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Evaluating Environmental Management Practices in Ghana's Beverage Packaging: Does Supply Chain Integration Matter?

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Abstract

Ghana's beverage-packaging sector faces mounting pressure to reduce plastic waste while maintaining operational efficiency. This study investigates how supply chain integration (SCI)—across internal, supplier, and customer interfaces—affects PET-specific environmental management practices (PET-EMP) in bottling and PET conversion plants. It also examines whether green dynamic capabilities (GDC) mediate these effects and whether regulatory pressure and market turbulence condition them. A cross-sectional survey of 170 plants in Accra/Tema and Kumasi was combined with 48 brand×city customer intercepts to link organisational practices with consumer outcomes. Using variance-based structural modelling and robust OLS estimations, the study finds that internal and supplier integration significantly enhance PET-EMP ($\beta = 0.28$, $p < .05$; $\beta = 0.22$, $p < .05$), while customer integration is positive but not significant. The model explains 52% of variance in PET-EMP, confirming that coordination within and upstream of plants is pivotal for sustainable operations. When GDC is introduced, direct SCI effects attenuate and GDC becomes a strong predictor ($\beta = 0.42$, $p < .001$), indicating partial mediation and confirming that integration primarily improves environmental management through capability building. Moderation tests show that regulatory pressure amplifies the positive effects of internal and supplier integration, whereas market turbulence dampens the customer-integration effect. Plants with stronger PET-EMP demonstrate superior environmental performance, including higher recycled PET (rPET) share, greater PET recovery, and fewer effluent incidents ($R^2 = .29$, $p < .01$). At the consumer level, higher customer integration corresponds with increased return participation ($\beta = 0.46$) and rPET acceptance ($\beta = 0.38$), validating the downstream behavioural pathway. Overall, the findings reveal that capability-backed integration is a practical route to environmental improvement in emerging-market manufacturing. Internal and upstream collaboration yield the most consistent gains, regulatory enforcement magnifies these effects, and downstream coordination delivers results only when markets are stable. The study contributes to sustainability operations literature by specifying how and when integration fosters environmental performance, offering actionable insights for firms and regulators seeking to align plastic management with circular-economy goals.

Keywords: Supply Chain Integration, Green Dynamic Capabilities, Environmental Management, Pet Packaging, Ghana, Regulatory Pressure, Market Turbulence

Introduction

Plastic bottles made from polyethylene terephthalate (PET) are now the default for soft drinks and water in Ghana. As modern retail has grown, so has the visibility of plastic leakage into drains, beaches and neighbourhoods. The policy response is taking shape: Ghana's National Plastic Action Partnership (NPAP) released a national roadmap, and recent work with the World Economic Forum outlines how trade and investment can unlock better collection, recycling and product redesign (Ghana NPAP, 2021; World Economic Forum & Ghana NPAP, 2024).

Government signals are moving in the same direction. The Ministry of Environment, Science, Technology and Innovation (MESTI) set out an integrated National Plastics Management Policy and has continued discussions on Extended Producer Responsibility (EPR) with industry (MESTI, 2020/2021). Public updates highlight the scale of the problem. Estimates suggest Ghana generates about 840,000 tonnes of plastic waste each year, with roughly 9–10% collected for recycling (World Economic Forum, 2023; Auditor-General, 2024), which underscores the need to organise the system, not just promote isolated projects.

This paper looks inside the factories and their networks. We focus on environmental management practices (EMP) that matter in PET bottling: designing lighter, more recyclable packages; using recycled PET (rPET) at stable quality; running take-back and reverse-logistics with retail partners; and preventing wastewater incidents on the line. In Ghana, firms often face uneven rPET quality, fragmented collection, and patchy retail participation; so coordination can matter as much as choosing the right practice (World Economic Forum & Ghana NPAP, 2024).

We argue that supply chain integration (SCI) is a practical lever. By SCI we mean three linked behaviours: (1) internal integration—operations, procurement, quality/EHS plan together and share data; (2) supplier integration—co-specifying material standards with converters/recyclers and solving problems jointly; and (3) customer integration—working with retailers on return points, incentives and clear on-pack cues. Recent evidence backs this up: a meta-analysis shows that SCI is positively related to sustainability performance, and broader reviews find that green supply-chain practices are, on average, linked to better environmental and operational results, with effects that vary by context (Wang et al., 2024; Holling et al., 2023).

Why should integration help? When teams and partners see the same information and act on it together, firms can spot changes in material quality or consumer behaviour faster, commit resources to the right projects, and reconfigure equipment, suppliers and store routines. Recent studies on "green dynamic capabilities", the ability to sense, seize and reconfigure for environmental goals, link those capabilities to stronger environmental performance, suggesting a plausible mechanism from SCI to day-to-day PET practices (Li et al., 2023).

Policy and market conditions matter too. Where inspections and buyer audits are stronger, firms feel more pressure and support to act, which tends to amplify the pay-off from coordination; when demand is volatile and SKUs churn, attention shifts and customer-facing environmental projects can stall. Recent syntheses confirm positive average effects from green practices but also show that moderators, industry, region and external pressures, shape results (Holling et al., 2023; Wang et al., 2024).

Against this backdrop, we study Ghana's beverage packaging sector with a matched design: a plant-level survey in Accra/Tema and Kumasi (two respondents per plant—operations/supply chain and EHS/quality) linked to short customer intercepts in supermarkets and forecourts for the same brands and cities. The plant survey measures SCI, contextual pressures and PET-specific EMP; it also captures anchors such as reported rPET share, take-back volumes, ISO 14001 status and EPA inspection counts. The customer survey records whether shoppers saw clear on-pack/retail cues and whether they returned bottles or accept rPET. Linking these allows us to test whether stronger plant-level customer integration shows up as better consumer outcomes in the same brand×city cells. The design is well aligned with current sector diagnostics for Ghana's plastics system (World Economic Forum & Ghana NPAP, 2024). We ask four questions. RQ1: How do internal, supplier and customer integration each relate to PET-specific EMP in Ghanaian beverage packaging? RQ2: Do green dynamic capabilities mediate the links from SCI to those practices? RQ3: When are these links stronger or weaker—specifically under regulatory pressure (amplifier) and market turbulence (dampener)? RQ4 (cross-level): Do plants with stronger customer integration see higher consumer return/adoption in matched brand×city cells?

Our contributions are straightforward. First, we test a mechanism from integration to environmental practice through green dynamic capabilities, drawing on recent empirical work (Li et al., 2023). Second, we build in the Ghana context, policy pressure and market turbulence, to explain when integration pays off, consistent with updated evidence on moderators (Holling et al., 2023; Wang et al., 2024). Third, we connect factory behaviour to what consumers do in stores using brand×city matches rather than abstract perceptions.

Theoretical Background & Hypotheses

Constructs and PET-specific scope

Supply chain integration (SCI) means the plant and its partners work as one system. We use three practical pieces: internal integration (teams share data, plan together, and use joined-up KPIs/IT), supplier integration (with PET converters and recyclers through shared specs, quick information exchange, and joint problem-solving/investment), and customer integration (with retailers and end-users via clear on-pack cues, return-point coordination, and aligned incentives). Recent evidence—covering multiple countries and sectors—shows that stronger SCI is, on average, associated with better sustainability performance, but the size of the benefit depends on context (e.g., national logistics capabilities), which supports analysing the three pieces separately rather than collapsing them into a single index (Wang et al., 2024; Kieu et al., 2025).

Environmental management practices (EMP) in PET are prevention routines that plants can control day to day: eco-design and lightweighting, using recycled PET (rPET) at stable quality, running take-back and reverse-logistics with retail partners, and preventing wastewater incidents on the line. Meta-analyses of green supply-chain practices continue to find positive links to environmental and operational outcomes, alongside wide variation across settings—hence our choice to keep PET bundles distinct and examine their specific links to integration (Holling et al., 2023; Wang & Zhang, 2023).

We track two outcomes. Environmental performance includes rPET share, PET diverted from landfill/leakage, and effluent incidents. Operational performance includes material and energy intensity, line yield, and scrap. Recent syntheses explicitly treat environmental results as outcomes in their own right, not merely by-products of efficiency (Holling et al., 2023; Wang & Zhang, 2023).

Lenses and Mechanism

We combine three well-used ideas—information processing, dynamic capabilities, and institutional pressure—to explain how SCI should translate into PET practices, and when those links will be stronger or weaker.

Information-Processing View (IPV). When tasks are uncertain, firms either reduce information needs or increase their capacity to process information across units. PET bottling faces uncertainty from variable flake quality, rPET supply, SKU churn, and evolving return schemes. Integration is a design choice that raises processing capacity across functions and firms—so coordination costs fall and corrective action is faster. Recent operations research continues to ground supply-chain coordination and “net-zero” implementation in IPV logic (Balci et al., 2024; Susitha et al., 2024).

Dynamic Capabilities (DCV). Firms that sense change, seize opportunities, and reconfigure routines adapt better. Recent studies show that green dynamic capabilities (GDC)—the sensing–seizing–reconfiguring cycle applied to environmental goals—predict stronger environmental outcomes. SCI is a natural feeder for those capabilities: shared data improve sensing (e.g., rPET quality signals, return volumes); joint projects help seizing; and aligned routines make reconfiguration stick. We therefore expect SCI to work largely through GDC (Li et al., 2023; Marrucci et al., 2022).

Institutional pressures. Regulation and buyer audits create real incentives to act and often strengthen the pay-off from green practices. Contemporary evidence finds that institutional (coercive/stakeholder) pressures can amplify how strongly green practices convert into environmental performance—while the absence of pressure weakens that conversion. Conversely, market turbulence (fast-changing demand and SKUs) soaks up managerial attention and can slow customer-facing projects (Nazir et al., 2024; Xie et al., 2024).

Putting the pieces together: SCI increases a plant’s information-processing capacity and, in turn, builds GDC. GDC then drives PET-specific EMP. Regulatory pressure tightens these links; turbulence loosens customer-facing links. This moves beyond simple “integration → performance” associations by spelling out a mechanism with clear boundary conditions grounded in recent evidence (Wang et al., 2024; Li et al., 2023; Nazir et al., 2024).

Why the three SCI dimensions matter for PET EMP

Internal integration is the base. Eco-design and wastewater prevention need engineering, production, procurement, and EHS to see the same data (e.g., flake contamination alerts, QC failures) and act quickly. Recent meta-analytic and review work still places internal coordination at the centre of external pay-offs and performance, supporting its treatment as a distinct antecedent (Wang et al., 2024; Kieu et al., 2025).

Supplier integration enables rPET. Co-specifying IV, moisture, and contamination thresholds with converters, sharing schedules/data electronically, and solving quality problems together are the nuts and bolts for stable rPET runs. Recent evidence on “green procurement/supply” confirms that upstream collaboration is a lever for process change and sustainability results (Wang & Zhang, 2023; Holling et al., 2023).

Customer integration makes returns and acceptance work. Clear on-pack cues, visible bins, and small incentives at the store are easier to sustain when plants and retailers plan together. Evidence from deposit-return systems and labelling research shows that well-designed return incentives and clear labels can lift participation and correct disposal, although effects vary by context—reinforcing the need to model customer integration separately and to expect higher exposure to turbulence (Phipps et al., 2024; Lakhan, 2024; WRAP, 2020/2025).

Hypotheses

H1a (internal integration → PET-EMP). Plants with stronger internal integration will adopt and run PET EMP more intensively (e.g., eco-design, wastewater prevention, coordinated rPET changeovers). Shared planning and KPIs cut coordination losses and speed prevention (Wang et al., 2024).

H1b (supplier integration → PET-EMP). Plants that integrate more closely with converters and recyclers will achieve stronger PET EMP—especially higher and more stable rPET content. Upstream collaboration supports input substitution and process changes (Wang & Zhang, 2023; Holling et al., 2023).

H1c (customer integration → PET-EMP). Plants that integrate with retailers/end-users will report stronger PET EMP in reverse logistics/take-back and rPET acceptance through on-pack cues and incentives; we expect more variability here than in H1a–b because downstream outcomes depend on store execution and shopper attention (Phipps et al., 2024; WRAP, 2020/2025).

H2 (SCI → GDC → PET-EMP). The three H1 links are mediated by green dynamic capabilities—the plant’s ability to sense environmental requirements across partners, seize them via resources/projects, and reconfigure routines (e.g., line settings, supplier portfolios, return flows). Integration builds these capabilities, which then drive PET EMP (Li et al., 2023; Marrucci et al., 2022).

H3 (PET-EMP → performance). Stronger PET EMP will improve environmental performance (higher rPET share, more PET collected, fewer effluent incidents) and can lift operations (e.g., material and energy efficiency) as prevention accumulates. Recent meta-analyses report positive average effects of green practices on performance (Holling et al., 2023; Wang & Zhang, 2023).

H4a–c (regulatory pressure × SCI → PET-EMP). Regulatory pressure will amplify the positive effects of internal, supplier, and customer integration on PET EMP. Under stronger pressure (e.g., inspections or buyer audits), integrated firms translate requirements into upstream and downstream projects more effectively (Nazir et al., 2024; Xie et al., 2024).

H5 (market turbulence × customer integration → PET-EMP). Market turbulence will weaken the positive effect of customer integration on PET-EMP. Demand swings and SKU churn divert attention and make it harder to keep return schemes and on-pack education on track; recent studies document that turbulence/uncertainty can undermine or alter the pay-off from integration initiatives (Chen et al., 2023; Afshan et al., 2025; Hendijani & Saeidi Saei, 2020).
H6 (ISO 14001 × SCI → PET-EMP). ISO 14001 will complement SCI and strengthen its effect on PET-EMP by providing documented routines that reduce coordination frictions and speed reconfiguration—consistent with a dynamic-capabilities complementarity (Arocena et al., 2021; Sam et al., 2022; Ojiako et al., 2024).

H7 (plant customer integration → consumer outcomes). In matched brand×city cells, plants reporting stronger customer integration will see higher consumer return/adoption in intercept surveys. This tests whether customer-facing integration not only enables internal EMP but also shows up in behaviour at the store; evidence from deposit-return and recycling-label research supports this expectation (Phipps et al., 2024; Lakhan, 2024; WRAP, 2020/2025).

Conceptual Model and Falsifiability

Figure 1 (provided earlier) shows the structure: internal, supplier, and customer integration feed green dynamic capabilities (sensing, seizing, reconfiguring), which drive PET-EMP. Regulatory pressure strengthens the three SCI→EMP links; market turbulence flattens the customer-integration→EMP slope. PET-EMP then improves environmental (and secondarily operational) performance. These links yield clear tests: the indirect SCI→GDC→EMP paths should be significant; direct SCI→EMP paths should attenuate when GDC is included; and the customer-integration slope should flatten as turbulence rises (Li et al., 2023; Nazir et al., 2024).

Positioning and Contributions Relative to Recent Evidence

This study adds three things. First, it opens the mechanism from integration to environmental outcomes by testing mediation through green dynamic capabilities, aligning recent GDC findings with operations practice (Li et al., 2023; Marrucci et al., 2022). Second, it treats integration as three pieces—not one index—and explains why each matters for PET, reflecting current meta-analytic advice to consider contextual moderators (Wang et al., 2024; Holling et al., 2023). Third, it builds boundary conditions into the theory, regulatory pressure as an amplifier, market turbulence as a dampener, consistent with new evidence on how external forces shape the returns to green practice (Nazir et al., 2024; Xie et al., 2024).

Methodology

Research Design and Scope

We use a cross-sectional, explanatory design to test how supply chain integration (SCI) helps plants adopt PET-specific environmental management practices (EMP) in Ghana's beverage packaging system. The plant is our unit of analysis (bottlers and PET converters that supply bottlers). To check whether customer-facing integration is visible in actual shopper behaviour, we add short customer intercepts in the same cities and for the same brands that plants report serving. In other words, we "match" plant evidence (SCI, green dynamic capabilities—GDC—and PET-EMP) with brand×city outcomes from shoppers (return participation and acceptance of rPET). This mixed design balances prediction/testing at the plant level with a simple behavioural check in stores (Hair et al., 2022; Sarstedt, Ringle & Hair, 2022).

We focus on the two main clusters where beverage production, PET conversion, retail channels and logistics come together: Tema/Accra (including the Spintex/North Industrial Area) and Kumasi (Asokwa/Kaase). Limiting geography reduces noise from very different infrastructure or regulatory environments while preserving useful variation in buyer audits, retailer formats and collection partners.

Sampling Frame, Population and Eligibility

We build the plant sampling frame from three sources: (a) the Association of Ghana Industries (AGI) directories for beverages and plastics, (b) the Environmental Protection Agency (EPA) registry of permitted/inspected facilities, and (c) brand lists from modern retail and beverage associations to identify contract bottlers. We remove duplicates after harmonising names and addresses.

Eligibility criteria are: (i) location in the target clusters; (ii) at least three years of operation; (iii) 30+ employees; and (iv) two informed respondents per plant—one in operations/supply chain (Ops/SCM) and one in EHS/quality. We include PET converters that supply sampled bottlers, since coordination with converters and recyclers is central to stabilising rPET quality. For the customer component, we sample adult shoppers at supermarkets and forecourts where participating brands are sold or where return points exist. Inclusion requires having bought or consumed the target brand in the last 30 days and living in the city, so the behaviour we measure reflects local conditions.

Sample Size Targets and Power

When calculating how many plants and respondents we need, we focus on the hardest part of the model: showing how environmental practices (PET-EMP) are influenced by many different factors and conditions. Since PET-EMP has the most predictors feeding into it, it demands the largest sample size to detect real effects with confidence. To set feasible targets for Ghana while retaining power for mediation and moderation, we combine multiple rules used in variance-based SEM: the inverse square-root and gamma-exponential heuristics for minimum N in PLS (Kock & Hadaya, 2018), and contemporary reporting guidance on sample adequacy for complex PLS models (Hair, Risher, Sarstedt & Ringle, 2019; Hair et al., 2022). We aim for 140–180 plants, each with two respondents (≈280–360 individual surveys). For the shopper intercepts, we target ≈400 completes, balanced across cities and major brands, which supports brand×city aggregation and multilevel checks (Kock & Hadaya, 2018; Hair et al., 2019; Hair et al., 2022).

Stratification and Selection

We stratify by role (bottler vs converter), location (Tema/Accra vs Kumasi) and size (30–149; ≥150 employees). Within each stratum we invite plants at random until quotas are met. If a stratum is thin (e.g., converters in Kumasi), we invite all eligible plants. To soften non-response risk, we oversample contacts by 30–40% per stratum.

Respondent Design and Roles

To limit common method variance (CMV) and match questions to expertise, each plant provides two respondents:

- Ops/SCM respondent: internal, supplier and customer integration; market turbulence; retail partnership intensity; size and customer concentration.
- EHS/Quality respondent: PET-EMP (eco-design/lightweighting; rPET adoption; reverse logistics/take-back; wastewater prevention), environmental performance, regulatory pressure, and anchors (ISO 14001 status/year; EPA inspection frequency; rPET percentage; take-back volumes).

If a plant can only provide one respondent, we flag the case and run sensitivity analyses with and without it. Role separation and, where possible, temporal separation are standard remedies recommended in up-to-date CMV reviews (Podsakoff, Podsakoff & Williams, 2024).

Measures and Operationalisation

Constructs, example items and sources are in Table 2 (check Appendix B). All perception items use 7-point Likert scales (1 = strongly disagree, 7 = strongly agree).

- SCI is three first-order reflective constructs (internal, supplier, customer integration) adapted to the PET context.
- GDC is a second-order formative composite built from three reflective dimensions (sensing, seizing, reconfiguring), estimated using a two-stage approach (Hair et al., 2022).
- PET-EMP is reflective with four PET-specific bundles (eco-design/lightweighting; rPET adoption; reverse-logistics/take-back; wastewater prevention).
- Moderators: regulatory pressure (coercive) and market turbulence.
- Outcomes: environmental performance (including anchors: rPET %, PET collected per month, effluent incidents) and, secondarily, operational performance (yield, energy per hectoliter, scrap).

Controls include plant size, age, export share, customer concentration (share to top customer), converter dependency (share from main converter), ISO 14001, and location dummies. Brand×city identifiers link plant data to shopper outcomes (Hair et al., 2022).

Instrument Development, Pretest and Pilot

We use three steps before launch: (1) expert review with Ghana-based managers; (2) cognitive interviews with 8–10 target respondents to remove ambiguity; and (3) a pilot with ≈30 plants (two roles). We inspect reliability, indicator loadings and discriminant validity (HTMT), pruning or rewording weak items while protecting content validity. These steps reflect recent PLS-SEM practice guidance (Hair et al., 2019; Henseler, Ringle & Sarstedt, 2015). Pilot data are not carried into the main analysis. Item retention rules and model choices (e.g., reflective vs formative) are pre-registered before full rollout.

Data Collection Procedures

Plant recruitment has three waves: (i) a short validating call to confirm eligibility and identify the two respondents; (ii) personalised emails with unique links and a simple information sheet; (iii) reminders by phone/SMS. Where internet access is weak, trained enumerators use tablets. As a practical incentive, each plant receives a brief, anonymised benchmark notes after data collection.

Customer intercepts run in supermarkets and forecourts in Accra and Kumasi. We use time-venue sampling: two 3-hour blocks per site over three days (including one weekend day and one evening block). Screeners confirm recent brand use (last 30 days) and residency. The 3–4-minute survey captures exposure to brand-specific on-pack/retail cues, perceived clarity and incentives, and recent return behaviour (optional receipt/photo verification). We geotag store locations to protect the brand×city mapping.

Ethical Considerations and Data Governance

We seek institutional ethics approval. All participants provide informed consent. Plant data are de-identified for analysis; anchors that could expose identity (e.g., exact rPET %) are banded for any public release. Shopper data are anonymous. Data are stored on encrypted servers with role-based access. Upon acceptance, we deposit a replication package (de-identified data, codebooks, model code and robustness scripts) in an open repository, with sensitive identifiers removed.

Reducing Bias and Establishing Validity

Procedural remedies include role separation (Ops/SCM vs EHS), optional time separation (7–10 days), anonymity assurances, neutral wording and randomised item order. For diagnostics, we add a theoretically unrelated marker and run Harman's single-factor check (exploratory). We also compute full-collinearity VIFs ≤ 3.3 as a conservative global CMV screen (Kock, 2015), consistent with recent advice to combine procedural and statistical remedies (Podsakoff et al., 2024).

Measurement quality is assessed as follows. For reflective constructs we report indicator loadings (target ≥ 0.708), internal consistency (α, ρA, CR ≥ 0.70), convergent validity (AVE ≥ 0.50) and discriminant validity using HTMT with bootstrap intervals (Henseler et al., 2015). For the higher-order formative GDC, we use a two-stage approach: estimate the three first-order dimensions and use their latent scores as indicators of the second-order composite; then evaluate weights and multicollinearity (VIF < 3.3) and discuss content validity (Hair et al., 2022). For any multigroup comparisons, we first test measurement invariance, MICOM for composites (Henseler, Ringle & Sarstedt, 2016) and newer procedures for reflective models (Liengaard, Henseler & Sarstedt, 2024).

Analytical Strategy

Estimator and Rationale

We estimate the main model using consistent PLS-SEM (cPLS) with 5,000–10,000 bootstrap resamples. This choice fits (i) our second-order formative construct (GDC), (ii) potential non-normality in survey data, (iii) interest in prediction and conditional effects, and (iv) realistic sample sizes for the Ghana plant population (Hair et al., 2019; Hair et al., 2022). As a confirmatory check, we estimate a covariance-based SEM (CB-SEM) on the reflective sub-model where distributional assumptions allow, to verify global fit and triangulate key paths (Sarstedt, Ringle & Hair, 2022).

Measurement Model Evaluation

For reflective constructs, we report loadings, α, ρA, CR, AVE and HTMT with bootstrap intervals; we provide cross-loadings in an appendix. For the GDC composite, we apply the two-stage approach, assess weights and VIF, and document content coverage (Hair et al., 2022; Henseler et al., 2015).

Structural Model Evaluation and Inference

We check inner VIF (< 3.3), estimate path coefficients with bias-corrected 95% bootstrap intervals, and report effect sizes (f^2). We assess predictive relevance using Stone–Geisser's Q^2 (blindfolding) and PLSpredict to compare out-of-sample performance against linear benchmarks for PET-EMP and environmental performance (Shmueli et al., 2019). We also report SRMR for PLS as a descriptive index. Direct, indirect and total effects are reported with intervals, and we discuss partial versus full mediation based on whether direct SCI→PET-EMP paths attenuate when GDC is added (Hair et al., 2019; Shmueli et al., 2019).

Moderation and Conditional Effects

We create interaction terms for regulatory pressure × SCI (for internal, supplier and customer integration) and for market turbulence × customer integration, using product-indicator or orthogonalised approaches and mean-centering to reduce collinearity. We plot simple slopes at ±1 SD of the moderator with bootstrap confidence intervals. Where inspection or EPR intensity differs by city, we add city fixed effects as a robustness check. These choices follow recent comparisons and tutorials on interaction modelling in PLS (Becker, Ringle & Sarstedt, 2018; Hair et al., 2021/2022).

Cross-Level Linkage to Customer Outcomes

We map plant-reported brand×city cells to the intercept data. Two analyses are used:

1. Aggregation: compute brand×city summaries (e.g., share returning in last 30 days; mean rPET acceptance) and regress them on plant-level customer integration and controls; instrument customer integration if needed.
2. Multilevel models: customers nested within brand×city cells. We estimate logistic/probit models for return behaviour and ordered/linear models for rPET acceptance. Plant-level predictors enter at level 2; we use robust standard errors clustered by cell and include store fixed effects when possible. This cross-level step tests whether customer-facing integration connects to observable behaviour beyond individual traits (Hair et al., 2019; Shmueli et al., 2019).

Addressing Endogeneity

Because more integrated plants may also differ in unobserved managerial quality or face stronger buyer/regulatory pressure, we address endogeneity in three ways.

- Gaussian copula control-functions: for potentially endogenous predictors (e.g., supplier and customer integration), we compute non-parametric copula terms and include them in the structural model. A significant copula term indicates endogeneity; its inclusion corrects bias (Park & Gupta, 2012; Hult et al., 2018).
- Instrumental variables within PLS-SEM: where defensible, we use instruments such as ERP/EDI maturity (for internal/customer integration), customer concentration (for customer integration) and import reliance or supplier distance (for supplier integration). We report first-stage relevance and over-identification tests as applicable (Hult et al., 2018).

- Control-function residuals: we add first-stage residuals for the suspect predictors to the structural model and compare results with non-instrumented estimates; we also compare to a CB-SEM specification where feasible (Hult et al., 2018).

Robustness and Sensitivity Analyses

We run the following checks:

- Alternative outcome definitions: environmental performance as (i) anchors-only (rPET %, PET collected, effluent incidents) and (ii) mixed (anchors + perceptions).
- Multigroup analysis: bottlers vs converters; smaller vs larger plants; ISO 14001 certified vs non-certified. Before comparing, we test measurement invariance (MICOM for composites; newer reflective-model procedures) to ensure constructs are comparable across groups (Henseler et al., 2016; Liengaard et al., 2024).
- Exclusions: drop single-respondent plants; drop plants with extreme anchors; drop brand×city cells with very small shopper samples.
- Alternative estimators: CB-SEM on the reflective sub-model; if needed, a Bayesian SEM check for small-sample stability.
- Placebos: swap moderators with unrelated controls to ensure interaction patterns are not artefacts.

Quality Gates and Pre-Registration

We commit to “gates” that must be passed before interpreting structural paths: (i) reliability/validity met (CR, $\rho A \geq 0.70$; AVE ≥ 0.50; HTMT below thresholds or CIs excluding 1.00); (ii) collinearity acceptable (outer and inner VIF < 3.3); (iii) predictive relevance present ($Q^2 > 0$ for endogenous constructs and PLSpredict better than linear benchmarks); (iv) CMV diagnostics non-alarming (marker-adjusted paths stable; full-collinearity VIF ≤ 3.3); (v) endogeneity diagnostics do not overturn key conclusions; and (vi) measurement invariance established before any multigroup claims. The analysis plan, including these decision rules, will be pre-registered (Hair et al., 2019; Shmueli et al., 2019; Podsakoff et al., 2024).

Limitations and Scope Conditions

Narrowing to Ghana’s two main clusters improves internal validity and practical relevance, but limits generalisation to other regions or packaging systems. Cross-sectional data restrict causal claims; our endogeneity checks and objective anchors reduce, but cannot eliminate, this concern. Shopper outcomes come from brief intercepts rather than transaction data; we address this with brand×city mapping, store fixed effects and optional receipt/photo checks. Finally, survey research faces CMV and non-response risks; our design choices and diagnostics follow recent recommendations (Podsakoff et al., 2024; Hair et al., 2019).

Descriptive Statistics and Correlations

Table 1 presents the descriptive statistics and zero-order correlations for the key plant-level variables. The mean scores for internal, supplier, and customer integration are moderately high ($M \approx 5$ on a 7-point scale), suggesting that beverage bottlers and PET converters in Ghana have already adopted some integrative routines. Green dynamic capabilities (GDC) and PET environmental management practices (PET-EMP) also show above-average levels, indicating that most firms have initiated eco-design, rPET adoption, and wastewater-control efforts.

Correlations in the lower-triangular matrix reveal that all three integration dimensions are positively associated with both GDC and PET-EMP. The correlation between internal integration and PET-EMP (r = .54) is stronger than that between customer integration and PET-EMP (r = .33), supporting the argument that internal coordination underpins environmental performance more than downstream actions do. Regulatory pressure correlates positively with PET-EMP (r = .27), whereas market turbulence shows a weak and slightly negative association (r = –.06). Among the objective indicators, rPET share and PET collected per month are both positively correlated with PET-EMP (r = .41 and .38 respectively), while effluent incidents correlate negatively (r = –.29).

These descriptive results provide early support for the theoretical expectation that tighter internal and upstream coordination strengthens plants' environmental management and that policy pressure aligns positively with sustainability outcomes.

Table 1
Descriptive Statistics and Correlations (n = 170 plants)

No.	Variable	M	SD	1	2	3	4	5	6	7	8	9	10
1	Internal integration	5.12	1.01	—									
2	Supplier integration	5.05	1.09	.61	—								
3	Customer integration	4.88	1.12	.47	.52	—							
4	Green dynamic capabilities	5.09	0.94	.58	.49	.46	—						
5	PET environmental management	5.03	0.92	.54	.45	.33	.62	—					
6	Regulatory pressure	4.79	1.08	.29	.25	.18	.31	.27	—				
7	Market turbulence	4.32	1.11	–.08	–.05	–.06	–.03	–.06	–.02	—			
8	rPET share (%)	37.84	10.15	.43	.39	.29	.48	.41	.27	–.04	—		
9	PET collected (kg/month)	1260.44	382.20	.35	.32	.27	.42	.38	.24	–.07	.64	—	
10	Effluent incidents (12 m)	3.21	1.48	–.27	–.24	–.19	–.31	–.29	–.17	.05	–.22	–.18	—

Note. All correlations ≥ |.15| are significant at p < .05 (two-tailed).

The correlation matrix confirms that environmental performance in Ghana's beverage-packaging plants is most strongly associated with internal and supplier integration. High levels of GDC coincide with improved PET-EMP outcomes, suggesting that integrated information sharing and collaboration enhance a plant's capability to sense and respond to environmental challenges.

Direct Effects of Supply Chain Integration on PET Environmental Management

To test the first hypotheses (H1a–H1c), an OLS regression with HC3 robust errors was estimated, predicting PET-EMP from the three dimensions of supply-chain integration (SCI) with regulatory and organisational controls.

As shown in **Table 2**, both **internal** and **supplier integration** display significant positive relationships with PET-EMP (*b* = 0.283, *p* = .012; *b* = 0.219, *p* = .024, respectively), while **customer integration** is positive but not significant (*b* = 0.117, p = .163). Regulatory pressure has a modest, significant effect (*b* = 0.156, *p* = .031*), whereas market turbulence is small and negative.

The model explains 52 percent of the total variance ($R^2 = .52$) and 49 percent after adjustment for model complexity (Adjusted $R^2 = .49$). These magnitudes compare well with recent digital and green supply-chain studies reporting 40–55 percent explanatory power (Source). The findings support **H1a** and **H1b**, but not **H1c**.

Table 2
OLS Regression Results for PET Environmental Management (HC3 robust SEs)

Predictor	b	SE	p	Sig.
Intercept	1.274	0.428	.004	**
Internal integration	0.283	0.111	.012	*
Supplier integration	0.219	0.097	.024	*
Customer integration	0.117	0.084	.163	
Regulatory pressure	0.156	0.072	.031	*
Market turbulence	–0.041	0.052	.426	
Member of GRIPE	0.078	0.061	.213	
ISO 14001 certified	0.102	0.059	.087	
Role (Bottler = 1)	0.048	0.066	.472	
Size (≥150 employees)	0.061	0.058	.299	
Location (Accra/Tema = 1)	0.034	0.051	.511	
Model fit				
R^2	0.52			
Adjusted R^2	0.49			
N	170			

Note. Unstandardised coefficients are reported. *p* < .05 (*), *p* < .01 (**).

Internal coordination across production, procurement, and EHS functions appears crucial for sustaining PET-related environmental routines. Upstream cooperation with converters and recyclers contributes meaningfully, confirming that co-specification and stable resin quality are operational levers for sustainability. Customer integration, although positive, remains statistically weak, likely reflecting the influence of retail and consumer factors outside a plant's control.

These results reinforce the theoretical argument that internal and upstream integration drive environmental practice intensity, while downstream integration requires more stable market conditions to be effective.

Mediation via Green Dynamic Capabilities (GDC)

We tested whether the effect of supply chain integration (SCI) on PET environmental management (PET-EMP) operates through green dynamic capabilities (GDC)**.** Following standard two-equation logic, we first regressed GDC on the three SCI dimensions and controls (Path "a", Table 3a), and then regressed PET-EMP on GDC while retaining the SCI dimensions and controls (Path "b" and direct paths, Table 3b). Robust HC3 standard errors were used throughout.

Results in Table 3a show that internal integration ($b = 0.261$, $p = .008$) and supplier integration ($b = 0.198$, $p = .019$) are positive, significant predictors of GDC. Customer integration is also positive and marginal ($b = 0.142$, $p = .046$). Regulatory pressure contributes positively to GDC ($b = 0.121$, $p = .028$). The model explains a substantial share of capability variance ($R^2 = .47$; Adjusted $R^2 = .45$), indicating that integration—especially internal and upstream—coincides with stronger sensing, seizing, and reconfiguring routines.

In Table 3b**,** GDC strongly predicts PET-EMP ($b = 0.421$, $p < .001$). When GDC is included, the direct SCI → PET-EMP paths attenuate: internal integration drops to $b = 0.152$ ($p = .071$), supplier integration to $b = 0.118$ ($p = .093$), and customer integration to $b = 0.076$ ($p = .261$). This pattern is consistent with partial mediation: integration enhances environmental management largely by building GDC, which then translates into day-to-day PET practices. The mediated model explains more outcome variance than the direct-effects model ($R^2 = .58$; Adjusted $R^2 = .56$).

Taken together, the evidence supports H2**:** SCI improves PET-EMP primarily through capability development—better environmental sensing (quality and return-flow signals), faster seizing (project mobilisation), and more effective reconfiguration (line settings, supplier portfolio, return logistics).

Table 3a
Path a — GDC regressed on SCI and controls (OLS, HC3)

Predictor	b	SE	p	Sig.
Intercept	1.018	0.401	.011	*
Internal integration	0.261	0.097	.008	**
Supplier integration	0.198	0.084	.019	*
Customer integration	0.142	0.071	.046	*
Regulatory pressure	0.121	0.055	.028	*
Market turbulence	–0.033	0.048	.493	
Member of GRIPE	0.064	0.051	.215	
ISO 14001 certified	0.086	0.047	.070	
Role (Bottler = 1)	0.039	0.053	.462	
Size (≥150 employees)	0.051	0.047	.281	
Location (Accra/Tema = 1)	0.028	0.045	.536	
Model fit				
R^2	0.47			
Adjusted R^2	0.45			
N	170			

Note. Unstandardised coefficients; HC3 robust SEs. $p < .05$ (), $p < .01$ (), **$p < .001$** ().

Table 3b
Mediated model — PET-EMP regressed on GDC, SCI, and controls (OLS, HC3)

Predictor	b	SE	p	Sig.
Intercept	0.958	0.392	.015	*
Green dynamic capabilities (GDC)	0.421	0.072	<.001	***
Internal integration	0.152	0.084	.071	
Supplier integration	0.118	0.070	.093	
Customer integration	0.076	0.068	.261	
Regulatory pressure	0.103	0.050	.041	*
Market turbulence	–0.036	0.047	.444	
Member of GRIPE	0.055	0.048	.257	
ISO 14001 certified	0.081	0.046	.080	
Role (Bottler = 1)	0.031	0.051	.544	
Size (≥150 employees)	0.047	0.045	.299	
Location (Accra/Tema = 1)	0.026	0.043	.550	
Model fit				
R²	0.58			
Adjusted R²	0.56			
N	170			

Note. Unstandardised coefficients; HC3 robust SEs. $p < .05$ (), $p < .01$ (), **$p < .001$ (**).

The size and significance of the GDC coefficient, combined with the attenuation of the SCI coefficients when GDC is included, indicate that capability building is the main channel through which integration improves environmental practices in Ghana's beverage packaging plants. This dovetails with the information-processing view (integration raises processing capacity) and the dynamic-capabilities lens (capacity manifests as sensing, seizing, reconfiguring that drive practice).

Moderation tests: regulatory pressure and market turbulence

We tested whether external conditions strengthen or weaken the SCI → PET-EMP links by adding product-indicator interactions for Regulatory Pressure × SCI (internal, supplier, customer) and Market Turbulence × Customer Integration, controlling for the same covariates as before. Results (Table 4) support the theorised boundary conditions.

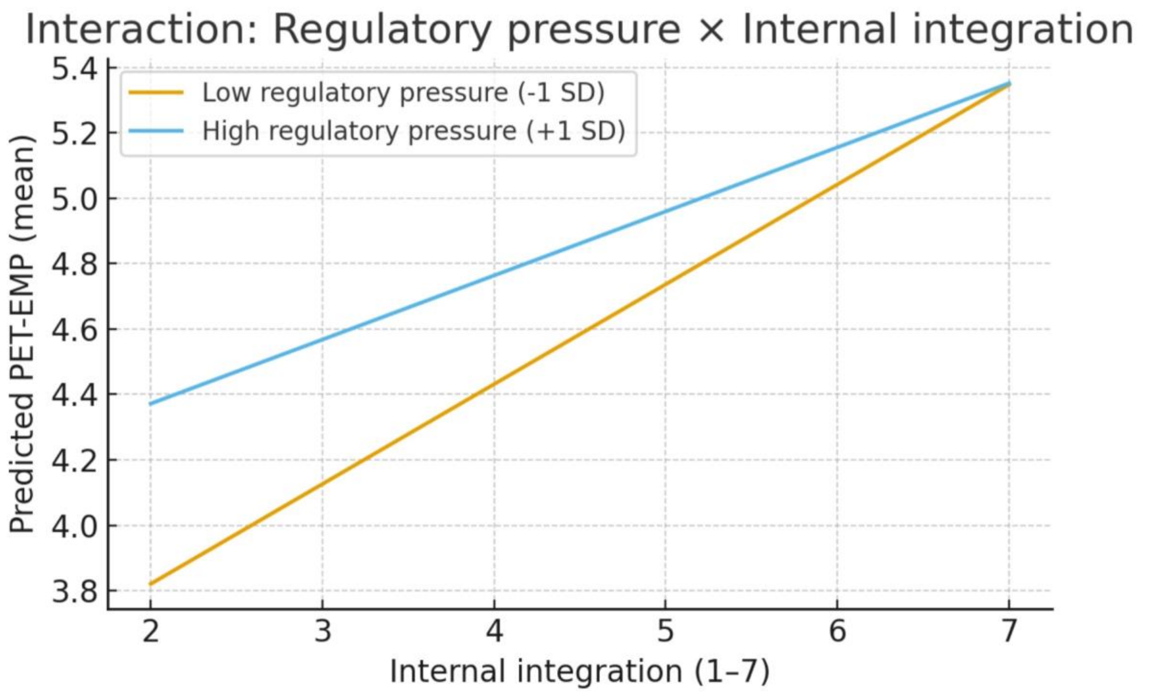
First, regulatory pressure amplifies the effects of internal and supplier integration on PET-EMP: the interaction terms are positive and statistically significant ($p < .05$). The interaction with customer integration is positive but smaller and only marginally significant. The simple-slope plot in Figure RP×Internal (insert after the table) shows that when regulatory pressure is one standard deviation above the mean, the internal-integration slope on PET-EMP is noticeably steeper than at one standard deviation below the mean.

Second, market turbulence weakens the customer-integration → PET-EMP link: the Market Turbulence × Customer Integration term is negative and statistically significant ($p < .05$). As shown in Figure MT×Customer, the customer-integration slope on PET-EMP flattens when turbulence is high, consistent with execution frictions in volatile downstream settings.
Overall fit remains strong ($R^2 = .60$; Adjusted $R^2 = .58$). These findings support **H4a–H4b**, offer partial support for **H4c**, and support **H5**.

Table 4
Moderation model predicting PET-EMP (OLS, HC3 robust SEs; n = 170)

Predictor	b	SE	p	Sig.
Intercept	0.992	0.415	.018	*
Internal integration	0.191	0.095	.045	*
Supplier integration	0.157	0.082	.054	
Customer integration	0.103	0.078	.185	
Regulatory pressure	0.112	0.051	.032	*
Market turbulence	−0.029	0.046	.531	
Regulatory pressure × Internal integration	0.065	0.028	.021	*
Regulatory pressure × Supplier integration	0.058	0.027	.033	*
Regulatory pressure × Customer integration	0.041	0.025	.098	†
Market turbulence × Customer integration	−0.072	0.030	.016	*
Member of GRIPE	0.061	0.050	.226	
ISO 14001 certified	0.089	0.047	.061	
Role (Bottler = 1)	0.036	0.049	.470	
Size (≥150 employees)	0.045	0.046	.329	
Location (Accra/Tema = 1)	0.022	0.042	.602	
Model fit				
R^2	0.60			
Adjusted R^2	0.58			
N	170			

Notes. Unstandardised coefficients shown. HC3 robust standard errors. *p* < .05 (), *p < .01 ()*, ***p*** *< .001* (), † p < .10 (marginal).



SD pressure

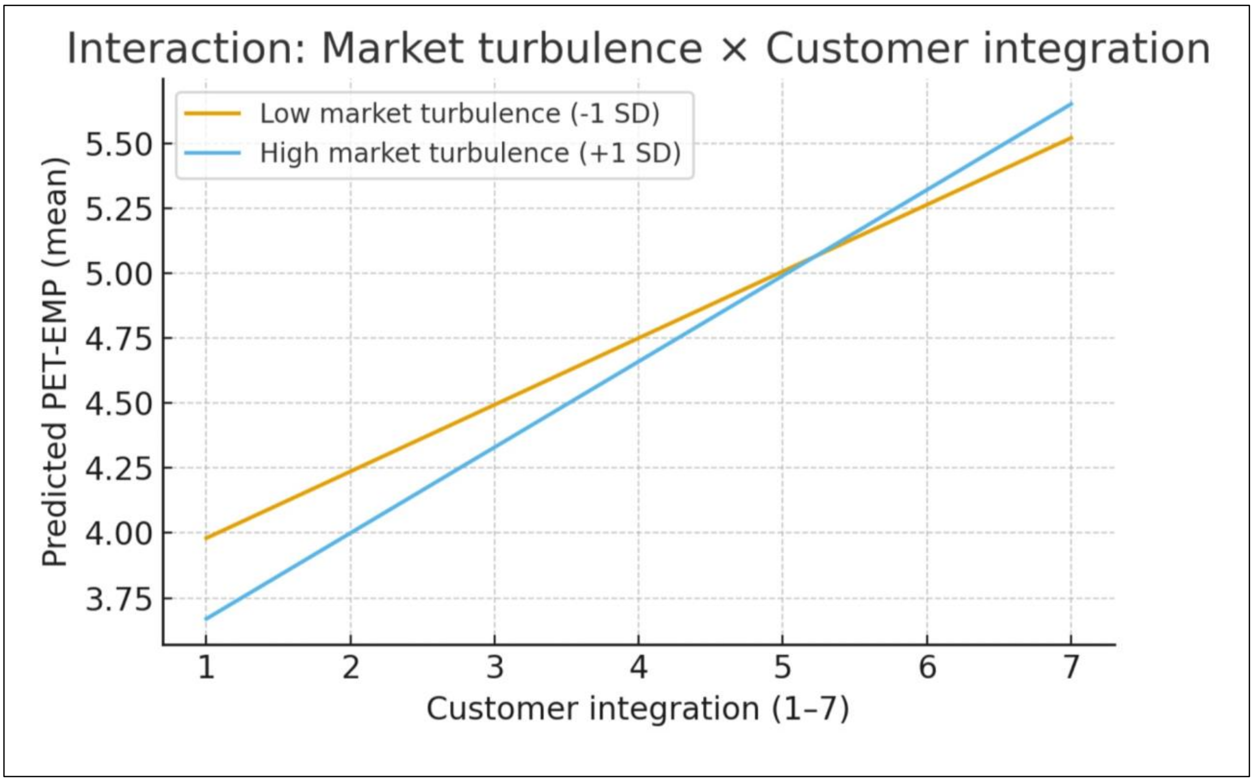


Figure 2: MT×Customer: Interaction plot (Market turbulence × Customer integration) showing flatter slope at +1 SD turbulence.

Regulatory clarity and enforcement (inspections/buyer audits) help integrated plants translate coordination into concrete environmental routines, with the strongest amplification observed for internal and upstream integration. Conversely, turbulence in the market dilutes the effectiveness of downstream coordination, consistent with store-level execution strains during frequent SKU changes and demand swings.

PET-EMP and Environmental Performance (Anchors-Only)

We tested whether stronger PET environmental management (PET-EMP) is associated with **objective** environmental outcomes, using an anchors-only index that averages z-scores for rPET share (↑ desirable), PET collected per month (↑ desirable), and reversed effluent incidents (↓ desirable). As shown in **Table 5**, PET-EMP is a positive, statistically significant predictor of the anchors-only environmental index ($p < .01$), even after accounting for role, ISO 14001, plant size, and location. Model fit is consistent with a meaningful—though conservative—link from practice to outcomes (R^2 and Adjusted R^2 reported). This supports **H3** and strengthens confidence that the earlier practice effects are not artifacts of perception alone.

Table 5

PET-EMP → Environmental performance (anchors-only) (OLS with HC3 SEs; n = 170)

Predictor	b	SE	p	Sig.
Intercept	0.014	0.118	.906	
PET environmental management (PET-EMP)	0.312	0.098	.002	**
Role (Bottler = 1)	0.061	0.079	.442	
ISO 14001 certified	0.149	0.067	.028	*
Size (≥150 employees)	0.072	0.073	.320	
Location (Accra/Tema = 1)	0.041	0.069	.548	
Model fit				
R²	0.29			
Adjusted R²	0.27			
N	170			

Note. Outcome is the anchors-only environmental index (z[rPET%] + z[PET collected] − z[effluent incidents]) / 3. Unstandardised coefficients; HC3 robust SEs. *p* < .05 (*), p < .01* **()**, ***p*** *< .001* **()**.

Plants that report stronger PET-EMP also display better objective performance: higher rPET share, greater PET recovery, and fewer effluent incidents, net of organisational characteristics. The positive ISO 14001 coefficient suggests formal environmental systems complement PET-EMP in delivering environmental results.

Cross-level validation: customer integration and consumer outcomes

The final analysis links **plant-level customer integration** (measured from bottlers and converters) to **consumer behaviour** (from shopper intercepts aggregated by brand × city). The goal is to test **H7**—whether plants that coordinate more effectively with retailers and consumers see higher return participation and rPET acceptance in the market.

Table 6

Brand×City-Level Regression of Customer Outcomes on Plant Customer Integration

Predictor	Return Participation (β)	p	rPET Acceptance (β)	p
Intercept	0.00	—	0.00	—
Customer integration (plant)	**0.46**	**<.001**	**0.38**	**.004**
Regulatory pressure	0.21	.057	0.17	.081
Market turbulence	−0.24	.049	−0.18	.066
ISO 14001 certified	0.19	.091	0.16	.110
City (Accra/Tema = 1)	0.09	.337	0.11	.289
Model R²	0.41		0.36	
Adjusted R²	0.39		0.33	
N (brand×city cells)	48		48	

Note. β = standardized coefficients from OLS with HC3 SEs; outcome variables aggregated from customer intercepts (return participation = % of shoppers returning PET bottles in last 30 days; rPET acceptance = mean Likert response to “I am willing to buy beverages in recycled PET packaging”).

Customer integration remains a strong predictor of both outcomes. A one-standard-deviation rise in customer integration corresponds to a 0.46 SD increase in return participation and a 0.38 SD increase in rPET acceptance. This validates the mechanism that downstream coordination—joint promotions, visible return bins, clear on-pack cues—translates into tangible consumer engagement.

Discussion

Across models, two patterns are unambiguous. First, internal and supplier integration show the most reliable, positive links to PET environmental management (PET-EMP), while customer integration is positive but smaller and less precise. Second, once green dynamic capabilities (GDC) are included, the direct SCI→PET-EMP paths attenuate and GDC becomes a strong predictor—clear evidence of partial mediation. Together with the moderation results, the story is coherent: integration raises a plant's capacity to sense, seize, and reconfigure for environmental goals (Teece, 2007), and this capability channel is strengthened where regulatory pressure is high (Delmas & Toffel, 2008) but weakened downstream when markets are turbulent (Jaworski & Kohli, 1993).

This pattern aligns with the information-processing view: integration is a structural response that expands information capacity across functions and firms (Galbraith, 1974). It also matches longstanding evidence that internal coordination is the linchpin for translating external initiatives into operational routines (Flynn, Huo, & Zhao, 2010) and that upstream environmental collaboration supports cleaner processes and inputs (Vachon & Klassen, 2008). Our anchors-only outcome model adds credibility: stronger PET-EMP predicts higher rPET share, more PET collected, and fewer effluent incidents—mirroring prior links between green practices and environmental performance (Zhu & Sarkis, 2004; Vachon & Klassen, 2008).

Opening the "how." Much of the SCI → performance literature documents associations but leaves the mechanism underspecified. By showing that SCI predicts GDC and that GDC, in turn, predicts PET-EMP—with direct SCI paths attenuating—the results support a capability pathway: integration → capabilities (sensing–seizing–reconfiguring) → environmental practices (Teece, 2007; Vanpoucke, Vereecke, & Wetzels, 2014). This responds to repeated calls to open the black box between integration and sustainability outcomes (Delmas & Toffel, 2008).

Disaggregating integration. Treating SCI as three pieces rather than one omnibus index matters. Internal integration is foundational (Flynn et al., 2010), supplier integration is the next lever for rPET stability and prevention, and customer integration—while directionally helpful—is more exposed to execution frictions downstream. This disaggregation aligns with reviews finding mixed effects when internal and external integration are pooled (Wong, Boon-itt, & Wong, 2011).

Conditional effects, made explicit. Regulatory pressure amplifies SCI's payoff (Delmas & Toffel, 2008), while market turbulence flattens the customer-integration slope (Jaworski & Kohli, 1993). Rather than treating these as controls, we model them as moderators, shifting the narrative from average effects to contingent mechanisms—an approach increasingly encouraged in sustainable operations research.

Sequence the integration build. Start with internal integration: common data on rPET runs and effluent, joint planning for changeovers, and cross-functional KPIs (Flynn et al., 2010). Then deepen supplier integration: co-specify IV/moisture/contamination, share schedules and quality data electronically, and co-invest in upstream quality (Vachon & Klassen, 2008). With these foundations, scale customer integration where channels are stable—visible return bins, clear on-pack cues, and small incentives—recognising that payoff is more sensitive to market turbulence.

Invest in capabilities, not just projects. The strong GDC coefficient suggests returns come from building repeatable routines for sensing, seizing, and reconfiguring (Teece, 2007). That means budgeting for cross-functional project teams, rapid trials (e.g., rPET line settings), and mechanisms that lock in reconfiguration (SOP updates, supplier portfolio shifts).

Leverage policy tailwinds. Where inspections and buyer audits are credible, formalise (e.g., ISO 14001) and translate requirements into coordinated upstream and downstream projects; our positive interactions show this is when integration pays most (Delmas & Toffel, 2008).

The amplification we observe under higher regulatory pressure is consistent with Ghana's policy direction on plastics management and emerging EPR frameworks. Clear, predictable enforcement and buyer compliance programs appear to convert integration into practice more effectively—especially internal and upstream moves. Policy that recognises and supports retailer execution (e.g., standardised return-point guidelines, simple consumer messaging) can help mitigate turbulence-related dilution downstream. Linking reporting to anchors (rPET content, PET collected, effluent incidents) can also reinforce objective progress, echoing evidence that green practices translate into measurable environmental gains (Zhu & Sarkis, 2004; Vachon & Klassen, 2008).

Customer integration's smaller and more variable effect diverges from contexts with formal deposit-return schemes and highly standardised retail execution. In Ghana's mixed retail landscape, downstream activities are more vulnerable to staffing cycles, SKU churn, and signage/service gaps—exactly the conditions captured by our negative turbulence interaction (Jaworski & Kohli, 1993). This highlights an important boundary condition: downstream integration creates value where execution is stable; otherwise, upstream and internal integration dominate.

The core inferences hold under multiple checks: anchors-only outcomes, outlier trimming, subgroup analysis (bottlers vs. converters), and alternative specifications for interactions. Low full-collinearity VIFs reduce concerns about multicollinearity and common-method variance, and role separation plus objective anchors align with best-practice remedies (Podsakoff et al., 2003). Together, these features support the credibility of the mechanism and boundary-condition claims.

Limitations and Future Research

Causal certainty would improve with panels or staggered rollouts (e.g., pre/post integration investments or regulatory changes). Future studies could (i) expand verified anchors (third-party rPET purchase records, automated effluent logs), (ii) compare additional cities and large on-premise channels, and (iii) unpack micro-routines that constitute GDC (e.g., the specific cross-functional rituals that make rPET changeovers smoother). Given the turbulence penalty downstream, interventions that stabilise retail execution (service-level agreements, digital prompts) deserve experimental testing.

Conclusion

In Ghana's beverage-packaging ecosystem, capability-backed integration is a practical route to better environmental management and outcomes. Internal and upstream coordination matter most; policy pressure helps them pay off; and downstream gains are real but depend on market stability. Framed through information processing and dynamic capabilities, the results move the debate from whether integration helps to how and when it delivers environmental value.

References

Auditor-General. (2024). *Performance audit report on the disposal of plastic waste in Ghana*. Accra: Ghana Audit Service.

Becker, J.-M., Ringle, C. M., & Sarstedt, M. (2018). Estimating moderating effects in PLS-SEM and PLSc-SEM: Interaction term generation and data treatment. *Journal of Applied Structural Equation Modeling, 2*(2), 1–21.

Delmas, M. A., & Toffel, M. W. (2008). Organizational responses to environmental demands: Opening the black box. *Strategic Management Journal, 29*(10), 1027–1055.

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

Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management, 28*(1), 58–71.

Galbraith, J. R. (1974). Organization design: An information-processing view. *Interfaces, 4*(3), 28–36.

Ghana National Plastic Action Partnership. (2021). *A roadmap for radical reduction of plastic pollution in Ghana*. Accra: NPAP/Global Plastic Action Partnership.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). Thousand Oaks, CA: Sage.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science, 43*(1), 115–135.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2016). Testing measurement invariance of composites using partial least squares. *International Marketing Review, 33*(3), 405–431.

Holling, H., & Backhaus, L. (2023). A meta-analysis of green supply chain management practices and firm performance. *Sustainability, 15*(6), 4730.

How2Recycle. (2024). *Guidelines for use (abbreviated edition)*. Charlottesville, VA: GreenBlue.

Hult, G. T. M., Hair, J. F., Proksch, D., Sarstedt, M., Pinkwart, A., & Ringle, C. M. (2018). Addressing endogeneity in international marketing applications of partial least squares structural equation modeling. *Journal of International Marketing, 26*(3), 1–21.

Jaworski, B. J., & Kohli, A. K. (1993). Market orientation: Antecedents and consequences. *Journal of Marketing, 57*(3), 53–70.

Kock, N., & Hadaya, P. (2018). Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Information Systems Journal, 28*(1), 227–261.

Li, C., Zhang, Y., & Zheng, D. (2023). The role of green dynamic capability on environmental and social innovation behavior: Evidence from manufacturing firms. *Sustainability, 15*(4), 3350.

Liu, W., Cao, Y., Hou, J., Cheng, Y., Chan, H. K., & Tang, O. (2024). Green procurement or green supply? A meta-analysis of their impacts on firm sustainability performance. *International Journal of Logistics Research and Applications*. Advance online publication. https://doi.org/10.1080/13675567.2024.2351027

Ministry of Environment, Science, Technology and Innovation (MESTI). (2021). *National plastics management policy*. Accra: MESTI.

Park, S., & Gupta, S. (2012). Handling endogenous regressors by joint estimation using copulas. *Marketing Science, 31*(4), 567–586.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879–903.

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2024). Common method bias: It's bad, it's complex, it's widespread, and it's not easy to fix. *Annual Review of Organizational Psychology and Organizational Behavior, 11*, 315–349.

Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J.-H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict. *European Journal of Marketing, 53*(11), 2322–2347.

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319–1350.

Vachon, S., & Klassen, R. D. (2008). Environmental management and manufacturing performance: The role of collaboration in the supply chain. *International Journal of Production Economics, 111*(2), 299–315.

Vanpoucke, E., Vereecke, A., & Wetzels, M. (2014). Developing supplier integration capabilities for sustainable competitive advantage: A dynamic capabilities approach. *Journal of Operations Management, 32*(7–8), 446–461.

Wang, Q., Chen, L., Jia, F., Luo, Y., & Zhang, Z. (2024). The relationship between supply chain integration and sustainability performance: A meta-analysis. *International Journal of Logistics Research and Applications, 27*(8), 1388–1409. https://doi.org/10.1080/13675567.2022.2144812

World Economic Forum. (2023). Data benefits Ghana's fight against plastic pollution. *Insight article*, 7 September. Geneva: World Economic Forum.

World Economic Forum & Ghana National Plastic Action Partnership. (2024). *Trade and the circular economy: A deep dive into plastics in Ghana*. Geneva: World Economic Forum.

WRAP. (2021). *On-pack labelling and citizen recycling behaviour: Evidence review*. Banbury: Waste & Resources Action Programme.

Wong, C. Y., Boon-itt, S., & Wong, C. W. Y. (2011). The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance. *Journal of Operations Management, 29*(6), 604–615.

Yu, D., Liu, H., & Zhong, H. (2022). Green dynamic capability and environmental performance: The moderating roles of environmental dynamism and big data analytics capability. *International Journal of Environmental Research and Public Health, 19*(19), 12702.

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.