

# THE IMPACT OF GREEN SUPPLY CHAIN MANAGEMENT IN THE CIRCULAR ECONOMY CONTEXT ON FIRM PERFORMANCE OF FDI ELECTRONICS ENTERPRISES IN DONG NAI PROVINCE

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**Abstract:** *This study examines the impact of Green Supply Chain Management (GSCM) in the context of the Circular Economy (CE) on the firm performance of foreign direct investment (FDI) enterprises manufacturing electronic components in Dong Nai Province, Vietnam. Survey data collected from 215 FDI firms were analyzed using the PLS-SEM model to test the effects of key determinant groups, including external pressures (regulatory pressure - RGL; market pressure - MKT; supplier pressure - SPL), internal motivation (IM), green supply chain management practices (GSCM), circular economy capability (CEC), collaborative capability (CC), and firm performance. The empirical results substantiate that GSCM exerts a positive and statistically significant impact on firm performance, with CEC acting as a critical mediator in bridging GSCM and performance outcomes. The components of GSCM also exhibit statistically significant effects in enhancing firm performance. In addition, the study provides several policy implications for the Dong Nai provincial government in the context of attracting a new generation of FDI in the electronic manufacturing sector.*

• Keywords: green supply chain management; circular economy; foreign direct investment; electronics industry.

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## 1. Introduction

The rapid expansion of the global electronics industry over the past decade, together with the growth of the digital economy, has significantly increased the demand for semiconductor components, Internet of Things (IoT) devices, telecommunications equipment, and control systems. The global consumer electronics market reached USD 1.178 trillion in 2024 and is projected to expand to USD 1.480 trillion by 2029, while the global semiconductor market is expected to exceed USD 697 billion by 2025 (Statista, 2024). However, such robust industrial expansion has inadvertently precipitated a surge in e-waste generation, with 62 million tons generated in 2023, of which only 22.3% was formally recycled, resulting in the accumulation of heavy metals and hazardous compounds in the environment (World Semiconductor Trade Statistics, 2024). The European Union has implemented three key regulatory frameworks, namely WEEE, RoHS, and REACH. Specifically, the Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU requires manufacturers to design products that are easy to disassemble, reuse, and recycle. Accordingly, Green Supply Chain Management (GSCM) has become a core strategic orientation for electronics enterprises worldwide.

A substantial body of research has focused on widely recognized GSCM practices, including eco-design, green procurement, investment recovery, environmental collaboration with customers, internal environmental

management, and waste management. The Sankey diagram visualizes the flow of impact, demonstrating that the strategic prioritization of critical GSCM practices such as eco-design, green procurement, green manufacturing, green packaging, green distribution, green marketing, green using, recycling, green information system, internal environmental management, and customer collaboration, together with continuous improvement and risk management, holds significant potential to translate GSCM practices into tangible operational benefits, thereby enhancing firm performance.

Against this backdrop, Vietnam has solidified its position as a pivotal FDI-driven electronics manufacturing hub in the region, as evidenced by the export value of the electronics industry reaching USD 110 billion in 2023, accounting for nearly 18% of the country's total export value, with FDI enterprises contributing more than 95% of the industry's total production value (General Statistics Office of Vietnam, 2024). The presence of multinational corporations such as Samsung, Intel, LG, Foxconn, and Luxshare has formed a multi-tier electronics industrial ecosystem, fostering the development of supporting industries in electronic components and ancillary services integrated into the global supply chains.

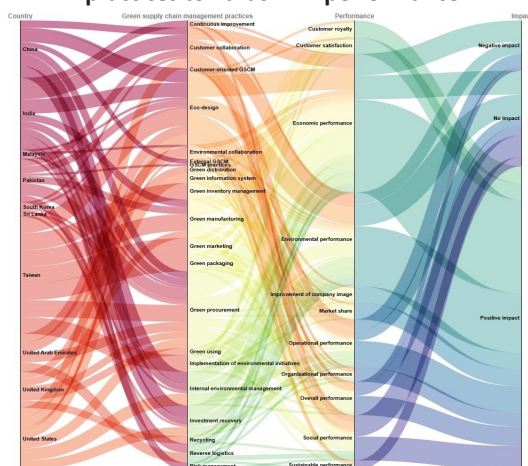
Among localities, Dong Nai Province stands out as a major industrial hub for electronic component manufacturing, serving both as a key electronics production center in Southern Vietnam and as one of the leading

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destinations for FDI inflows. According to the Dong Nai Provincial People's Committee (2024b), during the 2022-2024 period, the electronics sector accounted for over 20% of newly registered FDI capital in the province, reflecting a clear trend of production relocation from China, South Korea, and Taiwan to Vietnam to diversify global supply chains. In 2024, Dong Nai's total export value reached approximately USD 23.4 billion, of which the FDI sector contributed 75% - 85%, posting a 15.25% growth rate for computers, electronic products, and electronic components during the first nine months of the year (Dong Nai Provincial People's Committee, 2024a). However, the rapid expansion of the industry has also placed Dong Nai's FDI enterprises under increasing environmental compliance pressures from major export markets.

**Figure 1. Sankey diagram illustrating the flow of GSCM practices towards firm performance**



Source: Authors

In Vietnam, practical observations indicate that the adoption of both GSCM and circular economy practices remains at a nascent stage, primarily concentrated in top-tier FDI enterprises or operating under the strict mandates of parent corporations. For instance, Bosch Vietnam (Long Thanh) implements a rooftop solar power system with an annual output of approximately 2,300 MWh to align with the group's global carbon reduction targets; meanwhile, Mabuchi Motor Vietnam and Mitsuha Vietnam maintain environmental management systems in compliance with ISO 14001 standards, coupled with stringent chemical monitoring mechanisms as required by their Japanese parent companies. Although the electrical and electronics sector accounts for approximately 18% of Vietnam's total industrial production value and is characterized by high emission intensity, empirical studies in Vietnam remain limited and have predominantly focused on sectors other than electronics. Consequently, current literature fails to fully capture the actual level of GSCM adoption in this strategically pivotal sector.

## 2. Theoretical background and research hypotheses

### 2.1. Key concepts

#### 2.1.1. Green supply chain and Green supply chain management (GSCM)

**Green supply chain:** The concept of "Green Supply Chain" was first introduced in the "Responsible Manufacturing" study published by Michigan State University in 1996. It was defined as a manufacturing paradigm aimed at optimizing resource efficiency while mitigating negative environmental footprints (Handfield et al., 1997). Building upon this foundation, numerous scholars have subsequently expanded and refined the concept through various theoretical lenses. Notably, Zhang et al. (2020) conceptualize the green supply chain as a strategic lever, enabling firms to simultaneously reduce environmental impacts and bolster operational efficiency and competitiveness. Recent studies further corroborate that the green supply chain functions as a holistic system, integrating environmental criteria across all supply chain stages, from design, sourcing, manufacturing, distribution to end-of-life management (Saini et al., 2023).

**Green supply chain management (GSCM):** The concept became increasingly consolidated in the early 2000s, as evidenced by Srivastava (2007) contends that the majority of environmental impacts originate from various supply chain stages, thereby necessitating a more comprehensive managerial approach. GSCM is oriented towards reducing environmental impacts, limiting waste, while simultaneously enhancing firm performance (Vachon & Klassen, 2006). Furthermore, GSCM is conceptualized as a strategic orientation that bolsters competitive advantage, elevates corporate image, and enhances firm resilience against environmental turbulence and regulatory pressures (Nazir et al., 2024).

**Circular economy (CE):** The concept of the circular economy traces its origins to the study by Pearce and Turner (1990). It introduced a new economic paradigm based on the principle that all resources can be transformed into inputs for subsequent processes, standing in stark contrast to the traditional linear model of "take, make, consume, dispose" (Phùng Chí Sỹ, 2021). To date, a universally accepted definition of CE remains elusive. Academic literature and professional organizations have proposed various approaches, ranging from optimizing material flows (Liu et al., 2009), implementing closed-loop circulation mechanisms (Ellen MacArthur Foundation, 2013; European Commission, 2015), and applying the 3R principle (Ormazabal et al., 2016), to reintegrating resources into the value chain (Stahel, 2016), maintaining value at the highest possible level (Cullen, 2017), and decoupling economic growth from the exploitation of finite natural resources (Geissdoerfer et al., 2017).

## 2.2. Theoretical Foundations

### 2.2.1. GSCM Dimensions

Within the realm of supply chain management, GSCM is conceptualized as an integrative approach embedding environmental objectives across all supply chain activities.

According to Srivastava (2007), the scope of GSCM extends from raw material extraction, product design, procurement, manufacturing, and distribution to consumption and post-consumption management. Building on this perspective, scholars have identified distinct dimensions of GSCM practices and empirically validated them across diverse manufacturing contexts:

(i) Eco-design: extensively documented by Rasit et al. (2019) and Khan et al. (2024), this practice involves integrating environmental criteria at the design stage to mitigate ecological footprints throughout the product life cycle.

(ii) Green procurement: consistently identified in Rasit et al. (2019) and Khan et al. (2024), this dimension emphasizes the critical role of selecting suppliers based on environmental criteria to curb ecological impacts originating from upstream supply chain stages.

(iii) Investment recovery: discussed by Zhu and Sarkis (2004) and Green et al. (2012), this factor entails divestment, reuse, or recycling activities aimed at optimizing asset value and minimizing waste generation.

(iv) Environmental collaboration with customers: as examined by Younis et al. (2016) and Khan et al. (2024), this practice focuses on joint efforts with customers to achieve environmental goals.

(v) Internal environmental management: explored in Lee et al. (2012), Zhu and Sarkis (2004), and Green et al. (2012), this dimension underscores the pivotal roles of leadership commitment, interdepartmental coordination, and the effective operation of environmental management systems.

(vi) Waste management: identified by Srivastava (2007) as a core GSCM practice, this factor targets the control of waste flows to minimize environmental repercussions.

In synthesis, the review of prior literature suggests that these dimensions constitute the core GSCM constructs, serving as the theoretical foundation for the proposed research model.

### 2.2.2. Circular Economy Capability

Within sustainability research, the circular economy (CE) is recognized as a pivotal paradigm for mitigating environmental footprints and maximizing resource efficiency. Building upon this premise, Andersen (2007) developed the concept of circular economy capability (CEC) as a structural construct reflecting a firm's ability to organize, integrate, and effectively operate 3R practices (reduce-reuse-recycle) throughout the entire product life cycle.

From a managerial perspective, CEC extends beyond the mere capacity to perform recycling and reuse activities, it signifies the strategic alignment between internal resources and stakeholder collaboration, geared towards the simultaneous optimization of economic, social, and environmental objectives (Hoang Thi Hong Le et al., 2024; Nhan Cam Tri, 2025).

Empirical evidence substantiates that firms possessing robust CEC exhibit superior environmental management performance, more effective regulatory compliance, bolstered brand image, and enhanced competitive capability in the marketplace (Khan et al., 2024).

### 2.3. Research hypotheses

**External pressures and GSCM:** This study integrates the institutional theory and contingency theory to elucidate the relationship between external pressures and GSCM practices. From the institutional perspective, firms' behaviors are shaped by three distinct pressures (coercive, normative, and mimetic), thereby inducing isomorphism in managerial practices. Meanwhile, contingency theory posits that the effectiveness of GSCM is contingent upon its alignment with specific contextual characteristics.

(i) Regarding coercive pressure: firms implement GSCM to comply with legal requirements, such as the Nature Restoration Law (EU, 2024) aimed at ecosystem restoration, or the Vietnam Law on Environmental Protection 2020, which promotes the circular economy orientation. Beyond mandatory regulations, incentive mechanisms such as financial support and tax exemptions also incentivize corporate compliance (Zailani et al., 2012).

(ii) Concerning normative pressure: market signals and environmental norms established by customers, public opinion, and community groups significantly influence firms' decisions to adopt GSCM.

(iii) About mimetic pressure: upstream green innovations establish norms that compel downstream firms to adapt, reflecting both normative and mimetic isomorphism (Srivastava et al., 2021). When suppliers develop green technologies or optimize recycling processes, downstream firms can easily adopt such practices thanks to cost advantages and synchronized technical requirements.

Accordingly, the study proposes the following hypotheses:

H1a: Regulatory pressure positively influences GSCM adoption in firms.

H1b: Market pressure positively influences GSCM adoption in firms.

H1c: Supplier pressure positively influences GSCM adoption in firms.

### Internal motivation and GSCM:

Grounded in the Resource-Based View (RBV), internal motivation stems from firms' specific assets and capabilities, which are inimitable and instrumental in generating competitive advantages, thereby driving firms to proactively implement GSCM. The contingency approach further suggests that the efficacy of such motives is contingent upon the strategic fit between green initiatives and the organizational context (Stevels, 2022).

Regarding specific drivers, extant literature indicates that firms adopt GSCM not merely due to environmental stewardship but also owing to economic imperatives, such



as energy savings, waste reduction, optimized resource use, and increased recycling rates (Zhu et al., 2011). Furthermore, firms that strategically perceive environmental challenges as business opportunities (Sharma, 2000) exhibit a stronger inclination towards long-term innovation and sustainable strategies.

Therefore, the study postulates the following hypothesis:

H2: Internal motivation positively influences GSCM adoption in firms.

#### ***GSCM and circular economy capability:***

This study leverages contingency theory to elucidate the relationship between GSCM and CEC, positing that the efficacy of GSCM in fostering a circular economy is contingent upon achieving a strategic fit with the organizational context. GSCM focuses on mitigating ecological footprints through green process design and green logistics (Costantini et al., 2015). Although differing in focal emphasis, GSCM is conceptualized as a pivotal bridging mechanism that facilitates the transition from linear to circular models, thereby reducing resource consumption and enhancing firm performance, which subsequently bolsters CEC (Kazancoglu et al., 2018).

Extant literature corroborates the synergistic relationship between GSCM and the circular economy. Integrating circular economy principles into GSCM not only improves environmental performance (ENP) but also reshapes processes according to circular logic (Genovese et al., 2017). Consequently, GSCM plays a strategic role in fortifying firms' circular economy capability. Based on this rationale, the study proposes the following hypotheses:

H3a: Eco-design positively influences firms' CEC.

H3b: Green procurement positively influences firms' CEC.

H3c: Investment recovery positively influences firms' CEC.

H3d: Environmental collaboration with customers positively influences firms' CEC.

H3e: Internal environmental management positively influences firms' CEC.

H3f: Waste management positively influences firms' CEC.

#### ***Circular economy capability and firm performance:***

The relationship between CEC (circular economy capability) and firm performance is underpinned by contingency theory, emphasizing that the efficacy of circular economy initiatives is contingent upon their alignment with the organizational context. Turken et al. (2020) underscore that adopting circular economy practices necessitates supply chain restructuring and material flow redesign, thereby elevating operational complexity and risk. Moreover, circular economy implementation is shaped by technological, economic, and cultural factors, implying that no universal pathway exists for all firms (Genovese et al., 2017).

Notwithstanding these challenges, the circular economy is widely recognized as a critical strategy that enables firms to enhance performance across three dimensions: economic, environmental, and operational. Based on this rationale, the study proposes the following hypotheses:

H4a: CEC positively influences firms' economic performance (ECP).

H4b: CEC positively influences firms' environmental performance (ENP).

H4c: CEC positively influences firms' operational performance (OPE).

#### ***Collaborative capability, circular economy capability, and firm performance:***

The study draws upon the relational view to explain the role of collaboration in transforming CEC into firm performance. From this perspective, firms' competitive advantages in the circular context derive from "relational rents" accruing from deep collaboration with suppliers and customers. Consequently, collaboration is posited as a critical lever in optimizing circular supply chains.

Navigating an increasingly complex business landscape, firms rely heavily on collaboration to improve performance and enhance competitive advantage. Contemporary inter-organizational relationships take diverse forms, including strategic alliances, supply chains, industrial clusters, and business ecosystems (Vargo & Lusch, 2004). Extant literature substantiates that collaborative capability mitigates transaction costs, streamlines processes, and enhances competitive capability. Crucially, within circular supply chains, synergetic linkages between upstream and downstream actors is an essential condition (Yu et al., 2014). In synthesis, collaborative capability plays a significant moderating role in the nexus between the circular economy and firm performance, serving as a cornerstone for operational optimization and sustainable development. Based on this rationale, the study postulates the following hypotheses:

H5a: Collaborative capability positively moderates the relationship between CEC and firms' economic performance (ECP).

H5b: Collaborative capability positively moderates the relationship between CEC and firms' environmental performance (ENP).

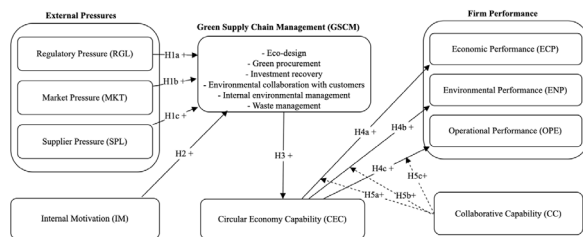
H5c: Collaborative capability positively moderates the relationship between CEC and firms' operational performance (OPE).

### **3. Research model, methodology and data**

#### **3.1. Research model**

Grounded in contingency theory, institutional theory, the resource-based view, the relational view, and building upon the frameworks established by Green et al. (2012), Sahoo and Vijayvargy (2021), and Dey et al. (2022), in conjunction with the proposed hypotheses, the author present the research model as illustrated in Figure 2.

Figure 2. Research model



Source: Authors

### 3.2. Research methodology

This study employs a mixed-methods approach, combining qualitative and quantitative techniques to ensure methodological comprehensiveness. The qualitative phase utilized in-depth interviews to validate and adapt international measurement scales, thereby ensuring semantic consistency and contextual relevance for the Vietnamese setting. Concurrently, this phase served to screen variables and identify potential new indicators. Ten middle-to-senior managers from FDI electronics enterprises, each possessing a minimum of five years' experience, were interviewed to refine the survey questionnaire.

The survey was conducted from August 2024 to May 2025. A total of 238 valid questionnaires were obtained from respondents currently holding managerial positions across 215 FDI electronic component manufacturers in Dong Nai Province. The participant profile included Chief Executive Officers (CEOs), and functional heads of Design, Procurement, Production, Logistics, and Business Development.

Quantitative data analysis was executed using Partial Least Squares Structural Equation Modeling (PLS-SEM).

### 4. Research results and discussion

Regarding measurement model assessment, all outer loadings in the study met the reliability threshold of  $\geq 0.7$  (Nguyen Minh Ha & Vu Huu Thanh, 2020). Convergent validity, as reflected by the Average Variance Extracted (AVE) values, ranged from 0.548 to 0.738; with all values exceeding the minimum required level of 0.5 (Fornell & Larcker, 1981). Discriminant validity was confirmed as the square root of AVE for each construct was greater than all corresponding inter-construct correlations, and the HTMT values ranged from 0.164 to 0.803; all below the threshold of 0.85. The Variance Inflation Factor (VIF) values of all relationships in the model were below the recommended threshold ( $VIF > 5$  or  $< 2$ ), ranging from 1.000 to 2.063 (Hair et al., 2017).

The coefficient of determination ( $R^2$ ) reached 0.602. The effect size ( $f^2$ ) indicated clear differences in the magnitudes of influence among the determinants of GSCM, CEC, and firm performance. The predictive relevance ( $Q^2$ ) results showed that all endogenous variables in the model achieved a moderate level of predictive accuracy. Specifically, GSCM had  $Q^2 = 0.329$ ; CEC has  $Q^2 = 0.284$ ; ECP has  $Q^2 = 0.342$ ; ENP has  $Q^2 = 0.333$ ; and OPE has  $Q^2 = 0.278$ . The positive  $Q^2$  values, ranging from 0.278 to 0.342; indicated that the

model exhibited moderate predictive capability for the dependent variables.

#### Direct effects SEM analysis

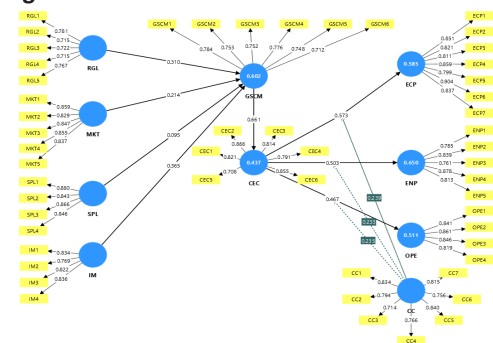
The study employed the bootstrapping technique in Smart-PLS with 5,000 resamples. The hypothesis testing results indicated that the majority of hypotheses were supported, with t-values exceeding 1.96 and p-values falling below 0.05; thereby confirming the statistical significance of the hypothesized relationships within the research model.

#### Indirect effects SEM analysis

The results revealed that regulatory pressure (RGL), market pressure (MKT), and internal motivation (IM) exerted significant indirect effects on CEC, as well as on the outcome variables including economic performance (ECP), environmental performance (ENP), and operational performance (OPE).

The findings, as illustrated in Figure 3, suggest that institutional pressures remain a key driving force compelling firms to implement GSCM. Both regulatory pressure and market pressure exhibited positive and statistically significant effects, confirming the coordinating roles of government intervention, industry norms and societal expectations in fostering GSCM. In contrast, the effect of supplier pressure lacked statistical significance, potentially reflecting the prevalence of short-term transactional relationships and a limited degree of environmental integration within the supply chain.

Figure 3. Results of the PLS-SEM structural model



Source: Results generated from Smart-PLS

Internal motivation demonstrated the most profound influence, highlighting the pivotal roles of top management commitment, environmental objectives, and innovation capability as fundamental drivers of GSCM from the resource-based view perspective. GSCM exerted a very strong impact on CEC, confirming its central role in the transition from the linear model to the circular model. Subsequently, CEC positively affected economic, environmental, and operational performance, indicating that the circular economy is not merely a normative concept but one that yields tangible operational value. Concurrently, collaborative capability played a significant moderating role, amplifying the impact of CEC on firm performance.

In summary, the findings provide robust empirical evidence validating the sustainable development strategy of FDI electronics enterprises in Vietnam.

## 5. Policy implications

### Policy implications for Vietnam

First, it is imperative to fortify the legal framework governing the circular economy and GSCM. Although Vietnam has promulgated Decision No. 687/QĐ-TTg (2022), the current legal system still lacks technical guidelines, evaluation criteria, and specific monitoring mechanisms. Therefore, a robust and coherent regulatory framework should be developed to bridge central and local levels, while supplementing regulations related to circular reporting, standardized compliance verification, and compliance inspection mechanism.

Second, it is essential to leverage market forces through industry standardization. Market pressure has been proven to exert a significant influence on GSCM, particularly within global electronics supply chains. Vietnam should promulgate sector-specific green standards (e.g., ISO 14001, RoHS, REACH), establish a phased roadmap for ESG reporting, develop green capability index systems, and strengthen the role of industry associations in harmonizing environmental requirements. This will enable FDI enterprises to enhance adaptive capacity and increase the likelihood of integration into the supply chains of Samsung, Apple, Intel, and other global lead firms.

Third, it is necessary to stimulate firms' internal motivation through economic incentive mechanisms. Internal motivation has been empirically shown to exert a stronger effect than external pressure on the implementation of GSCM. Accordingly, policies should link incentives to environmental performance outcomes through green credit instruments, conditional reductions in environmental taxes and fees, prioritized customs clearance, expedited VAT refunds, and infrastructure fee reductions for enterprises meeting green standards. All these measures should be integrated within the MRV (Monitoring-Reporting-Verification) system and coupled with claw-back mechanisms to ensure substantive effectiveness.

Fourth, the establishment of a "green supplier program" is required. A standardized training, consulting, assessment program will enable both FDI firms and satellite suppliers to strengthen their capacity to meet international requirements, linked with an industry-specific "green capability scorecard".

Fifth, it is recommended to pilot circular industrial clusters in the electronics sector. This model would include shared testing and certification infrastructure, solvent regeneration stations, circular packaging systems, and a centralized MRV data platform. A performance-based incentive mechanism (environmental KPIs) and an infrastructure co-investment fund would help mitigate compliance costs and shorten certification lead times for firms operating within the cluster.

Sixth, strengthening supply chain collaborative capability is paramount. As collaborative capability has been shown to play a strong moderating role, policy should promote inter-organizational cooperation through thematic policy dialogues, on-site technical consultancy (LCA, MFCA, RoHS), and shared standardized data sets to synchronize

supplier evaluation procedures.

### Managerial implications at the firm level

FDI electronics enterprises should internalize GSCM as a core operational strategy rather than perceiving it merely as a regulatory tick-box exercise. In green procurement, firms should establish a comprehensive governance mechanism consisting of minimum criteria, a weighted scoring system, and a performance-based bonus-malus scheme. At the design stage, firms should prioritize eco-design, focusing on material rationalization, optimizing recyclability, and standardizing components.

In operations, firms should implement value-hierarchy-based material and waste management processes and strictly apply the waste management hierarchy. In addition, internal compliance systems such as ISO 14001 should be upgraded, with responsibility matrices established and quarterly internal audits maintained. Finally, firms should strengthen top management commitment, empower middle management, and foster a culture of "green operational transformation" through factory-level continuous improvement initiatives.

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