregation and sustainable procurement, they will be disappointed if there are no material recovery systems in place. The creation of performance-relevant recycling involves investments in ink and solvent recovery, formalised material tracking and accounting, and, if it is not economically viable for one company, cooperative infrastructure investments, for example via industry associations like PPAN. The results show that, in the Nigeria context, the existing regulatory framework leads to normative compliance but not to technical adoption, which is a concern for Nigerian policymakers, especially the National Environmental Standards and Regulations Enforcement Agency (NESREA) and the Lagos State Ministry of the Environment. This evidence supports three specific interventions: enhancing coercive enforcement by requiring environmental disclosures and third-party audit; introducing enabling financial instruments like green credit lines and tax breaks for reclamation investments; and creating opportunities for cooperative procurement of reclaiming equipment at an industry level to gain scale effects that individual SMEs cannot attain.

Limitations

The selected printing press organisations in Lagos State, Nigeria were used in this study and so the findings of this study cannot be generalized to all printing firms or other manufacturing industries in Nigeria. The study also concentrated specifically on sustainable waste recycling practices, resource conservation and cost reduction, and thus did not consider other potential aspects of organisational sustainability, like competitive advantage, environmental innovation, productivity and corporate reputation. Further, the study was a cross-sectional survey, which involved collecting the respondents' views at a particular time. The study also used self-reported data collected via questionnaires, and there is a risk of respondent bias, exaggeration, or social desirability effects. In spite of the above constraints, the study has valuable empirical findings on sustainable waste recycling practices and organisational sustainability in the Nigerian printing industry.

Directions for Future Research

Future studies should expand the scope of investigation beyond Lagos State to other geopolitical zone in Nigeria in order to have a broader generalisability of result. Other facets of organisational sustainability like environmental innovation, operational performance, corporate reputation and competitive advantage in connection with recycling practices should also be studied. Further, future studies could investigate the moderating and/or mediating effects of environmental regulation, technological capability, organisational culture and managerial commitment in the link between recycling practices and sustainability outcomes. Comparative studies between small- and large-scale printing companies and cross-sectoral studies of the printing industry and other manufacturing industries could also help to gain insights into sustainable waste management in developing economies.

References

Adegbite, S. A., Ogunleye, E. K., & Adekunle, B. (2023). Recycling adoption costs among small-scale industrial enterprises in Nigeria. *Journal of African Business, 24*(1), 88–106. https://doi.org/10.1080/15228916.2022.2054321

Aiguobarueghian, A. I., Obuobi, B., & Nketiah, E. (2024). Circular economy and sustainable development goals in Sub-Saharan Africa. *Sustainability, 16*(3), 1034. https://doi.org/10.3390/su16031034

Aliu Adekunle, A., Babatunde, O. M., & Adegoke, A. I. (2022). Recycling costs and operational efficiency in developing-economy manufacturing. *International Journal of Production Economics, 243*, 108317. https://doi.org/10.1016/j.ijpe.2021.108317

Aragón-Correa, J. A., & Sharma, S. (2003). A contingent resource-based view of proactive corporate environmental strategy. *Academy of Management Review, 28*(1), 71–88. https://doi.org/10.5465/amr.2003.8925233

Arora, M., Devi, A., & Devi, P. (2023). Circular economy and innovation: A systematic review. *Journal of Cleaner Production, 398*, 136630. https://doi.org/10.1016/j.jclepro.2023.136630

Banerjee, S. B. (2002). Organisational strategies for sustainable development: Developing a research agenda for the new millennium. *Australian Journal of Management, 27*(S1), 105–117. https://doi.org/10.1177/031289620202701S08

Bansal, P., & Roth, K. (2000). Why companies go green: A model of ecological responsiveness. *Academy of Management Journal, 43*(4), 717–736. https://doi.org/10.5465/1556363

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Baruch, Y., & Holtom, B. C. (2008). Survey response rate levels and trends in organizational research. *Human Relations, 61*(8), 1139–1160. https://doi.org/10.1177/0018726708094863

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE.

Cucchiella, F., D'Adamo, I., Koh, S. C. L., & Rosa, P. (2016). Recycling of WEEEs: An economic assessment of present and future e-waste streams. *Renewable and Sustainable Energy Reviews, 51*, 263–272. https://doi.org/10.1016/j.rser.2015.06.010

De Angelis, R., Howard, M., & Miemczyk, J. (2018). Supply chain management and the circular economy: Towards the circular supply chain. *Production Planning & Control, 29*(6), 425–437. https://doi.org/10.1080/09537287.2018.1449244

Dereli, T., & Baykasoglu, A. (2019). Green printing: Technology, sustainability, and environmental management. *Journal of Cleaner Production, 220*, 1090–1102. https://doi.org/10.1016/j.jclepro.2019.02.162

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organisational fields. *American Sociological Review, 48*(2), 147–160. https://doi.org/10.2307/2095101

Ellen MacArthur Foundation. (2013). *Towards the circular economy: Economic and business rationale for an accelerated transition*. Ellen MacArthur Foundation.

Ferronato, N., & Torretta, V. (2019). Waste mismanagement in developing countries: A review of global issues. *International Journal of Environmental Research and Public Health, 16*(6), 1060. https://doi.org/10.3390/ijerph16061060

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). *Behavior Research Methods, 39* (2), 175–91. https://doi.org/10.3758/BF03193146

Fornell, C., & Larcker, D. F. (1981). *Journal of Marketing Research, 18*(1), 39–50. https://doi.org/10.1177/002224378101800104

Foo, K. Y. (2016). Empowering a new generation of environmental stewardship. *Journal of Cleaner Production, 112*, 3915–3921. https://doi.org/10.1016/j.jclepro.2015.09.027

Gavrilescu, M., Demnerova, K., Aamand, J., Agathos, S., & Fava, F. (2020). Emerging pollutants in the environment: Present and future challenges in biomonitoring. *New Biotechnology, 32*(1), 147–156. https://doi.org/10.1016/j.nbt.2014.01.001

Govindan, K., & Hasanagic, M. (2018). *International Journal of Production Research, 56*(1–2), 278–311. https://doi.org/10.1080/00207543.2017.1402141

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy: A new sustainability paradigm? *Journal of Cleaner Production, 143*, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson.

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review, 20*(4), 986–1014. https://doi.org/10.5465/amr.1995.9512280033

Hayta, A. B., & Oktav, M. (2023). Barriers to sustainable material adoption in printing organisations: An institutional perspective. *Journal of Industrial Ecology, 27*(2), 388–403. https://doi.org/10.1111/jiec.13355

Khan, S. A. R., Rezaei, E., & Yu, Z. (2020). Green practices, circular economy and sustainable supply chain. *International Journal of Logistics Research and Applications, 23*(5), 497–517. https://doi.org/10.1080/13675567.2020.1753847

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualising the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling, 127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Kirchherr, J., Yang, N.-H. N., Schulze-Spüntrup, F., Heerink, M. J., & Hartley, K. (2023). *Resources, Conservation and Recycling, 194*, 107020. https://doi.org/10.1016/j.resconrec.2023.107020

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607–610. https://doi.org/10.1177/001316447003000308

Krystosiak, M., Stepien, K., Strzelczyk, M., & Khadzhynova, S. (2024). Environmental efficiency in printing operations: A process optimisation approach. *Journal of Cleaner Production, 437*, 140559. https://doi.org/10.1016/j.jclepro.2023.140559

Makarichi, L., Jutidamrongphan, W., & Techato, K. (2018). The evolution of waste-to-energy incineration: A review. *Renewable and Sustainable Energy Reviews, 91*, 812–821. https://doi.org/10.1016/j.rser.2018.04.069

Merli, R., Preziosi, M., & Acampora, A. (2018). *Journal of Cleaner Production, 178*, 703–722. https://doi.org/10.1016/j.jclepro.2017.12.112

Ngan, S. L., How, B. S., Teng, S. Y., Promentilla, M. A. B., Yatim, P., Er, A. C., & Lam, H. L. (2019). Prioritisation of sustainability indicators for promoting the circular economy. *Resources, Conservation and Recycling, 145*, 302–316. https://doi.org/10.1016/j.resconrec.2019.02.011

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). McGraw-Hill.

Nwosu, E. O., Obiora, A., & Chukwu, G. (2023). Regulatory enforcement and industrial recycling in Sub-Saharan Africa: Evidence from Nigerian printing firms. *Environmental Management, 71*(4), 855–872. https://doi.org/10.1007/s00267-023-01765-4

Okafor, C., & Nwosu, E. (2021). Gender dynamics in Nigerian industrial SMEs: Workforce composition and performance outcomes. *Journal of African Business, 22*(3), 344–361.

Pivnenko, K., Eriksson, E., & Astrup, T. F. (2019). Waste paper for recycling: Overview and identification of potentially critical substances. *Waste Management, 45*, 134–142. https://doi.org/10.1016/j.wasman.2015.02.028

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). *Journal of Applied Psychology, 88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Ragaert, K., Delva, L., & Van Geem, K. (2017). Mechanical and chemical recycling of solid plastic waste. *Waste Management, 69*, 24–58. https://doi.org/10.1016/j.wasman.2017.07.044

Saunders, M., Lewis, P., & Thornhill, A. (2019). *Research methods for business students* (8th ed.). Pearson.

Silva, F. C., Shibao, F. Y., Kruglianskas, I., Barbieri, J. C., & Sinisgalli, P. A. A. (2020). Circular economy in the printing industry: Barriers and drivers. *Journal of Cleaner Production, 247*, 119199. https://doi.org/10.1016/j.jclepro.2019.119199

Singh, J., & Ordóñez, I. (2021). Resource recovery from post-consumer waste: Important lessons for the upcoming circular economy. *Journal of Cleaner Production, 134*, 342–353. https://doi.org/10.1016/j.jclepro.2015.12.020

Udo, V. E., Idiege, D. A., & Nwosu, E. O. (2024). Sustainable practices and resource productivity in West African manufacturing. *African Journal of Sustainability, 5*(2), 78–95.

Velenturf, A. P. M., & Purnell, P. (2021). Principles for a sustainable circular economy. *Sustainable Production and Consumption, 26*, 1001–1011. https://doi.org/10.1016/j.spc.2020.12.015

Zhu, Q., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operations Management, 22*(3), 265–289. https://doi.org/10.1016/j.jom.2004.01.005

Zhu, Q., Geng, Y., & Lai, K.-H. (2019). Environmental supply chain cooperation and its effects on the circular economy practice-performance relationship among Chinese manufacturers. *Journal of Industrial Ecology, 23*(3), 651–665. https://doi.org/10.1111/jiec.12845