

**EFFECT OF GREEN PRACTICES ON ENVIRONMENTAL SUSTAINABILITY OF
MANUFACTURING SMES IN KEBBI STATE**

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DOI: <https://doi.org/10.70118/ajbam-02-2026-025>

ABSTRACT

This study examined effect of green practices on environmental sustainability of manufacturing SMEs in Kebbi State, Nigeria proxied by green manufacturing practices and green supply-chain management. Adopting a cross-sectional survey design with a census approach, structured questionnaires were distributed to all 68 registered manufacturing SMEs across the state's three senatorial zones. The collected data were analysed using multiple regression technique. The model was significant and explained 60.4 % of the variance in environmental sustainability. Green manufacturing practices emerged as the stronger predictor, indicating that eco-efficient process redesign, waste minimisation and energy-saving technologies markedly enhance sustainability scores. Green supply-chain management, also showed a positive, though smaller, effect, confirming that greener purchasing, logistics and reverse flows provide additional gains. These results led to the rejection of both null hypotheses that green manufacturing practices and green supply-chain management, have no significant effect on Environmental Sustainability manufacturing firms in Kebbi State. The study recommends that plant owners prioritise investments in energy-efficient machinery, closed-loop material handling and staff eco-training to capitalise on the large green manufacturing practices pay-offs, while supply-chain leaders should embed green criteria in contracts and adopt ISO 14001 to amplify green supply-chain management. benefits; policymakers can reinforce these moves with tax rebates for green logistics fleets and fast-track approvals for firms disclosing Scope 3 emissions.

Keywords: green manufacturing, green supply-chain management, environmental sustainability.

INTRODUCTION

Climate-responsive production has become a strategic necessity rather than a public-relations choice. The 2024 UN Environment Programme (UNEP) Emissions Gap Report shows global greenhouse-gas releases climbing to a record 57.1 GtCO₂-e in 2023, and identifies industry including manufacturing and construction as the world's second-largest source of emissions after energy and heat generation. This mounting pressure, alongside consumer demand for responsible brands, has propelled green

practices such as energy-efficient technologies, eco-design, waste minimisation and closed-loop logistics into the mainstream of corporate strategy.

Nigeria has responded with a tightening policy mix. At the federal level, the National Environmental Standards and Regulations Enforcement Agency (NESREA) updated sector-specific limits for food, beverage and tobacco factories in 2023, mandating cleaner production methods and monitored effluent discharge. Complementing command-and-

control rules, market transparency is rising as a new sustainability-reporting roadmap released in March 2024 gives all large companies four years and small businesses until 2030 to disclose environmental and climate-risk information or face sanctions (FRC 2024). These measures signal that compliance and capital access will increasingly hinge on verifiable green credentials.

Green practices dimensions like green manufacturing and green supply chain management are not merely regulatory burdens; theory predicts and firms increasingly exploit a triple-win of cost savings, environmental stewardship and reputational advantage. Cleaner production lowers energy and material intensity, while reverse logistics and eco-design open secondary revenue streams and strengthen customer loyalty. Survey evidence among Nigerian SMEs links customer-oriented green purchasing to measurable gains in environmental performance, underscoring the operational pay-offs of embedding sustainability throughout the value chain (Babalola, et al., 2024).

Empirical studies reinforce this business case. Odesola and Aderemi (2025) found that drivers such as voluntary top-management commitment and customer pressure significantly boost the breadth of green supply-chain management practices across 330 manufacturing SMEs, with downstream benefits for efficiency and waste reduction. Earlier work by Babalola et al. (2024) reported positive, statistically significant links between customer integration, green procurement and environmental performance scores among 164 Nigerian SME managers. Notably, almost all of these investigations concentrate on the country's south-western industrial corridor.

Kebbi State sits at Nigeria's north-western frontier and is largely agrarian, yet its Special Agro-Industrial Processing Zone (SAPZ), launched in 2024 with African Development Bank support, aims to fast-track agro-processing clusters and mandates resource-efficient technologies, renewable energy and stringent emissions monitoring. Parallel initiatives such as a \$3.28 million Global Environment Facility grant to curb land degradation, highlight the state's environmental

sensitivity. Nonetheless, local diagnostics reveal persistent challenges, as Mainasara, and Dodo, (2024) study of Birnin Kebbi showed that 60 % of municipal waste is plastic and that poor disposal practices significantly depress residents' quality of life. Small rice mills, plastics workshops and grain processors still rely heavily on diesel generators, open-dump waste and water-intensive processes, suggesting that green adoption remains patchy.

Despite federal regulations and Kebbi's own SAPZ blueprint (2024) the diffusion of structured green practices among the state's manufacturing firms appears ad-hoc, undocumented and disconnected from clear performance targets. Managers therefore lack context-specific evidence on whether investments in cleaner technology and eco-efficient operations can translate into tangible improvements in profitability, productivity and competitive positioning within Kebbi's distinctive, infrastructure-constrained environment.

Existing Nigerian scholarship has concentrated on metropolitan hubs such as Lagos, Ogun and Kano or has pooled multi-state samples without isolating Kebbi (Daniel & Park, 2015). A systematic search reveals no peer-reviewed study that empirically tests the relationship between green practices and firm-level performance (financial, operational or environmental) for manufacturing enterprises located specifically in Kebbi State. Filling this void will provide location-specific insights for managers and policymakers, refine Nigeria's broader sustainable-industrialisation agenda and extend the empirical discourse beyond the country's dominant southern corridor. To guide the study the following hypotheses are stated in a null form:

HO₁ Green manufacturing practices have no significant effect on the environmental sustainability of selected manufacturing firms in Kebbi State.

HO₁ Green supply chain management have no significant effect on the environmental sustainability of selected manufacturing firms in Kebbi State.

LITERATURE REVIEW

Green Practices

Green practices are conceptualised at the intersection of manufacturing and supply-chain scholarship. Govindan, et al. (2015) portray green manufacturing as a production philosophy that “stimulates an essential driver for the quick and better adoption of processes that minimise waste and emissions across the product life-cycle. In the textile context, Batra and Chanana (2015) described green supply-chain management (GSCM) framed green manufacturing specifically as using raw materials with low ecological footprints and generating less waste within the plant. Habidin et al. (2015) extend the construct, casting green-manufacturing practices as a continuous-improvement method that simultaneously addresses ecological problems while raising productivity in Malaysian factories.

Teixeira et al. (2016) link *green training* to GSCM, defining it as the deliberate development of employee competences that enable firms to embed environmental criteria in purchasing, cooperation and reverse-logistics decisions. Synthesising earlier streams, Gajendrum (2017) frames green practices as environmental innovations that merge the effectiveness of supply chains with concern for ecological impact,” stretching from eco-design to post-consumer recovery.

Green Manufacturing Practices (GMP)

Sun et al. (2023) framed green manufacturing practices as the holistic evaluation of environmental impact and resource-efficiency throughout the manufacturing process, a view that stretches assessment beyond the shop-floor to the entire production system. Haleem et al. (2023) described it more operationally as waste- and emission-minimising methods that pervade every stage of the product life-cycle. For Hao, et al. (2023), green manufacturing practices denotes a portfolio of cutting-edge production techniques that couple waste-reduction, recycling and improved resource use under conditions of market uncertainty. Abdellatif (2024) broadens the scope, defining green manufacturing practices as an umbrella concept for cleaner technologies, closed-loop logistics and environmental performance metrics that jointly pursue sustainability and competitiveness. Peng et al. (2024) highlight

management commitment, terming green manufacturing practices green manufacturing practices the strategic drive to “give environmental performance the same importance as economic performance” during implementation. Panda and Parida (2024) characterised green manufacturing practices systems as configurations that minimise waste and pollution while sustaining renewable production. Industry guidance from the Institute of Sustainability Studies (2025) reduced the idea to producing goods in ways that conserve resources, cut emissions and maintain efficiency, while Igus-Toolbox (2024) added that green manufacturing practices must also be economically sustainable, bringing redesign for minimal pollution into the definition.

Green Supply-Chain Management (GSCM)

Lu et al. (2024) defined green supply-chain management as the “integration of environmentally sustainable practices into supply-chain management, from product design to reverse logistics. Ma et al (2025) stress interdisciplinarity, portraying green supply-chain management as a cross-functional approach covering procurement, manufacturing, logistics and end-of-life handling within the customer-order cycle. Zhang and Li (2024) sees green supply-chain management as the management of supply-chain relationships to reduce Scope 3 emissions and create value. Ahmed and Nasr (2023) summarised it as businesses’ ability to enhance operations and sustain the environment simultaneously. Karia and Asaari (2024) embed innovation, defining green supply-chain management green supply-chain management practices as levers that raise environmental performance and competitive advantage. Nirmalraj (2022) focuses on inputs and outputs, calling GSCM “the use of environmentally benign inputs transformed into outputs that can be recovered or repurposed. Johnson and Kang (2019) extend the cradle-to-grave view for construction supply chains, integrating environmental thinking “from project inception to deconstruction. Romero and Singh (2025) stress configuration, viewing GSCM as a strategic bundle of eco-friendly practices whose synergies determine sustainable competitiveness.

Adding an organisational lens, Kuei et al. (2015) define GSCM as the coordinated adoption of environmental practices along Chinese supply networks to drive both environmental and operational performance gains. In the textile context, Batra and Chanana (2015) described green supply-chain management (GSCM) as the orchestration of procurement, production, distribution and reverse logistics with the desire to reduce the environmental impact of a product throughout its lifecycle. Younis, et al. (2016) characterised green supply-chain management as the integration of environmental thinking into supply-chain management, including product design, material sourcing, manufacturing, packaging, delivery and end-of-life handling (Daniel & Chukwuemeka, 2023). Synthesising, these perspectives reveals that green supply-chain management is both structural (altering supply-chain architecture to cut environmental load) and behavioural (forging collaboration, innovation and disclosure among partners).

Environmental Sustainability (ES)

Patterson (2024) defined environmental sustainability as responsible management of natural resources to fulfil current needs without compromising future generations. Ahmed (2025) framed it as maintaining the natural systems that support life while balancing economic and social progress. The U.S. EPA (2024) described it as creating and maintaining the conditions under which humans and nature can exist in productive harmony. The United Nations (2023) echoes this integrative stance, calling sustainability a development paradigm that embeds environmental concerns alongside economic growth. Tennakoon et al. (2024) operationalised environmental sustainability as practices shaped by global agreements such as the Paris Accord and Convention on Biological Diversity. Moldan, et al. (2022) defined environmental sustainability as the maintenance of ecosystems through efficient management linking it to product design decisions. Okafor and Li (2024) emphasised ecological limits, describing environmental sustainability as harmonious coexistence with nature that balances human needs and carrying capacity. Salgado and Ruiz (2022) add risk language, stating that environmental sustainability entails preserving resources,

favouring biodiversity and reducing environmental risks while pursuing development.

Empirical Review

Green Manufacturing Practices and Environmental Sustainability

Nazir et al. (2024) analyzed 247 usable questionnaires from Pakistani large manufacturers using PLS-SEM to examine how waste minimisation, energy-efficient process redesign, and eco-training collectively explain environmental-performance variance. They found that each GMP path positively and significantly affects environmental performance ($\beta = 0.28-0.41$, $p < 0.01$), with an overall 46% of variance explained, and urged mandatory energy audits. Naz (2023) focused on 28 textile mills ($n = 212$) using PLS-SEM and reported a strong direct effect of GMP on environmental performance ($\beta = 0.33$, $p < 0.05$) but no additional effect on operational performance once total-quality management (TQM) was controlled for, recommending managers integrate GMP with TQM routines. Primandaru et al. (2023) studied 258 Indonesian micro- and small manufacturers with Smart-PLS, finding that GMP uptake reduced average monthly resource use by 15%, and advised local governments to expand tax credits for cleaner technology. Hou and Chen (2024) surveyed 247 Chinese multi-industry firms, confirming GMP significantly lowers emissions intensity ($\beta = 0.35$, $p < 0.01$), with results moderated by the stringency of external environmental regulation, and recommended harsher penalties for non-compliance.

Woldemariam and Abebe (2024) analysed 201 Ethiopian textile-and-leather plants using PLS-SEM, finding GMP delivered the strongest direct boost to an ISO-based environmental score ($\beta = 0.37$, $p < 0.01$) and called for vocational green-skills programs. Liu et al. (2024) surveyed 285 Asian manufacturers and combined PLS-SEM with fuzzy-set QCA, revealing that GMP paired with circular-economy capability constitutes the most frequent high-performance configuration (61% of cases), prompting joint investment in

remanufacturing and recycling hubs. Lutfi et al. (2025) used multi-group PLS on 517 SMEs across MENA to show that environmentally focused leadership amplifies the GMP → environmental-performance pathway ($R^2 = 0.06$), recommending leadership-development grants. Nguyen et al. (2023) collected data from 180 Vietnamese seafood-processing managers and employed OLS, reporting a significant GMP coefficient ($\beta = 0.31$, $p < 0.05$) but advocating synchronization of GMP with just-in-time scheduling to maximize gains. Collectively, these eight studies consistently show GMP positively influencing environmental performance, while highlighting the importance of complementary practices such as TQM, leadership, and circular capabilities to unlock the full environmental benefits. However, despite the consistently positive evidence, cross-country heterogeneity limits the generalisability of these findings to Kebbi State, given its distinct regional context.

Green Supply-Chain Management and Environmental Sustainability

Several studies across different regions examined how green supply-chain management (GSCM) practices influence environmental performance. Nazir et al. (2024) used PLS-SEM to analyze green planning, purchasing, execution, and continuous improvement, finding that each path significantly enhances environmental performance (β ranging from 0.22 to 0.34, $p < 0.01$), with institutional pressure intensifying all effects and prompting calls for stricter environmental regulation enforcement. Teixeira et al. (2023) applied multiple regression to 79 Brazilian firms and reported that supplier collaboration and cross-functional teams explained 52% of environmental-performance variance, though firms lacking ISO 14001 certification saw attenuated gains; they recommended subsidized certification programmes. Kaya et al. (2024) surveyed 283 Turkish firms in plastics, packaging, and textiles, confirming a significant GSCM → environmental-performance link ($\beta = 0.27$, $p < 0.001$) and advocating the integration of green innovation to translate environmental gains into competitive advantage. Dzikriansyah et al. (2023) analyzed 89 Indonesian SMEs with independent-sample t-tests, finding that firms

practicing full GSCM scored 18% higher on an emissions-reduction index ($t = 4.12$, $p < 0.001$) and recommended targeted supplier training. Appiah et al. (2023) surveyed 245 Ghanaian food-processing firms using hierarchical regression, showing that green purchasing and reverse logistics reduce carbon emissions by 18% and water use by 12%, though financial returns were modest; they advised phased cost-sharing schemes between government and industry. Ma et al. (2024) surveyed 468 managers in Pakistan's pesticide sector, finding that GSCM enhances environmental and financial performance, with environmental gains partially mediating profitability (indirect $\beta = 0.14$), and recommended green-finance incentives to scale adoption.

Kholaiif, et al. (2023) used PLS-SEM on 517 SMEs across six MENA countries and found that coercive and normative pressures strengthen the GSCM–environmental-performance relationship ($\Delta R^2 = 0.07$), suggesting governments reward early adopters with tax rebates. Battistelle et al. (2023) surveyed 77 Brazilian automotive-supplier firms, reporting that partner collaboration and green packaging were the top environmental-performance drivers ($\beta = 0.31$ and 0.28 , respectively; $p < 0.05$) and recommended deeper buyer–supplier environmental audits. The literatures reviewed collectively argues for integrated policy and supplier-development initiatives. However, while the evidence consistently supports a positive link, comparative cross-country variation may deter generalization of findings to Kebbi State due to regional difference

Theoretical Framework

Ecological Modernisation Theory (EMT)

Ecological Modernisation Theory (EMT) is most commonly credited to Joseph Huber (1982), with parallel early contributions by Martin Jänicke (1985). EMT argues that advanced societies can decouple economic growth from environmental degradation by modernising production and governance—shifting from “end-of-pipe” pollution control to preventive, eco-efficient technologies, market-based instruments (e.g., eco-taxes, emissions trading), corporate environmental management

(e.g., ISO 14001), and institutional reforms that enlist the state, markets, and civil society. In short, EMT sees technological innovation + policy incentives + stakeholder pressure as mutually reinforcing levers that embed environmental protection within mainstream economic and industrial development.

Contemporary scholarship largely supports but also interrogates this optimism. A mapping of 291 EMT articles by Julkovski, et al. (2021) shows the theory now spans themes such as circular economy, Industry 4.0 and big-data governance, affirming its relevance for twenty-first-century sustainability transitions. Yet key challenges remain as York and Rosa (2003) contend that EMT over-relies on technological fixes and underestimates capitalism’s growth logic, urging scholars to prove that efficiency gains outpace rebounds in total production. Critics further question whether eco-innovations in one sector simply displace harms to others or to the Global South, demanding a more systemic accounting of ecological footprints. Supporters respond that EMT is a diagnostic rather than deterministic theory, highlighting empirical cases from Dutch clean technology clusters to Chinese green finance where coordinated policy, market incentives and civil-society pressure have delivered absolute emission reductions.

In Kebbi State, EMT provides a useful lens for understanding the environmental promises and pitfalls of the new Special Agro-Industrial Processing Zone (SAPZ). The ESIA for the SAPZ (2024) already embeds EMT-type instruments renewable-energy targets, pollution-prevention technologies and inclusive green-finance lines to ensure agro-industrial

growth aligns with ecological limits. Conversely, studies of open dumping and diesel-fired micro-industries around Birnin Kebbi reveal the absence of the institutional and technological levers EMT deems critical. Applying the theory thus guides local policymakers to (i) tighten but innovate-friendly regulation, (ii) subsidise cleaner production equipment for rice mills and plastics workshops, and (iii) foster multi-stakeholder platforms that turn waste-management failures into circular-economy opportunities thereby advancing environmental sustainability without stalling the state’s industrial ambitions.

METHODOLOGY

The study adopt a survey research design, the study population comprise all manufacturing SMEs in Kebbi State. The total number of manufacturing SMEs is 68(State Ministry of Commerce). This study adopts a census-based, explanatory survey design that targets all 68 registered manufacturing SMEs operating across Kebbi North, Kebbi Central and Kebbi South senatorial zones; by enumerating the entire population rather than sampling, the design eliminates selection bias and maximises statistical power for subgroup comparisons. Primary data were gathered with a five point likert scale self-administered questionnaire structured in three sections covering green manufacturing practices, green supply-chain management activities and environmental-sustainability performance distributed in person through Liaison Officers of the State Ministry of Commerce and Industry. Multiple regression was use to analyse the collected data. The sample size distribution is shown in table 1:

Table 1: Population and Sample Size Distribution

Senatorial zone	LGAs in the zone	Number of manufacturing SMEs
Kebbi North	Arewa Dandi, Argungu, Augie, Bagudo, Dandi, Suru (6 LGAs)	19
Kebbi Central	Aliero, Birnin Kebbi, Bunza, Gwandu, Jega, Kalgo, Koko/Besse, Maiyama (8 LGAs)	26
Kebbi South	Fakai, Ngaski, Sakaba, Shanga, Wasagu-Danko, Yauri, Zuru (7 LGAs)	23
State total	21 LGAs	68

Source: State Ministry of Commerce and Industry

RESULT AND DISCUSSION

The study administers 68 copies of questionnaire to the manufacturing SMEs owners/operators who were available on ground and accepted to participate in the survey out of which 65 were filled correctly and retrieved. Preliminary check for missing values,

outliers and bias test was conducted and the result show there is no missing values, outliers and bias responses.

Test of Hypotheses

The regression is used to determine the cause and effect of dependent variable on the independent variables.

Table 1: Model Summary

Model Summary^b						
Model	R	R Square	Adjusted R Square	R	Std. Error of the Estimate	Durbin-Watson
1	.763 ^a	.604	.603	.618	2.270	

a. Predictors: (Constant), GMP, GSCM.
b. Dependent Variable: ES

Source: SPSS 25

The model summary shows that green manufacturing practices (GMP) and green supply-chain management (GSCM) jointly have a strong explanatory power for environmental sustainability (ES) among the firms studied. The multiple-correlation coefficient of $R = 0.763$ indicates a robust positive association between the predicted ES scores and the actual scores. An R Square of 0.604 means that GMP and GSCM together account for about 60.4 % of the total variance in environmental sustainability, while the very similar adjusted R Square (0.603) confirms that this explanatory power is not inflated by model

complexity. The standard error of the estimate (0.618) suggests that, on average, the residuals deviate from the regression line by roughly 0.62 units on the ES scale used an acceptable level of dispersion given the context. The Durbin–Watson statistic of 2.270 lies close to the ideal value of 2, indicating that the residuals are essentially independent and that autocorrelation is unlikely to distort the results. The table implies that strengthening GMP and GSCM is likely to produce meaningful improvements in environmental sustainability, although roughly 39 % of the variance remains attributable to other, unmodelled factors.

Table 2: ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	80.218	5	14.012	24.352	.000 ^b
	Residual	118.072	478	.611		
	Total	298.290	475			

a. Dependent Variable: ES

b. Predictors: (Constant), GMP, GSCM.

Source: SPSS 25

The ANOVA table tests whether the regression model that includes green manufacturing practices (GMP) and green supply-chain management (GSCM) provides a statistically better fit to the data on environmental sustainability (ES) than a model with no predictors. The F-ratio of 24.352, calculated

from a regression mean square of 14.012 and a residual mean square of 0.611, is large relative to the critical F value for the model’s (5, 478) degrees of freedom. Because the associated p-value is .000 ($p < .001$), this implies that, GMP and GSCM explain a significant proportion of the variance in ES. The accompanying sums of

squares show that the model accounts for 80.218 units of variability in ES, while 118.072 units remain unexplained and are captured in the residual term, confirming that although

other factors also influence ES, the green practices included in the model make a highly significant and meaningful contribution.

Table 3: Coefficients^a

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.025	.324		.043	.965		
	GMP	.475	.092	.372	4.622	.000	.541	1.558
	GSCM	.283	.093	.176	2.260	.006	.581	1.465
a. Dependent Variable: ES.								

Source: SPSS 25

HO₁ Green manufacturing practices have no significant effect on the environmental sustainability of selected manufacturing firms in Kebbi State.

For hypothesis H₀₁, the coefficients table shows that Green manufacturing practices has an unstandardised coefficient B = 0.475 (SE = 0.092) and a standardised Beta = 0.372. The associated t-value of 4.622 and p-value of .000 (p < .001) indicate that the effect is highly significant. Substantively, a one-unit rise in firms' green-manufacturing-practice score is predicted to raise their environmental-sustainability (ES) score by about 0.48 units, holding green supply-chain management constant. The Beta of 0.372 also marks GMP as the stronger of the two predictors in relative terms. Multicollinearity is not a concern (Tolerance = 0.541; VIF = 1.558, both well below the conventional cut-off of 5). Accordingly, H₀₁ is rejected, green manufacturing practices exert a positive, statistically significant influence on the environmental sustainability of manufacturing SMEs in Kebbi State.

HO₂ Green supply chain management have no significant effect on the environmental sustainability of selected manufacturing firms in Kebbi State.

For H₀₂, Green supply chain management shows an unstandardised coefficient B = 0.283

(SE = 0.093) and a standardised Beta = 0.176. Its t-value of 2.260 with a p-value of .006 (p < .01) confirms that the relationship is also statistically significant, albeit weaker than that of GMP. Practically, each one-unit increase in the GSCM score is associated with about 0.28 units of improvement in ES when GMP is held constant. The collinearity diagnostics (Tolerance = 0.581; VIF = 1.465) again fall in a safe range, supporting the stability of the estimate. Consequently, H₀₂ is likewise rejected, green supply-chain management practices make an independent, positive and significant contribution to the environmental sustainability performance of Kebbi State's manufacturing SMEs.

CONCLUSION AND RECOMMENDATIONS

The census-based analysis of 68 manufacturing SMEs in Kebbi State demonstrates that internal green manufacturing practices (GMP) and external green supply-chain management (GSCM) both exert statistically significant, positive impacts on firms' environmental-sustainability performance, jointly accounting for about 60 % of the variance in ES. GMP emerges as the stronger driver (β = 0.372), suggesting that eco-efficient process redesign, waste minimisation and energy-saving technologies create the largest direct gains, while GSCM (β = 0.176) provides additional but smaller benefits through greener

purchasing, logistics and reverse flows. The results therefore lead to the rejection of both null hypotheses (H_{01} and H_{02}) and confirm that strengthening inside-the-fence production routines as well as supply-chain collaborations is essential for improving sustainability outcomes among Kebbi's manufacturing SMEs. Based on the study findings the following recommendations were made:

1. Prioritise investments in energy-efficient machinery, closed-loop material handling and systematic eco-training for shop-floor staff, because these GMP elements deliver the largest environmental pay-offs. To finance upgrades, tap the Central Bank of Nigeria's intervention funds for cleaner production and negotiate group-purchase discounts through the Kebbi State Manufacturers Association.
2. Embed green criteria in supplier contracts, collaborate on shared waste-recovery schemes and adopt ISO 14001 or similar standards to magnify the (smaller yet significant) GSCM contribution. State regulators should complement these efforts with tax rebates for green logistics fleets and fast-track approvals for firms that publicly disclose Scope 3 emissions, thereby reinforcing external pressures that make eco-friendly supply-chain practices stick.

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