

CIRCULAR ECONOMY INTEGRATION IN OPERATIONS MANAGEMENT: EFFECTS ON OPERATIONAL PERFORMANCE AND BRAND EQUITY

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ABSTRACT

In the context of globalization and escalating resource depletion pressures, the transition from the traditional linear economy to a circular economy (CE) has emerged as an inevitable strategic orientation. This study aims to examine the effects of integrating a triad of core circular economy practices—namely eco-design, green procurement, and reverse logistics on firms’ operational performance and brand equity. This study employs a mixed-methods design, beginning with a qualitative phase involving semi-structured interviews with 10 industry experts to refine the measurement scales. In the quantitative phase, data were collected from a survey of 350 manufacturing firms located in industrial zones in Southern Vietnam, specifically in Ho Chi Minh City, focusing on small and large enterprises in the electronics and consumer goods sectors. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The empirical results confirm that all three circular practices, spanning input sourcing, product design, and end-of-life recovery, exert positive and significant impacts on both operational performance and brand equity. Notably, the findings reveal that operational performance serves as a complementary partial mediator, substantially amplifying the effect of green initiatives on brand equity. These results provide practical evidence cautioning firms against the “greenwashing” trap, while reinforcing a critical strategic message: sustainability commitments can only generate competitive advantage and foster enduring market trust when they are deeply embedded in an operational system characterized by excellence, leanness, and resource optimization.

Keywords: Circular economy, Eco-design, Green procurement, Reverse logistics, Operational performance, Brand equity.

1. INTRODUCTION

In the context of a global economy facing intensifying pressures from resource depletion, environmental degradation, and increasingly stringent sustainability regulations, recent empirical trends (2024-2025) indicate that while many firms adopt green practices, the integration of multiple pillars into a unified operational strategy is still in its infancy in emerging markets like Vietnam. The traditional linear economic model based on the “take–make–dispose” principle has revealed inherent systemic limitations. In response to these challenges, the Circular Economy (CE) has emerged as a strategic paradigm aimed at optimizing resource utilization through practices such as reuse, recycling, and product life extension. Beyond mitigating ecological externalities, this model offers firms opportunities to reconfigure their value chains, thereby enhancing operational efficiency and establishing long-term competitive advantage.

Within the domain of operations management, the integration of circular economy principles has driven a transition toward sustainable and closed-loop production systems. The core pillars of this transformation include eco-design, green procurement, and reverse logistics. This ecosystem of practices enables firms to exert tighter control over input standards, optimize product architecture, and recover value from end-of-life materials. Such a comprehensive intervention not only directly improves operational performance through waste reduction and cost efficiency, but also signals a strong commitment to Extended Producer Responsibility (EPR). These substantive commitments play a critical role in strengthening stakeholder trust and enhancing intangible brand assets in the marketplace. While previous research has focused on individual practices, there is a significant research gap regarding how internal operational improvements translate into intangible market assets like brand equity through the lens of Signaling Theory, particularly in the post-pandemic Vietnamese context

Addressing this research gap, the present study aims to evaluate the impact of a triad of circular economy practices (eco-design, green procurement, and reverse logistics) on brand equity, while elucidating the mediating role of operational performance in this relationship. By employing a quantitative approach based on Partial Least Squares Structural Equation Modeling (PLS-SEM), this study seeks to provide robust empirical evidence underscoring the critical importance of aligning sustainability initiatives with operational excellence in contemporary operations management.

2. THEORETICAL BACKGROUND

2.1. Circular Economy (CE)

The circular economy is an economic model that seeks to optimize resource utilization by extending the life cycle of products, materials, and energy through activities such as reuse, recycling, remanufacturing, and value recovery, thereby replacing the traditional linear model based on the “take–make–dispose” sequence. According to Stahel, CE focuses on extending product lifespans through repair, reuse, and remanufacturing, thereby reducing the need for new resource extraction, waste treatment costs, and environmental pollution [1, 2]. Recent studies by Sharma et al. and Firoozi et al. suggest that circular economy integration is no longer just a waste management tool but a source of supply chain resilience [3, 4].

2.2. Green Brand Equity (BE)

Green brand equity refers to a set of intangible assets and liabilities associated with a brand’s environmental commitments [4]. It is constituted by dimensions such as green brand image, customer satisfaction, trust, and green loyalty [4, 5]. From a signaling theory perspective, green brand equity is formed when firms credibly communicate their environmental performance, thereby reducing information asymmetry between firms and stakeholders.

2.3. Eco-Design (ED)

Eco-design represents a proactive operational capability that embeds environmental criteria into product development processes, thereby influencing cost structures, material efficiency, and lifecycle impacts at the earliest stages of production. From a process integration perspective, eco-design reduces downstream operational inefficiencies by minimizing material waste, simplifying production processes, and enhancing product durability. Under the RBV framework, eco-design can be viewed as a valuable and hard-to-imitate capability that improves operational performance through resource optimization and process standardization.

Empirical evidence from Mishra et al. and Khan et al. indicates that eco-design enhances operational management efficiency by optimizing resource utilization and reducing waste [6, 7]. By embedding environmental criteria into product development, eco-design directly

improves operational performance through resource efficiency and waste minimization. Therefore, the following hypothesis is proposed:

Hypothesis H1: Eco-design has a positive effect on Operational performance.

From a signaling theory perspective, eco-design serves as a credible signal of environmental responsibility, particularly when reflected in tangible product attributes such as durability, recyclability, and reduced toxicity. Consumers are increasingly willing to pay premium prices for environmentally friendly products [2]. Therefore:

Hypothesis H2: Eco-design has a positive effect on Brand equity.

2.4. Green Procurement (GP)

Green procurement represents a strategic supply chain capability through which firms integrate environmental standards into sourcing decisions, supplier evaluation, and procurement processes. Rather than being a compliance-driven activity, GP enhances supply chain transparency, reduces uncertainty, and strengthens coordination across upstream partners. From an operational standpoint, GP improves input quality consistency, reduces process variability, and minimizes waste generation, thereby enhancing operational performance. Appolloni et al. suggest that GP has evolved from a compliance-driven activity into a strategic advantage, while Bag et al. and Sahoo and Vijayvargy demonstrate its role in reducing inventory levels, defects, and waste management costs [8, 9, 10]. Accordingly:

Hypothesis H3: Green procurement has a positive effect on operational performance.

From a signaling perspective, GP enhances brand credibility by demonstrating verifiable commitment across the entire supply chain, not just at the product level. This reduces reputational risk and strengthens stakeholder trust, particularly in contexts where consumers are sensitive to ethical sourcing. Therefore:

Hypothesis H4: Green procurement has a positive effect on brand equity.

2.5. Reverse Logistics (RL)

Reverse logistics is a critical operational capability that enables firms to recover value from end-of-life products through collection, sorting, remanufacturing, and recycling processes [7]. Within CE systems, RL functions as a mechanism for closing material loops and stabilizing input supply, thereby reducing dependence on volatile raw material markets. The use of recycled materials typically requires less energy and significantly lowers waste treatment costs, thereby improving profit margins. Firoozi et al. argue that well-managed reverse logistics systems optimize internal material flows, minimize supply chain disruptions, and directly enhance operational efficiency and profitability [3]. Thus:

Hypothesis H5: Reverse logistics has a positive effect on operational performance.

In the context of increasing consumer sensitivity to environmental issues, initiatives such as product take-back programs, packaging return schemes, and lifetime recycling commitments serve as credible and powerful signals of Extended Producer Responsibility (EPR). Proactive recovery of electronic waste or packaging demonstrates a firm's genuine ethical commitment to society [4]. These signals help reduce consumer skepticism regarding greenwashing, thereby strengthening trust, enhancing brand image, and significantly increasing intangible brand equity. Therefore:

Hypothesis H6: Reverse logistics has a positive effect on brand equity.

2.6. Operational Performance (OP)

Within the circular economy context, operational performance is extended to encompass sustainable performance, with a focus on optimizing inputs to generate maximum outputs

while minimizing environmental impact. OP is typically assessed through three dimensions: resource efficiency, cost optimization, and process improvement [7, 11]. Superior operational performance—characterized by durable products and clean processes—provides tangible evidence supporting firms' marketing claims. When operations are stable and transparent, customers develop strong trust that their consumption supports a responsible system. Moreover, operational excellence enables firms to maintain competitive pricing, thereby reinforcing brand positioning [6, 9]. Accordingly:

Hypothesis H7: Operational performance has a positive effect on brand equity.

3. METHODOLOGY

This study adopts a mixed-methods research design, integrating both qualitative and quantitative approaches. In the qualitative phase, 10 semi-structured interviews were conducted with operations managers from the HCMC Industrial Park Association to validate the suitability of international scales for the Vietnamese context.

In the subsequent quantitative phase, a purposive quota sampling technique was employed. The sample of 350 firms consists of manufacturing enterprises in Ho Chi Minh City (65%, including the former Ba Ria–Vung Tau and Binh Duong provinces), and Dong Nai (35%). The sectors include Food Processing (40%), Electronics (30%), and Textiles (30%).

After data cleaning, the dataset was analyzed using SPSS 27 and SmartPLS 3.2. The analytical procedure strictly followed the two-step approach of Partial Least Squares Structural Equation Modeling (PLS-SEM). For the measurement model, reliability was assessed using Cronbach's Alpha and Composite Reliability (CR). Convergent validity was evaluated based on outer loadings and Average Variance Extracted (AVE). Discriminant validity was established using the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) ratio.

For the structural model, multicollinearity was examined using the Variance Inflation Factor (VIF). Subsequently, a bootstrapping procedure with 5,000 resamples was conducted to test the significance and robustness of the proposed hypotheses. The model's explanatory power was assessed using the coefficient of determination (R^2) and effect size (f^2). Finally, indirect effect analysis was performed to examine the mediating role of operational performance.

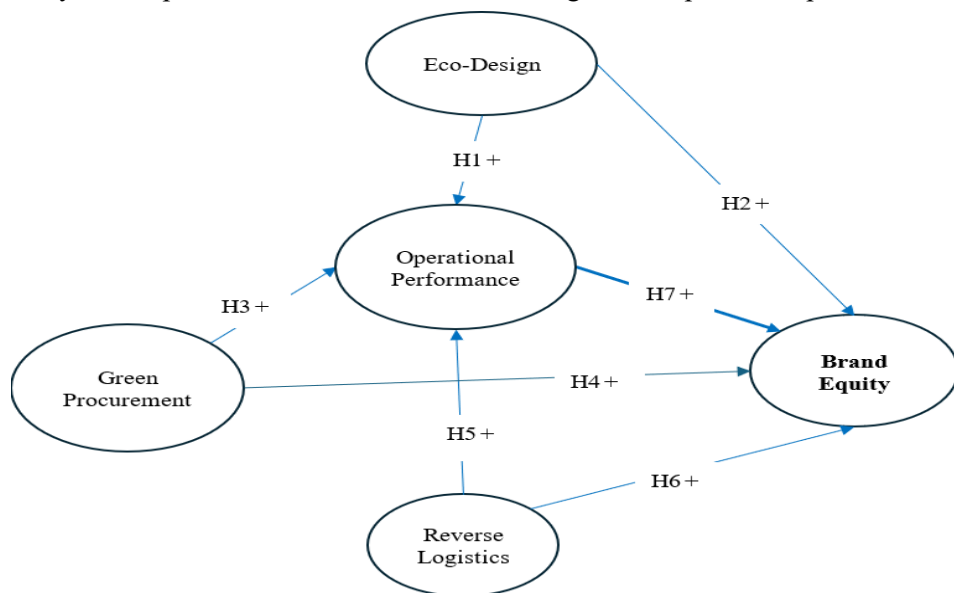


Figure 1. Research model

Source: Proposed by the author (2026)

4. RESULTS

Following data collection via email distribution and Google Forms, a total of 350 valid responses were retained for analysis using SPSS and SmartPLS. Measurement scales were evaluated using Cronbach's Alpha, Composite Reliability (CR), and outer loadings [12]. As reported in Table 2, all constructs exhibit Cronbach's Alpha values exceeding 0.7 [13], CR values above 0.7, and outer loadings greater than 0.4 [14], indicating high internal consistency and reliability. Additionally, Variance Inflation Factor (VIF) values range from 1.102 to 2.835, all below the threshold of 3, suggesting that multicollinearity is not a concern in the model.

Table 1. Descriptive Statistics of Constructs

Construct	Mean	Std. Deviation	Skewness	Kurtosis
ED	3.85	0.72	-0.45	0.12
GP	3.72	0.81	-0.32	-0.05
RL	3.68	0.78	-0.15	-0.21
OP	3.92	0.65	-0.55	0.45
BE	4.01	0.68	-0.48	0.38

Source: Author's analysis results (2026)

Table 2. Reliability and validity assessment results

Variable	Loadings	Cronbach's Alpha	CR	AVE	VIF
BE	0.831 - 0.894	0.782	0.938	0.750	1.102 - 2.101
ED	0.774 - 0.830	0.868	0.901	0.655	2.318 - 2.565
GP	0.829 - 0.858	0.899	0.915	0.710	2.001 - 2.835
OP	0.847 - 0.897	0.752	0.807	0.682	1.681 - 2.581
RL	0.741 - 0.862	0.801	0.820	0.729	1.716 - 2.815

Source: Author's analysis results (2026)

All indicator loadings exceed 0.7, indicating strong item reliability, while all Average Variance Extracted (AVE) values are above 0.5, confirming adequate convergent validity [12].

Discriminant validity is supported by the Fornell–Larcker criterion (Table 3), where the square roots of AVE for each construct (ranging from 0.854 to 0.884) exceed the corresponding inter-construct correlations. Furthermore, the Heterotrait–Monotrait (HTMT) ratios reported in Table 4 range from 0.115 to 0.594, all below the conservative threshold of 0.9, thereby confirming satisfactory discriminant validity [15].

Table 3. Fornell-Larcker

	BE	ED	GP	OP	RL
BE	0.884				
ED	0.512	0.854			
GP	0.401	0.117	0.857		
OP	0.804	0.501	0.409	0.869	
RL	0.460	0.474	0.306	0.435	0.864

Source: Author's analysis results (2026)

Table 4. Heterotrait-Monotrait Ratio

	BE	ED	GP	OP	RL
BE					
ED	0.563				
GP	0.440	0.130			
OP	0.594	0.555	0.453		
RL	0.511	0.181	0.115	0.487	

Source: Author’s analysis results (2026)

The coefficient of determination for the mediating variable, operational performance (OP), is $R^2 = 0.558$, indicating that eco-design (ED), reverse logistics (RL), and green procurement (GP) jointly explain 55.8% of the variance in OP. Similarly, the R^2 value for the dependent variable, brand equity (BE), is 0.631, suggesting that ED, GP, RL, and OP together explain 63.1% of the variance in BE.

Furthermore, predictive relevance (Q^2) values obtained through the blindfolding procedure are all above zero, confirming that the model has adequate predictive capability.

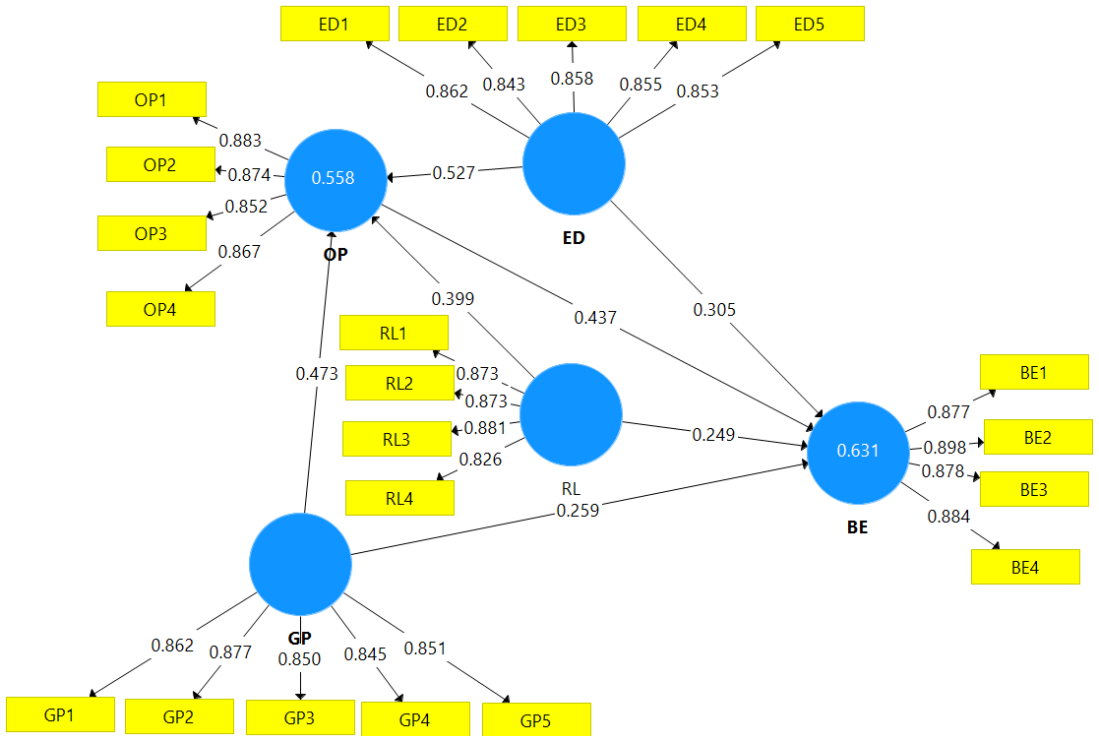


Figure 2. Model testing results

Source: Author’s analysis results (2026)

All hypothesized relationships are statistically significant, with p-values below 0.05. Therefore, all hypotheses are supported by the empirical data, and the constructs in the model demonstrate strong theoretical validity.

Table 5. Structural model results

Relationship	Path coefficient	T Statistics	P-value
ED → BE	0.305	6.159	0.000

ED → OP	0.527	9.295	0.000
GP → BE	0.259	3.695	0.000
GP → OP	0.473	5.726	0.000
RL → BE	0.249	5.726	0.000
RL → OP	0.399	9.735	0.000
OP → BE	0.437	6.742	0.000

Source: Author's analysis results (2026)

To assess the mediating role of operational performance (OP), the study follows the analytical procedure proposed by Zhao et al. [16] in conjunction with the guidelines of Hair et al. for PLS-SEM [17]. The Variance Accounted For (VAF) index is employed to quantify the extent of mediation, calculated as the ratio of indirect effect to total effect. According to Hair et al., VAF values $\leq 20\%$ indicate no mediation, values between 20% and 80% indicate partial mediation, and values above 80% indicate full mediation [12]. The bootstrapping results with 5,000 resamples are summarized in Table 6

Table 6. Mediation analysis results

Relationship	Direct effect	Indirect effect	Total effect	VAF
ED → OP → BE	0.305	0.230	0.535	43.0%
GP → OP → BE	0.259	0.207	0.466	44.4%
RL → OP → BE	0.249	0.173	0.422	41.0%

Source: Author's analysis results (2026)

The indirect effect of eco-design (ED) on brand equity (BE) via operational performance (OP) is statistically significant ($\beta = 0.230$, $p = 0.000$), while the direct effect of ED on BE is also significant ($\beta = 0.305$, $p = 0.000$). As both effects are positive, OP serves as a complementary partial mediator. The VAF value of 43% indicates that 43% of the effect of eco-design on brand equity is transmitted through improvements in operational performance.

Similarly, the indirect effect of green procurement (GP) on BE through OP is significant ($\beta = 0.207$, $p = 0.000$), alongside a significant direct effect ($\beta = 0.259$, $p = 0.001$). The positive signs of both effects confirm the role of OP as a complementary partial mediator. The VAF value of 44.4% suggests that the influence of green procurement on brand equity is partially channeled through enhanced operational capabilities.

Likewise, the indirect effect of reverse logistics (RL) on BE via OP is significant ($\beta = 0.173$, $p = 0.000$), and the direct effect is also significant ($\beta = 0.249$, $p = 0.000$). With both effects being positive, OP again functions as a complementary partial mediator. The VAF value of 41% indicates that reverse logistics contributes to brand equity both directly and indirectly through operational performance improvements.

To evaluate the relative importance of independent variables, effect size (f^2) was assessed. According to Cohen, f^2 values below 0.02 indicate negligible effects, values between 0.02 and 0.35 indicate moderate effects, and values above 0.35 indicate strong effects [18].

Table 7. Effect size (f^2) results

Relationship	f^2 value	Effect Size
ED → BE	0.191	Medium
ED → OP	0.374	Large

GP → BE	0.151	Medium
GP → OP	0.402	Large
RL → BE	0.157	Medium
RL → OP	0.183	Medium
OP → BE	0.414	Large

Source: Author's analysis results (2026)

The results indicate that all independent variables exert substantial effects within the model. Specifically, eco-design, green procurement, and reverse logistics demonstrate strong effects on operational performance and moderate effects on brand equity. In contrast, operational performance exhibits a strong effect on brand equity.

The model fit indices were satisfactory with SRMR = 0.062 (below 0.08) and NFI = 0.912. Furthermore, a robustness check was performed by splitting the sample by firm size, confirming the stability of the results

5. DISCUSSION

This study provides empirical support for all proposed hypotheses and offers several important theoretical insights by explaining the underlying mechanisms through which circular economy practices influence both operational and market-based outcomes. The findings confirm that eco-design, green procurement, and reverse logistics significantly enhance operational performance, which can be interpreted through the Resource-Based View (RBV). Consistent with prior studies, these practices function as capability-building mechanisms that improve resource efficiency, reduce process variability, and enhance system integration [6].

From a theoretical standpoint, this suggests that circular practices are not merely environmental initiatives but constitute strategic operational capabilities that are valuable, rare, and difficult to imitate.

Beyond their impact on operational performance, eco-design, green procurement, and reverse logistics also demonstrate direct and positive effects on brand equity. From the perspective of signaling theory [2], efforts to enhance supply chain transparency and implement sustainable design function as credible signals that resonate with modern consumers, who are increasingly concerned about product origins and ecological footprints.

The study further reveals that operational performance acts as a complementary partial mediator in the relationships between eco-design, green procurement, reverse logistics, and brand equity. This finding reinforces and extends prior research by Lin and Zhou, Chen, while aligning with the arguments of Firoozi et al. regarding the pivotal role of operational performance. Specifically, the positive effects of circular practices on brand equity are not only direct but are also transmitted through the optimization of firms' operational capabilities [3, 4, 5].

Compared with prior studies that often examine circular economy practices in isolation, this study provides a more holistic perspective by analyzing the combined effects of eco-design, green procurement, and reverse logistics within an integrated model. This integrated approach offers a more realistic representation of how circular economy principles are implemented in practice and how they jointly influence firm performance.

6. CONCLUSION

This study investigates the impact of circular economy (CE) integration on operational performance and brand equity using empirical data collected from 350 manufacturing firms in Vietnam. Employing Partial Least Squares Structural Equation Modeling (PLS-SEM), the findings provide robust evidence that eco-design, green procurement, and reverse logistics significantly enhance operational performance and directly contribute to brand equity. More importantly, operational performance is identified as a complementary partial mediator, indicating that the influence of circular practices on brand equity is not only direct but also transmitted through improvements in operational capabilities.

From a theoretical perspective, this study makes several important contributions. First, it advances the circular economy literature by examining the integrated effects of multiple CE practices within a unified framework, rather than analyzing them in isolation. This provides a more comprehensive understanding of how circular principles are operationalized in real-world manufacturing systems. Second, the study extends the Resource-Based View (RBV) by conceptualizing eco-design, green procurement, and reverse logistics as strategic capabilities that enhance operational efficiency and create competitive advantage. Third, it contributes to signaling theory by demonstrating that operational performance serves as a critical mechanism through which internal sustainability efforts are translated into externally perceived brand value. This integration of capability-based and signaling perspectives offers a more nuanced explanation of how sustainability initiatives generate both internal and market-based outcomes, particularly in the context of emerging economies.

From a managerial perspective, the findings suggest several strategic implications. First, firms should reposition green procurement from a compliance-oriented activity to a strategic supply chain capability by fostering close collaboration with environmentally responsible suppliers and establishing lifecycle-based sourcing standards. Second, eco-design should be institutionalized as a core design philosophy integrated across product development and production processes, enabling firms to simultaneously achieve resource efficiency and market differentiation. Third, reverse logistics should be developed not only as a cost-reduction mechanism but also as a strategic tool for strengthening brand credibility through visible sustainability initiatives such as product take-back and recycling programs. Finally, firms should align operational and marketing functions to ensure that sustainability claims are supported by measurable operational improvements, thereby reducing the risk of greenwashing and enhancing long-term customer trust.

Despite its contributions, this study has several limitations. The use of purposive quota sampling may limit the generalizability of the findings beyond the surveyed manufacturing sectors in Vietnam. Additionally, the model focuses on three core circular practices and does not incorporate other potentially relevant factors such as digital transformation or circular business model innovation. Future research is encouraged to expand the model by including additional constructs and exploring moderating variables such as institutional pressures, technological capabilities, or industry-specific dynamics. Longitudinal studies could also provide deeper insights into the causal relationships and long-term impacts of circular economy implementation.

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APPENDIX: MEASUREMENT SCALES

Construct	Code	Measurement Items	Source
Eco-Design (ED)	ED1	The firm designs products to minimize material and energy consumption throughout their life cycle.	Mishra et al. (2023), Khan et al. (2021)
	ED2	The firm integrates environmental criteria into the product development stage (e.g., design for recycling).	
	ED3	The firm focuses on improving product durability, lifespan, and repairability.	
	ED4	The firm designs products for easy disassembly to facilitate component value recovery.	
	ED5	The firm prioritizes the reduction or substitution of hazardous substances in product structures.	
Green Procurement (GP)	GP1	The firm selects suppliers based on their environmental performance and green certifications (e.g., ISO 14001).	Appollo ni et al. (2014), Bag et al. (2021)
	GP2	The firm requires suppliers to meet specific environmental standards for input materials.	
	GP3	The firm conducts regular environmental audits or assessments of its primary suppliers.	
	GP4	The firm collaborates closely with suppliers to co-develop environmentally friendly materials.	
	GP5	The firm provides technical guidance or support to help suppliers improve their environmental management systems.	
Reverse Logistics (RL)	RL1	The firm has an efficient system for collecting used products from customers.	Khan et al. (2021), Firoozi et al. (2024)
	RL2	The firm actively sorts and processes recovered materials for remanufacturing or recycling.	
	RL3	The firm implements packaging return or reuse programs.	
	RL4	The firm manages end-of-life product disposal in an environmentally responsible manner.	
Operational Performance (OP)	OP1	Circular practices have significantly reduced material and energy waste.	Garza-Reyes et al. (2026), Khan et al. (2021)
	OP2	The firm has achieved better cost optimization through resource efficiency.	
	OP3	Internal processes have become leaner, more stable, and less volatile.	
	OP4	The overall quality and reliability of the production system have improved.	

Brand Equity (BE)	BE1	Customers perceive our brand as a leader in environmental responsibility (Green Brand Image).	Chen (2010), Sharma et al. (2023)
	BE2	Environmental commitments have increased customer trust in the brand.	
	BE3	Customers exhibit high levels of satisfaction and loyalty toward our green products.	
	BE4	The brand is strongly associated with sustainability and circular economy principles.	