A Statistical Framework For Sustainable Supply Chain Management In It Hardware Products

G S Srinivas Murthy,*[1] Dr. S Thamarai Selvi[2] , Dr. V Vijay Durga Prasad[3]

[1*]Research Scholar, Department of Business Administration, Cauvery College for Women (Autonomous), affiliated to Bharathidasan University, Tiruhirappalli, Tamilnadu - 620018, saisrinivasmurthy@gmail.com
[2]Research Supervisor, Department of Business Administration, Cauvery College for Women (Autonomous), affiliated to Bharathidasan University, Tiruhirappalli, Tamilnadu - 620018, thamaraiselvi75@gmail.com
[3]Co-Supervisor, Department of Management Studies, PSCMR College of Engineering and Technology, Vijayawada, AndhraPradesh,520001,vijaydurgaprasad@gmail.com

Abstract
The growing urgency of environmental sustainability has compelled organizations across industries to redesign their supply chain operations. The IT hardware sector, characterized by rapid product obsolescence, complex global sourcing, and significant e-waste generation, presents unique sustainability challenges. This study proposes a quantitative Sustainable Supply Chain Management (SSCM) framework integrating environmental, social, and economic dimensions to evaluate sustainable supply chain performance. Using primary data collected from 245 respondents across IT hardware manufacturers, distributors, and retailers in India, the study employs Structural Equation Modeling (SEM), Analytic Hierarchy Process (AHP), and multiple regression analysis to validate the proposed Triple-Pillar SSCM Model. The findings reveal that environmental sustainability practices, particularly green procurement and reverse logistics, are the most significant predictors of sustainable supply chain performance, followed by economic and social sustainability practices. Supplier relationship quality partially mediates the sustainability-performance relationship, while regulatory compliance intensity strengthens the impact of economic sustainability practices. The model demonstrates strong explanatory power (R^2 = 0.81) and provides actionable insights for supply chain practitioners. The study further contributes to the literature on sustainable entrepreneurship by illustrating how sustainability-oriented supply chain practices can enable innovation-driven growth and competitive advantage, particularly in SME-dominated and entrepreneur-led sectors in emerging Asian economies such as India. The findings highlight the role of sustainability as a strategic driver of innovation and value creation beyond regulatory compliance.

Keywords: Sustainable Entrepreneurship; Sustainable Supply Chain Management; Green Innovation; SMEs; Emerging Markets

1. Introduction

The IT hardware sector in the world is a significant source of electronic waste, with a production of about 53.6 million metric tonnes of electronic waste each year, which is one of the fastest growing solid waste streams in the world. Precious metals and hazardous substances are found in components like printed circuit boards, lithium-ion batteries, cathode ray tubes, semiconductor devices, among others. Sustainable supply chain management (SSCM) can provide a systematic way of dealing with this economic growth-ecological responsibility tension (Raman et al., 2023; Koberg and Longoni, 2019).

SSCM in IT hardware includes the design, operation and monitoring of supply chains with a clear emphasis on minimizing environmental impacts, fair labour practices and economic viability over the lifecycle of the product - the extraction of raw materials, ultimate disposal, and recycling of the end-of-life product. Although the topic of scholarly interest has increased, relatively limited studies have suggested statistically validated, industry-specific SSCM frameworks of IT hardware that are based on emerging economy data (India) (Rajeev et al., 2017; Govindan and Hasanagic, 2018).

The growing complexity of the global supply chains, the growing environmental consciousness and the pressure of regulations have established sustainability as a strategic priority and not as a peripheral issue. The IT hardware companies have to strike a balance between quicker advancement in technology and sustainable resource management and waste management policies. This issue is especially acute in the emerging markets where infrastructure constraints and enforcement of regulations differ greatly depending on the location (Dubey et al., 2017; de Oliveira et al., 2018; Tumpa et al., 2019).

In the emerging economies like India, the actions of entrepreneurial firms and SMEs, which are operating on limited resources, but seek to achieve growth in an innovation-based manner, are increasingly shaping sustainability. These companies tend to incorporate the environmental and social aspects within their business strategy as an element of differentiation and competitive advantage. In this regard, the study of sustainable supply chain management through the lens of sustainable entrepreneurship would shed more light on the way companies can generate value and overcome environmental challenges (Yu et al., 2022; Hariyani et al., 2024).

India has the second largest mobile phone and third largest personal computer market in the world. It has an IT hardware industry marked by a thriving local production industry, high dependency on imported parts, and underdeveloped yet developing e-waste disposal systems. This background provides an especially good background in which to formulate SSCM models that could be applied to the emerging-market IT supply chains (Malhotra, 2024). Moreover, the fast growth of online technologies and raising awareness of consumers about environmental concerns is transforming market expectations. Not only do firms now have to produce products of high quality, they must also engage in responsible sourcing, production, and disposal of their products. The transition has opened up chances of innovation-led companies to design sustainable business frameworks that make business profitable at the same time take care of the environment (Manavalan & Jayakrishna, 2019).

The current research fulfills three main contributions. To do that, it determines the key dimensions of sustainable supply chain performance in IT hardware, with the help of a synthesis of the existing literature and consultation with experts. Second, it develops and analyzes a measurement tool based on the exploratory and confirmatory factor analysis. Third, it measures the relative contribution of each dimension of sustainability with structural equation modeling and multiple regression to yield a framework applicable in practice, with strong statistical support. This study is able to give a strong framework, which can be used by practitioners and policymakers, by combining sustainability practices and empirical validation process. Moreover, it also adds to the general discussion of sustainable entrepreneurship by presenting how sustainability-based supply chain management can foster innovation-based growth and competitive edge in the emerging markets in Asia.

1.1 Research Objectives

The analytical objectives of this research are: (i) to determine and rank the antecedents of sustainable supply chain performance of IT hardware; (ii) to test the structural relationship between green procurement, reverse logistics, supplier auditing, carbon footprint reduction, and supply chain performance; and (iii) to suggest a quantitatively validated SSCM model of IT hardware products.

2. Literature Review

The theoretical background of the conceptual framework of sustainable supply chain management is based on three theoretical traditions, such as stakeholder theory, natural resource-based view, and institutional theory. According to the stakeholder theory, companies should take into consideration the expectations of not only shareholders but also employees, communities, regulators, and the natural environment. Natural resource-based view builds on resource based view of the firm by stating that pollution prevention, product stewardship, and sustainable development capabilities are sources of competitive advantage. Institutional theory describes the reasons why companies can embrace sustainability through the emergence of mimetic, normative, and coercive pressures on the company by their peers in the industry, professional associations, and the regulatory bodies (Yawar and Seuring, 2017; Beske-Janssen et al., 2015; Lee, 2016).

In IT hardware, empirical studies have been conducted previously on green purchasing criteria, adherence to e-waste regulations, circular economy, and life-cycle assessment techniques. Nevertheless, there is a great void in the process of incorporating these dimensions into one statistically proven model. Moreover, the vast majority of the existing frameworks are created in the realm of developed economies, and they can be hardly applied to the supply chain patterns common in India and other BRICS countries (Tseng et al., 2018; Luthra et al., 2017; Laari et al., 2017).

Methodologically, SEM has become the leading method to test complex causal models in research on supply chains because of its capacity to jointly estimate measurement and structural relationships as well as measurement error. AHP is a strict, quantitative approach to assigning priority to decision criteria using matrices of pairwise comparisons, and is thus very suitable when analyzing the sustainability indicators. Hybrid MCDM-SEM approach, which combines both SEM and AHP in the same study has been utilized in healthcare and automotive supply chains but has not been systematically implemented in IT hardware yet (Kurniawan and Hartini, 2025).

Based on the concept of sustainable entrepreneurship, companies in emerging economies are progressively turning to sustainability-based strategy in attaining growth and competitive difference through innovation. Flexibility and adaptability of entrepreneurial firms, especially SMEs, can help them to consider the environment and social concerns in their supply chain practices much better than big and inflexible organizations. This is consistent with the notion of entrepreneurial orientation, which focuses on innovativeness, proactiveness, and risk-taking as the drivers of firm performance (Hossain and Kauranen, 2016; Cohen and Winn, 2017; Schaltegger and Wagner, 2017).

The ability to innovate is crucial in this respect as it helps companies to convert sustainability efforts into new business models, processes, and products. Sustainability-driven innovation can facilitate the use of the refurbishment, remanufacturing, and e-waste recycling models in the circular economy in industries where a high rate of technological change and product obsolescence occur like in the IT hardware industry. Such methods do not only ensure a smaller environmental impact, but also generate new economic opportunities, especially in resource-limited environments (Fernando et al., 2019; Aboelmaged, 2018).

Although the role of sustainable entrepreneurship has become increasingly critical, there is a dearth of empirical research that has incorporated the entrepreneurial orientation, innovation capability and sustainable supply chain management into a single analysis. This disparity is especially clear in terms of new Asian economies, where the state of the institutions, market dynamics, and resource limitations are vastly dissimilar to the ones in the developed countries. Filling this gap offers a chance to gain a better insight into the interaction between sustainability, innovation, and entrepreneurship in such situations to impact firm performance.

3. Proposed Research Framework

The Triple-Pillar SSCM Model, which is presented in this paper conceptualizes sustainable supply chain performance (SSCP) in IT hardware as a second-order latent construct that is influenced by three first-order latent constructs: Environmental Sustainability Practices (ESP), Social Sustainability Practices (SSP), and Economic Sustainability Practices (ECSP). All the pillars are operationalized by several observable indicators based on the literature and tested with the help of interviews with experts.

The model also assumes that Regulatory Compliance Intensity (RCI) - the extent to which a company regards government and industry regulations as enforceable - moderates SSCP and that Supplier Relationship Quality (SRQ) mediates these relationships. The hypotheses of these moderating and mediating effects are based on institutional theory and literature on supply chain partnership respectively.

Sustainability practices in the context of new economies like India are usually influenced by entrepreneurial behavior and ability of firms to be creative given the limited resources. Entrepreneurial Orientation (EO), which is a trait of innovativeness, proactiveness, and risk-taking, is a strategic stance of firms that are active and seek new opportunities and adaptive strategies. Companies with greater entrepreneurial orientations will tend to incorporate sustainability-related business approaches into their supply chain management that include green procurement, reverse logistics, and socially responsible sourcing.

Innovation Capability (IC) is the capability of the firm to convert sustainability initiatives into new products, processes and business models. It helps organizations to translate sustainability practices into quantifiable performance results, which enhances sustainable supply chain performance. Such constructs add a wider outlook since they are able to connect sustainability practice with value creation that is basically based on innovation, especially in sectors that are dominated by SMEs and entrepreneur-driven.

Table 1: Constructs, Dimensions, and Indicator Items

Construct	Dimension	Sample Indicator Items
Environmental Sustainability Practices (ESP)	Green Procurement	Preference for RoHS-compliant components; supplier environmental certification (ISO 14001); use of recycled materials in packaging
	Carbon Footprint Management	Scope 1, 2, 3 emission monitoring; logistics mode optimization; energy efficiency in warehousing
	Reverse Logistics & E-waste	Product take-back program; refurbishment and remanufacturing capacity; recycling partner certification
Social Sustainability Practices (SSP)	Labour Standards	Supplier code of conduct; child labour prohibition clause; factory audit frequency
	Community Development	Local sourcing ratio; CSR investment in supply chain communities; digital skills training programs
Economic Sustainability Practices (ECSP)	Cost Efficiency	Total cost of ownership analysis; lean inventory management; demand forecasting accuracy
	Supply Chain Resilience	Dual sourcing ratio; safety stock levels; disruption recovery time (MTTR)

Six hypotheses are advanced based on the framework. H1: ESP positively and significantly affects SSCP. H2: SSP has a significant positive effect on SSCP. H3: ECSP contributes substantially to a positive impact on SSCP. H4: SRQ mediates the effect between ESP and SSCP. H5: RCI has a positive moderating effect between ECSP and SSCP. H6: SSCP has a significant positive effect on firm competitive advantage. H7: EO produces a large positive impact on ESP. H8: EO produces a large positive impact on SSP. H9: EO has a significant positive effect on ECSP. H10: EO has a significant positive effect on IC. H11: IC has a significant positive effect on SSCP. H12: IC mediates the association amid ESP, SSP, ECSP and SSCP. The hypotheses H1-H6 are tested in the current research, whereas H7-H12 give a theoretical foundation to the future research.

The model combines environmental, social and economic sustainability practices to the institutional and relational elements and also reflects the contribution of entrepreneurial orientation and innovation capability in helping firms to convert sustainability initiatives into performance results. This view reflects the interplay between sustainability, innovation and entrepreneurial behavior in the development of competitive advantage especially in the emerging markets scenario.

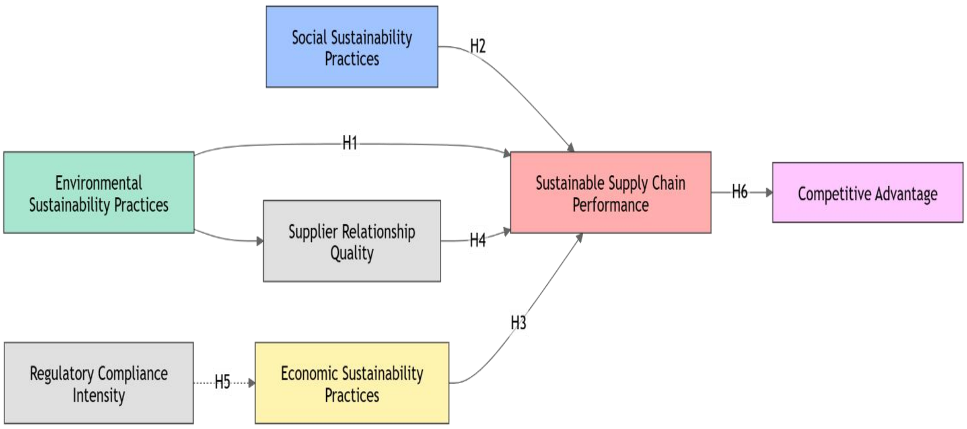

Figure 1: Conceptual Framework of Sustainable Supply Chain Performance in IT Hardware

Figure 1 represents the conceptual framework of the research, which shows how the environmental, social, and economic sustainability practices relate to sustainable supply chain performance. The three practices that model the antecedents of sustainable supply chain performance (SSCP) are environmental sustainability practices (ESP), social sustainability practices (SSP), and economic sustainability practices (ECSP). Supplier relationship quality (SRQ) is suggested to mediate between the ESP and SSCP, and regulatory compliance intensity (RCI) between ECSP and SSCP. The framework also stipulates the notion that sustainable supply chain performance is an important factor in firm competitive advantage.

4. Research Methodology

4.1 Survey Design and Data Collection

The survey was carried out in January-June 2024. Structured questionnaire: On a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree), a structured questionnaire was conducted to provide information to supply chain managers, procurement officers, and sustainability directors working in an IT hardware company. The sampling frame was selected based on the membership directory of the Electronic Industries Association of India (ELCINA), the Manufacturers Association of Information Technology (MAIT) and the India Electronics and Semiconductor Association (IESA).

To be sure of representation of three strata, a stratified random sampling technique was undertaken to include Tier-1 OEM manufacturers (n = 95), Tier-2 component distributors (n = 82), and Tier-3 retail and after-sales organizations (n = 68). There were 312 questionnaires sent out, 261 returned of which 245 were considered as complete and valid giving a usable response rate of 78.5. The sample size is larger than 200 which is the minimum requirement of SEM with latent variables.

4.2 Analytic Hierarchy Process (AHP)

The three sustainability pillars and their sub-criteria were prioritized by AHP through the pairwise comparison judgments of a panel of 12 domain experts, who included academicians, industry practitioners, and policymakers. The pairwise comparison matrices were built based on Saaty nine-point scale and global priority weights were determined with the help of the eigenvector method. Any value below 0.10 was considered satisfactory as Consistency Ratio (CR).

Table 2: AHP Pairwise Comparison Matrix — Sustainability Pillars

Criteria	Environmental (ESP)	Social (SSP)	Economic (ECSP)	Weight
Environmental (ESP)	1.000	2.500	1.800	0.476
Social (SSP)	0.400	1.000	0.667	0.185
Economic (ECSP)	0.556	1.500	1.000	0.339
Consistency Ratio (CR) = 0.004 | Maximum Eigenvalue (λmax) = 3.006				

The AHP findings show that the most important pillar is Environmental Sustainability Practices (weight = 0.476) and then Economic Sustainability Practices (0.339) and Social Sustainability Practices (0.185). The expert judgments are consistent as the CR of 0.004 is less than the threshold of 0.10.

4.3 Confirmatory Factor Analysis (CFA)

The measurement model was evaluated by performing CFA before structural estimation with AMOS 26.0. Construct reliability was tested using composite reliability (CR > 0.70), convergent validity using average variance extracted (AVE > 0.50) and discriminant validity using the Fornell-Larcker criterion. The measurement model exhibited acceptable fit: χ^2/df = 1.94, CFI = 0.963, TLI = 0.958, RMSEA = 0.062, SRMR = 0.051.

Table 3: CFA Measurement Model — Reliability and Validity Statistics

Construct	Items	Cronbach's α	CR	AVE	Factor Loadings Range
Environmental Sustainability Practices (ESP)	9	0.893	0.901	0.614	0.712 – 0.881
Social Sustainability Practices (SSP)	7	0.861	0.874	0.581	0.688 – 0.849
Economic Sustainability Practices (ECSP)	8	0.877	0.886	0.596	0.701 – 0.863
Supplier Relationship Quality (SRQ)	6	0.844	0.858	0.562	0.672 – 0.831
Regulatory Compliance Intensity (RCI)	5	0.832	0.847	0.548	0.659 – 0.822
Sustainable SC Performance (SSCP)	7	0.906	0.913	0.631	0.731 – 0.896

4.4 Structural Equation Modeling (SEM)

In AMOS 26.0, the maximum likelihood estimation was used to estimate the structural model. The mediation effects (H4) were tested by bootstrapping with a resample of 5,000 to create bias-corrected 95 percent confidence intervals of indirect effects. Hierarchical regression was used as well to test the moderation effect of RCI (H5) by adding the interaction term (ECSP × RCI) in the third step.

5. Results And Analysis

5.1 Descriptive Statistics

Table 4: Descriptive Statistics and Correlations (n = 245)

Variable	Mean	SD	1	2	3	4	5	6
1. ESP	3.74	0.63	1.000					
2. SSP	3.51	0.71	0.583**	1.000				
3. ECSP	3.68	0.67	0.541**	0.492**	1.000			

Variable	Mean	SD	1	2	3	4	5	6
4. SRQ	3.59	0.69	0.612**	0.537**	0.581**	1.000		
5. RCI	3.42	0.74	0.398**	0.412**	0.487**	0.453**	1.000	
6. SSCP	3.66	0.65	0.701**	0.594**	0.672**	0.634**	0.523**	1.000
** Correlation is significant at the 0.01 level (2-tailed)								

Inter-construct correlations are all statistically significant ($p < 0.01$). ESP has the greatest correlation with SSCP ($r = 0.701$), which is in line with AHP prioritization. ECSP exhibits the second correlation ($r = 0.672$), and SSP has a moderate, yet significant relationship ($r = 0.594$). The correlation between SRQ and SSCP ($r = 0.634$) indicates that it may mediate.

5.2 Structural Model Results

Table 5: SEM Structural Path Coefficients

H	Path	Std. Coeff. (β)	S.E.	p-value	Decision
H1	ESP → SSCP	0.412	0.048	< 0.001	**Supported**
H2	SSP → SSCP	0.218	0.051	< 0.001	**Supported**
H3	ECSP → SSCP	0.337	0.049	< 0.001	**Supported**
H4	ESP → SRQ → SSCP (Indirect)	0.143	0.031	< 0.01	**Supported (Mediation)**
H5	ECSP × RCI → SSCP	0.187	0.042	< 0.01	**Supported (Moderation)**
H6	SSCP → Competitive Advantage	0.563	0.055	< 0.001	**Supported**

The six hypotheses have empirical support. ESP is the best direct predictor of SSCP ($\beta = 0.412$, $p = 0.001$), which is consistent with AHP priority weights. The fact that ESP is indirectly related to SRQ through SSCP ($\beta = 0.143$, 95% CI [0.088, 0.209]) is a validation of partial mediation by supplier relationship quality. The moderation analysis indicates that the positive impact of ECSP on SSCP is enhanced at the greater levels of RCI ($\beta = 0.187$, $p < 0.01$), which means that regulatory pressure enhances the sustainability-performance connection. This model has a high explanatory power as it explains 81 % of the variance in SSCP ($R^2 = 0.81$).

5.3 Multiple Regression Analysis

Hierarchical multiple regression was done to further confirm the SEM results and to measure predictor dominance, SSCP was the dependent variable. Three models were estimated: Model 1 incorporated control variables only (firm size, complexity of the supply chain, years in operation); Model 2 incorporated the three sustainability pillars; Model 3 incorporated interaction terms

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Table 6: Hierarchical Multiple Regression Results (Dependent Variable: SSCP)

Predictor Variable	Model 1 β	Model 2 β	Model 3 β	Significance
Firm Size (Control)	0.098*	0.071	0.063	ns in M2, M3
Supply Chain Complexity (Control)	0.124*	0.089	0.081	ns in M2, M3
Years in Operation (Control)	0.082	0.058	0.051	ns
ESP	—	0.408***	0.389***	p < 0.001
SSP	—	0.211***	0.198***	p < 0.001
ECSP	—	0.331***	0.307***	p < 0.001
ECSP × RCI (Interaction)	—	—	0.181**	p < 0.01

Predictor Variable	Model 1 β	Model 2 β	Model 3 β	Significance
R^2	0.074	0.793	0.812	
ΔR^2	—	0.719***	0.019**	
F-statistic	6.41***	148.63***	127.92***	

Model 2 with the three sustainability pillars demonstrates a statistically significant $\Delta R^2 = 0.719$ (F-change = 148.63, p = 0.001) and it is concluded that the model has a significant explanatory power. The leading predictor in Model 3 is ESP (β = 0.389, p < 0.001), which is in line with the results of SEM. The moderation effect is validated by the interaction term ECSP × RCI (β = 0.181, p < 0.01) whereby an intensified positive effect of the economic sustainability practices on the supply chain performance is observed when the regulatory compliance is high.

5.4 AHP Sub-criteria Weight Analysis

Table 7: Final Global Priority Weights — All Sub-criteria

Rank	Sub-criterion	Local Weight	Global Weight	Parent Pillar
1	Green Procurement Practices	0.421	0.200	ESP (0.476)
2	Reverse Logistics & E-waste Management	0.339	0.161	ESP (0.476)
3	Supply Chain Resilience	0.471	0.160	ECSP (0.339)
4	Carbon Footprint Management	0.240	0.114	ESP (0.476)
5	Cost Efficiency & Lean Practices	0.529	0.179	ECSP (0.339)
6	Labour Standards & Fair Trade	0.562	0.104	SSP (0.185)
7	Community & Stakeholder Development	0.438	0.081	SSP (0.185)

The two most important sub-criteria in all the dimensions of sustainability are green procurement practices (global weight = 0.200) and reverse logistics and e-waste management (0.161). Their supremacy highlights the significance of upstream sourcing choices and downstream recovery infrastructure in defining the performance of SSCM in general in IT hardware.

6. Discussion

The empirical findings converge to justify the Triple-Pillar SSCM Model and provide some insights into theory and practice. In theory, the result that the environmental sustainability practices have the most significant impact on the SSCP (β = 0.412 in SEM; weight in AHP = 0.476) can be generalized to the IT hardware environment, where the capabilities of pollution prevention and product stewardship seem to have a more value-creating influence than either the social sustainability or economic sustainability initiatives (Wong et al., 202
This observation becomes especially important in the context of the emerging economies like India when companies have begun to work under the conditions that demand a trade-off of cost-effectiveness with environmental responsibility. The supremacy of environmental sustainability is an indication that companies are seeking to establish eco-efficient approaches as a survival and competitive means in the long term (Wang et al., 2020).

Of special interest is the mediation role of the quality of supplier relationships (SRQ) in the ESP-SSCP path. It suggests that the green procurement and carbon management performance benefits are not achieved in a vacuum but are mediated by the quality of dyadic relations with suppliers. This result is consistent with the literature on supply chain partnership and it is important to note that joint sustainability planning, information sharing, and mutual sustainability auditing as enablers of environmental performance outcomes (Anjum et al., 2024).

In terms of entrepreneurship, this highlights the importance of relational capabilities in facilitating firms, especially SMEs and new ventures, to develop strategic alliances that can help them achieve sustainability-related innovation. Firms that are entrepreneurially oriented tend to use such partnerships to co-create value, and increase performance in their supply chains (Zhang et al., 2025; Purwanto, 2022).

The institutional theory predictions are verified by the moderation by regulatory compliance intensity

(RCI): the stronger the regulatory regime under which firms have to conduct their operations, the more the sustainability performance gains occur as a result of investments in economic sustainability (cost efficiency, supply chain resilience). This implies that regulatory stringency can serve as a tool by policymakers to enhance sustainability benefits of economic efficiency efforts that are already being implemented by firms (Khan et al., 2021). The presented finding also highlights the relevance of institutional settings when it comes to developing sustainable entrepreneurial ecosystems. Regulatory frameworks in emerging markets do not only help in ensuring compliance, but also make innovation thrive by pushing firms to use cleaner technologies and more efficient methods of operation (Al Koliby et al., 2025).

In a practical perspective, the AHP output provides a clear prioritization of advice to IT hardware supply chain managers. The main point of intervention should be green procurement, which includes compliance with RoHS, environmental certification of suppliers, and recycled content. This should be one of the priorities that the organizations that are yet to have formal supplier environmental qualification criteria. The second intervention with the greatest potential impact is reverse logistics infrastructure (such as certified e-waste recycling collaboration, product take-back programs, etc.) (Kannan & Gambetta, 2025).

These discoveries are especially applicable to the case of entrepreneur-led businesses and SMEs, which tend to be resource-constrained and need to focus on sustainability initiatives with the greatest impact. Green procurement and reverse logistics can provide such firms with the opportunity to not only attain environmental gains but also cost effectiveness which will help such firms to gain competitive advantage in the market.

Additionally, the great explanatory ability of the model ($R^2 = 0.81$) gives evidence that sustainability practices are not an outer part but core to the performance of firms operating in the IT hardware industry. This supports the claim that sustainability can be a strategic source of innovation and value generation instead of a compliance-only requirement (Wong et al., 2020).

The implications of the results in the context of sustainable entrepreneurship are that sustainability-oriented supply chain practices can help firms to create innovative business models, especially those that are consistent with the principles of the circular economy, including refurbishment, recycling, and product life extension. Such practices are not only less harmful to the environment, but also generate new sources of revenue and new market opportunities (Zhang et al., 2025).

On the whole, the results support the interdependence of sustainability, innovation, and institutional variables to influence firm performance. The combination of the environmental, social and economic aspects into a single framework offers a holistic perspective of how companies can attain sustainable development in new market settings, which is closely aligned with the overall strategies of sustainable entrepreneurship and innovation in Asia.

7. Conclusion

This paper develops and validates the Triple-Pillar SSCM Model for IT hardware products, integrating AHP, CFA, SEM, and hierarchical regression in a hybrid quantitative framework. Based on survey data from 245 respondents across the Indian IT hardware supply chain, the study demonstrates that environmental sustainability practices (ESP) are the most critical driver of sustainable supply chain performance, followed by economic sustainability practices (ECSP) and social sustainability practices (SSP). Supplier relationship quality partially mediates the ESP-SSCP relationship, while regulatory compliance intensity positively moderates the ECSP-SSCP path.The model achieves high explanatory power ($R^2 = 0.81$), providing supply chain practitioners with a statistically rigorous basis for investment prioritization. Green procurement and reverse logistics emerge as the highest-impact intervention levers, offering actionable guidance for IT hardware firms seeking to embed sustainability across their supply chains. The findings also highlight that sustainability-oriented practices can serve as strategic drivers of innovation and competitive advantage, particularly in SME-dominated and entrepreneur-driven sectors in emerging economies such as India. By integrating environmental and operational efficiencies, firms can move beyond compliance-based approaches toward value-creating and innovation-led growth. Future research should examine the longitudinal dynamics of this framework using panel data, extend the analysis to include Tier-2 and Tier-3 suppliers, and explore cross-country comparative studies to assess the generalizability of the Triple-Pillar Model beyond the Indian context. Further investigation into the role of entrepreneurial orientation and innovation capability in shaping sustainability-driven performance outcomes would also strengthen the integration of sustainable entrepreneurship and supply chain management research.

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