

IMPACT OF GREEN SUPPLY CHAIN BEHAVIOUR ON ORGANIZATIONAL SUSTAINABILITY: A TRIPLE BOTTOM LINE PERSPECTIVE

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Abstract

This study examines how Green Supply Chain Behaviour (GSCB) influences organisational sustainability in the Delhi NCR region. It focuses on key GSCB dimensions, including eco-design, green purchasing, green manufacturing, green distribution and packaging, internal environmental management, investment recovery, reverse logistics, and cooperation with consumers. Data were collected through a structured questionnaire administered to 475 manufacturing and supply chain professionals. Using Partial Least Squares Structural Equation Modelling (PLS-SEM), the research evaluated the impact of these green practices on environmental, economic, social, and overall firm performance. The results reveal that eco-design, green manufacturing, internal environmental management, and reverse logistics significantly enhance sustainability outcomes, while green purchasing and packaging show more limited effects. The model demonstrated strong explanatory power (R^2 range: 0.481–0.539) and good fit indices (SRMR = 0.033; NFI = 0.903). Overall, the study provides robust empirical evidence that adopting GSCB meaningfully contributes to sustainable performance, offering valuable insights for policymakers and industry stakeholders in emerging economies.

Keywords: Green Supply Chain Behaviour, Organisational Sustainability, Green Manufacturing.

Introduction

Driven by the escalating challenges of environmental degradation and climate change, organisations worldwide are under mounting pressure to adopt sustainable business practices. A key approach to achieving this is Green Supply Chain Management (GSCM), which integrates environmental considerations into supply chain processes from procurement through to end-of-life product disposal (Diab et al., 2015). GSCM encompasses a range of practices such as green purchasing, eco-friendly manufacturing, sustainable packaging, distribution, and reverse logistics aimed at reducing ecological footprints and enhancing sustainability performance (Jassim et al., 2020).

Organisational sustainability extends beyond profit generation, encompassing environmental stewardship and social responsibility. Embedding green behaviours in supply chain operations not only mitigates environmental risks but also strengthens competitiveness, operational

efficiency, and corporate reputation (Marhamati & Azizi, 2017). This is particularly critical in emerging economies like India, where rapid industrialisation and urbanisation heighten environmental pressures. In the Delhi NCR region a major manufacturing and urban hub there is a growing need to embrace sustainable supply chain practices in response to stricter regulations, evolving consumer expectations, and globalised supply chain demands (Bagri et al., 2023).

Despite existing policy frameworks and the proven benefits of GSCM, there remains limited empirical evidence on how green supply chain behaviours translate into organisational-level sustainability in this region. Addressing this gap, the present study investigates the influence of practices such as green procurement, supplier collaboration, waste reduction, and clean technology adoption on firms' environmental, economic, and operational performance. Drawing on prior global research (Choi & Hwang, 2015; Zaid et al., 2018) and situating the analysis within India's dynamic industrial landscape, this research offers region-specific insights. Focusing on Delhi NCR companies, it contributes to the discourse on sustainable industrial development and provides actionable guidance for managers, policymakers, and practitioners seeking to align operational strategies with long-term environmental objectives.

Literature Review

The rise of green concerns and sustainable development objectives has revolutionized the business environment for organizations around the world. An increasingly large body of literature has attempted to investigate the uptake and impacts of Green Supply Chain Management (GSCM) as a key catalyst of sustainability. GSCM can be defined as incorporating environmental considerations into supply chain management, such as product design, material acquisition, manufacturing processes, distribution, and end-of-life activities (Diab, Al-Bourini, & Abu-Rumman, 2015). In the case of India's fast-industrialising and urbanising areas such as Delhi NCR, knowing how green supply chain activities attribute to organisational sustainability is especially important.

GSCM involves practices that reduce the harmful effects of supply chain activities on the environment. They involve green purchasing, green manufacturing, environmentally friendly packaging, recycling, reverse logistics, and cooperation with eco-friendly stakeholders (Jassim, Al-Mubarak, & Hamdan, 2020). Companies that adopt such practices aim to make optimal use of resources, lessen waste and emissions, and be in line with international sustainability standards.

The integrated model of GSCM is facilitated by internal environmental management systems and external partnerships. Choi and Hwang (2015) underscore the collaborative capability's contribution to amplifying the effectiveness of GSCM practice, noting that companies are required to harmonise green activities both in the organisation and in their supply chains. The resulting integration fosters increased operational efficiency, environmental compliance, and ultimately sustainable performance.

Substantial research has established that GSCM has a positive impact on firm performance. Diab et al. (2015) established in their research on Jordanian food industries that green practices like eco-design, green procurement, and waste minimization greatly improved operational, environmental, and financial performance. Likewise, Marhamati and Azizi (2017) found that

internal green practices and external partnership have a significant impact on green performance and firm competitiveness. Their research corroborates the argument that environmental initiatives of a firm are not standalone efforts but are part of larger supply chain dynamics.

In the Indian scenario, Bagri et al. (2023) have identified some of the hindrances to the adoption of GSCM as being a lack of awareness, scarcity of resources, and poor training. Contrary to these challenges, the study highlights the capability of GSCM to enhance environmental as well as economic performance in industries based in the Delhi-NCR area.

Organisational sustainability is a multi-faceted concept that includes environmental, economic, and social aspects. The triple bottom line approach is now the overall philosophy to evaluate the long-term consequence of business operations (Zaid, Jaaron, & Bon, 2018). Their study in Palestine proved that GSCM, especially with the backup of green human resource practices, contributes positively to sustainable performance.

The integration of GSCM in business practices can decrease greenhouse gas emissions, save costs on operations, and improve brand reputation. Jassim et al. (2020) identified green manufacturing and marketing as the most significant practices that affected firm performance, while green packaging and design performed lower or even negative impacts. This indicates that the performance of GSCM practices is dependent upon the industry, location, and organisational maturity.

Choi and Hwang (2015) also established the mediating effect of collaboration in amplifying the advantages of GSCM. The research indicates that companies with effective collaborative competencies are in a position to execute green practices more effectively and deliver superior sustainability performance. Notwithstanding international momentum, adoption and performance of GSCM practices significantly differ across developing economies. Bagri et al. (2023) study was on Indian automotive industries, using the ISM model to determine GSCM drivers and barriers. Kumar & Bhatia (2020) The research indicated that poor knowledge of reverse logistics, weak institutional support, and few resources were factors that impeded successful adoption. These are very practical concerns in the Delhi NCR area, where numerous small and medium enterprises have fewer infrastructural resources (Kumar & Mathur, 2020). Furthermore, GSCM literature tends to focus on industrial sectors with mature supply chain structures. There is limited region-specific research on the NCR region, which is marked by high population density, industrial diversification, and environmental pressures. This lacuna highlights the importance of localised research to identify how green supply chain behaviors are imitated, modified, and executed to suit unique socio-economic and environmental contexts.

Current research also emphasizes the need to combine Industry 4.0 technologies with GSCM for the sake of enhancing sustainability. Ghadge et al. (2022) demonstrated that IoT, AI, and blockchain technologies can improve transparency, traceability, and efficiency in supply chains. The digital technologies facilitate real time monitoring of emissions, energy consumption and waste, thus enhancing the uptake of GSCM practices.

Research Methodology

This part describes the research design and approach used to assess the role of Green Supply Chain Behaviour (GSCB) in organisational sustainability in the Delhi NCR market. A quantitative, empirical method was used to investigate how green practices affect environmental, economic, social, and overall firm performance.

Research Design

The research utilized a descriptive cross-sectional research design based on a structured questionnaire. Emphasis was laid on the measurement of relations between certain green supply chain behaviors—like eco-design, green purchasing, green manufacturing, green packaging, investment recovery, and reverse logistics—and various dimensions of organisational sustainability.

For the regional focus on Delhi NCR, this design enabled contextual comprehension of how manufacturing and supply companies implement GSCB and the consequential sustainability impacts. The design is suitable for hypothesis testing and aligns with similar methodologies adopted by Choi and Hwang (2015) and Zaid et al. (2018) in GSCM research.

Conceptual Framework and Hypotheses

The conceptual framework for this study positions GSCB as the independent construct and organisational sustainability (comprising environmental, economic, social, and firm-level performance) as the dependent construct. Based on prior literature, the following hypotheses were tested:

- H1: Green purchasing significantly impacts organisational sustainability.
- H2: Green manufacturing significantly impacts organisational sustainability.
- H3: Green distribution and packaging significantly impact organisational sustainability.
- H4: Internal environmental management significantly influences organisational sustainability.
- H5: Investment recovery is significantly related to environmental performance.
- H6: Reverse logistics is significantly associated with both environmental and financial performance.
- H7: GSCB significantly impacts economic performance, environmental, social, and overall firm performance.
- H8: GSCB significantly impacts environmental performance.
- H9: GSCB significantly impacts social performance.
- H10: GSCB significantly impacts firm performance.

Sampling and Data Collection

A stratified purposive sampling technique was employed to collect data from industrial clusters within Delhi NCR, including Gurugram, Noida, Faridabad, Bawana, and Bhiwadi. The population included manufacturing and supply chain firms across the automotive, electronics, textiles, and chemical industries.

Respondents were mid-to-senior-level professionals, operations heads, supply chain managers, and sustainability officers who have firsthand knowledge and decision-making authority related to green supply chain practices.

A total of 475 responses were targeted to ensure statistical validity for structural modelling and subgroup analysis. Data was collected via a structured questionnaire administered through online platforms and in-person visits.

Research Instrument and Scale Design

The questionnaire consisted of three major sections:

1. Demographics – capturing organisational and respondent characteristics.
2. GSCB Practices – measured on a 5-point scale ranging from 1 = ‘Not considering’ to 5 = ‘Implemented successfully’.
3. Sustainability Outcomes – measured on a 5-point Likert scale from 1 = ‘Strongly Disagree’ to 5 = ‘Strongly Agree’.

The constructs for GSCB and sustainability were borrowed from validated scales used in prior studies (Zhu et al., 2008; Khan & Qianli, 2017).

Validity and Reliability

Table 1 shows the statistical results of construct reliability and validity on several factors applied in the research study. These measurements are crucial in the assessment of the internal consistency and convergent validity of the measurement model employed in the study. The indicators employed in the table include Cronbach's alpha, Composite Reliability (ρ_a and ρ_c), and Average Variance Extracted (AVE).

Cronbach's alpha measures for all dimensions vary between 0.901 (CC) and 0.953 (EP), which are significantly higher than the generally accepted minimum of 0.70. This indicates a high degree of internal consistency of the items within each construct. That is, the items included under each factor consistently measure the same construct.

Composite Reliability (ρ_a and ρ_c) adds further strength to the internal consistency. Although Cronbach's alpha is a well-established measure, composite reliability (particularly ρ_c) is thought to be more suited in structural equation modeling. All ρ_a values are nearly equal to Cronbach's alpha, confirming the internal coherence. The ρ_c values range from 0.931 (CC, IR) to 0.960 (EP), again exceeding the minimum recommended value of 0.70. This confirms that the constructs are consistently measured across different indicators.

Average Variance Extracted (AVE) values assess the amount of variance captured by a construct, with the variance due to measurement error. According to Hair et al. (2019), AVE values above 0.50 indicate good convergent validity. In this table, AVE scores range from 0.738 (SP) to 0.784 (RL), suggesting that all constructs have strong convergent validity. This implies that the indicators of each construct truly represent the intended latent variable.

From the above results, we can conclude that the measurement model demonstrates both reliability and validity. High Cronbach's alpha and composite reliability values indicate that the constructs are measured consistently. Similarly, the AVE values indicate that the latent constructs explain a substantial portion of the variance in their indicators.

Each construct, ranging from CC (Cooperation with consumers), ED (Eco Design), to RL (Reverse Logistics) and SP (Social Performance), demonstrates sound psychometric properties. This reliability and validity analysis builds a strong foundation for further structural modelling and hypothesis testing, as the constructs can be considered both reliable and valid for use in subsequent analysis.

Table 1 Construct reliability and validity

Factor	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
CC	0.901	0.901	0.931	0.771
ED	0.942	0.942	0.952	0.741
EP	0.953	0.953	0.960	0.752
EPA	0.926	0.926	0.944	0.770
FP	0.916	0.917	0.937	0.749
GDP	0.935	0.936	0.949	0.756
GM	0.926	0.927	0.944	0.772
GP	0.941	0.942	0.952	0.740
IEM	0.925	0.926	0.944	0.770
IR	0.902	0.902	0.931	0.772
RL	0.908	0.909	0.936	0.784
SP	0.941	0.941	0.952	0.738

3.5.1 Pre-testing and Pilot Study

The questionnaire was pre-tested with academic experts and industry professionals. A pilot study with 40 respondents confirmed the clarity and content validity of the instrument.

3.5.2 Reliability

Cronbach's Alpha and Composite Reliability (CR) were computed for all constructs. Values exceeding 0.70 confirmed internal consistency.

3.5.3 Validity

- Convergent Validity was tested using Average Variance Extracted (AVE).
- Discriminant Validity was verified using the Fornell-Larcker criterion.

Exploratory Factor Analysis (EFA)

EFA was performed using SPSS to extract the underlying factor structure of the GSCB and sustainability constructs. Factors with eigenvalues greater than 1 and loadings above 0.50 were retained. The results confirmed the multidimensional nature of GSCB and validated the constructs for SEM.

Structural Equation Modelling (SEM)

To test the hypothesised relationships, Partial Least Squares Structural Equation Modelling (PLS-SEM) was employed using SmartPLS 4.0. SEM allowed estimation of the strength, direction, and significance of the paths between GSCB constructs and dimensions of organisational sustainability.

The model was evaluated based on:

- Path coefficients (β) and t-values
- Coefficient of determination (R^2)
- Effect size (f^2) and Predictive relevance (Q^2)

The base structural equation used was:

$$OS = \beta_1 \times GSCB + \varepsilon$$

Where:

- OS = Organizational Sustainability
- GSCB = Green Supply Chain Behaviour
- β_1 = Path coefficient
- ε = Error term

Empirical Findings

Path Coefficient

Table 2 and Figure 1 present the path coefficients derived from Structural Equation Modelling (SEM), which measures the strength, direction, and significance of relationships among constructs in the conceptual framework of green supply chain behaviour (GSCB) and organisational sustainability. The path coefficient (original sample), t-statistics, and p-values are used to determine the statistical significance and practical influence of each relationship. A path is considered significant when the p-value is below 0.05, with stronger confidence levels indicated at $p < 0.01$ and $p < 0.001$.

Cooperation with Consumers (CC) significantly influences Economic Performance (EP) ($\beta = 0.107$, $p = 0.022$), Environmental Performance (EPA) ($\beta = 0.168$, $p = 0.001$), Firm Performance (FP) ($\beta = 0.169$, $p = 0.000$), and Social Performance (SP) ($\beta = 0.134$, $p = 0.005$), indicating that customer collaboration enhances sustainability across financial, environmental, and social dimensions.

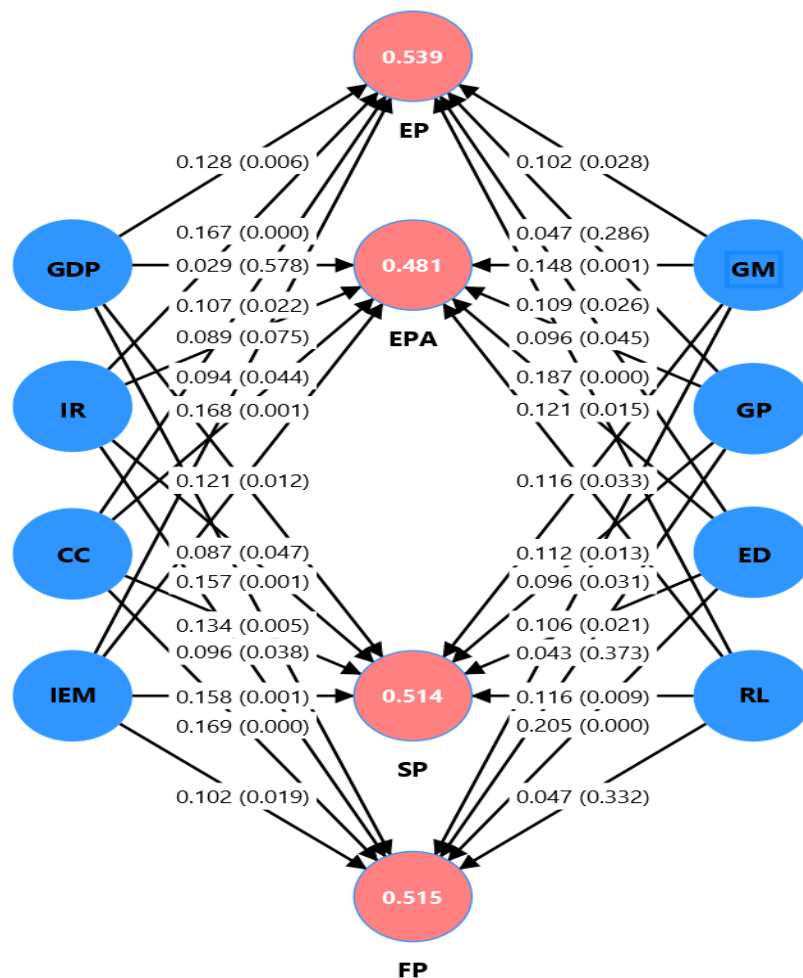


Figure 1: Path Coefficient

Eco Design (ED) demonstrates a strong and significant effect on all four outcome dimensions: EP ($\beta = 0.109$, $p = 0.026$), EPA ($\beta = 0.121$, $p = 0.015$), FP ($\beta = 0.205$, $p = 0.000$), and SP ($\beta = 0.106$, $p = 0.021$). These results highlight that integrating environmentally responsible design directly contributes to performance improvements.

Green Distribution & Packaging (GDP) significantly influences EP ($\beta = 0.128$, $p = 0.006$) and FP ($\beta = 0.157$, $p = 0.001$), but has no significant impact on EPA and SP. This suggests that logistics and packaging innovations mainly impact operational and financial efficiency.

Green Manufacturing (GM) positively affects EP ($\beta = 0.102$, $p = 0.028$), EPA ($\beta = 0.148$, $p = 0.001$), FP ($\beta = 0.096$, $p = 0.031$), and SP ($\beta = 0.148$, $p = 0.001$), indicating that clean production practices enhance sustainability in all areas.

Green Purchasing (GP) shows mixed results. While it significantly impacts EPA ($\beta = 0.096$, $p = 0.045$) and SP ($\beta = 0.112$, $p = 0.013$), it does not significantly affect EP or FP. This indicates that green procurement influences social and environmental outcomes more than financial ones.

Internal Environment Management (IEM) significantly contributes to EP ($\beta = 0.094$, $p = 0.044$), EPA ($\beta = 0.121$, $p = 0.012$), FP ($\beta = 0.102$, $p = 0.019$), and SP ($\beta = 0.158$, $p = 0.001$), underscoring the importance of internal practices, such as environmental training and audits, for overall sustainability.

Investment Recovery (IR) shows strong effects on EP ($\beta = 0.167$, $p = 0.000$), FP ($\beta = 0.096$, $p = 0.038$), and SP ($\beta = 0.087$, $p = 0.047$), though its impact on EPA is marginal ($p = 0.075$), suggesting financial and social benefits from resource recovery mechanisms.

Reverse Logistics (RL) has significant positive effects on EP ($\beta = 0.187$, $p = 0.000$), EPA ($\beta = 0.116$, $p = 0.033$), and SP ($\beta = 0.116$, $p = 0.009$), but no significant impact on FP ($p = 0.332$). This shows that while RL enhances environmental and social dimensions, it may not directly improve financial outcomes.

Table 2 Path Coefficient			
Path	Original sample (O)	T-Statistics (O/Stdev)	P-values
CC -> EP	0.107	2.291	0.022**
CC -> EPA	0.168	3.406	0.001*
CC -> FP	0.169	3.544	0.000***
CC -> SP	0.134	2.815	0.005***
ED -> EP	0.109	2.223	0.026**
ED -> EPA	0.121	2.435	0.015**
ED -> FP	0.205	4.192	0.000***
ED -> SP	0.106	2.316	0.021**
GDP -> EP	0.128	2.735	0.006**
GDP -> EPA	0.029	0.556	0.578
GDP -> FP	0.157	3.386	0.001***
GDP -> SP	0.062	1.249	0.212
GM -> EP	0.102	2.202	0.028

GM -> EPA	0.148	3.235	0.001***
GM -> FP	0.096	2.163	0.031**
GM -> SP	0.148	3.199	0.001**
GP -> EP	0.047	1.066	0.286
GP -> EPA	0.096	2.004	0.045**
GP -> FP	0.043	0.891	0.373
GP -> SP	0.112	2.480	0.013**
IEM -> EP	0.094	2.014	0.044
IEM -> EPA	0.121	2.505	0.012**
IEM -> FP	0.102	2.354	0.019**
IEM -> SP	0.158	3.376	0.001***
IR -> EP	0.167	3.741	0.000***
IR -> EPA	0.089	1.780	0.075*
IR -> FP	0.096	2.080	0.038**
IR -> SP	0.087	1.989	0.047**
RL -> EP	0.187	3.908	0.000***
RL -> EPA	0.116	2.127	0.033**
RL -> FP	0.047	0.971	0.332
RL -> SP	0.116	2.608	0.009***

Model fit

Table 3 presents the model fit indices used to assess the adequacy of the proposed structural model compared to the saturated model. These indices include SRMR (Standardised Root Mean Square Residual), D_ULS (Unweighted Least Squares discrepancy), D_G (Geodesic discrepancy), Chi-square, and NFI (Normed Fit Index).

The SRMR value for the estimated model is 0.033, which is well below the acceptable threshold of 0.08, indicating a good fit between the observed and predicted correlation matrices. d_ULS (2.475) and d_G (1.035) are slightly higher than the saturated model values but remain within acceptable limits, suggesting minimal discrepancy between the models. The Chi-square value for the estimated model is 3166.300, close to the saturated model's 3102.328, further supporting a reasonable fit.

The NFI value of 0.903 exceeds the recommended minimum of 0.90, indicating that the model explains the data better than a null model and is considered acceptable. Overall, the reported indices confirm that the proposed structural model achieves a good fit, validating its suitability for hypothesis testing and interpretation of green supply chain behavior's impact on sustainability outcomes.

Table 3 Model fit		
Model fit indices	Saturated model	Estimated model
SRMR	0.027	0.033
d_ULS	1.668	2.475
d_G	1.008	1.035

Chi-square	3102.328	3166.300
NFI	0.905	0.903

R-square

Table 4 presents the R-square and adjusted R-square values, which indicate the proportion of variance in the dependent variables explained by the model. The R-square for Economic Performance (EP) is highest at 0.539, suggesting that 53.9% of its variance is explained by the predictors. Firm Performance (FP) and Social Performance (SP) follow closely with R-square values of 0.515 and 0.514, respectively. Environmental Performance (EPA) has the lowest R-square at 0.481. All adjusted R-square values remain very close to the original, confirming the model's consistency and strong explanatory power across all sustainability dimensions.

Table 4 R-square		
Factors	R-square	R-square adjusted
EP	0.539	0.532
EPA	0.481	0.473
FP	0.515	0.508
SP	0.514	0.507

f-square

Table 5 presents the F-square values, which indicate the effect size of each exogenous (independent) variable on endogenous (dependent) variables in the structural model. An f-square value of 0.02 is considered small, 0.15 medium, and 0.35 large. In this model, most f-square values fall in the small range, suggesting that individual predictors have modest but meaningful effects on outcomes. For instance, Eco Design (ED) shows the highest impact on Firm Performance (FP) with an f-square of 0.041. Reverse Logistics (RL) has notable effects on Economic Performance (EP) (0.038) and Environmental Performance (EPA) (0.013). Internal Environment Management (IEM) demonstrates a moderate influence on Social Performance (SP) (0.026). Meanwhile, Cooperation with Consumers (CC) contributes to FP (0.030) and EPA (0.028). These values reflect that while no single construct overwhelmingly dominates, multiple green practices jointly contribute to sustainability outcomes, reinforcing the multifactorial nature of green supply chain effectiveness.

Table 5 f-square												
Factors	CC	ED	EP	EPA	FP	GDP	GM	GP	IEM	IR	RL	SP
CC			0.013	0.028	0.030							0.019
ED			0.012	0.014	0.041							0.011
EP												
EPA												
FP												
GDP			0.018	0.001	0.026							0.004
GM			0.012	0.022	0.010							0.023
GP			0.002	0.009	0.002							0.014
IEM			0.010	0.014	0.011							0.026
IR			0.031	0.008	0.010							0.008

RL			0.038	0.013	0.002							0.014
SP												

Conclusion

The empirical analysis of green supply chain behaviour (GSCB) in this study reveals its substantial and multidimensional impact on organisational sustainability in the Delhi NCR region. The results derived from PLS-SEM demonstrate that various GSCB components, including eco-design, green purchasing, green manufacturing, green distribution and packaging, internal environmental management, investment recovery, reverse logistics, and cooperation with consumers, contribute significantly to sustainability outcomes, albeit with varying effect sizes.

Key findings indicate that eco-design and green manufacturing have a consistent and positive influence across all four sustainability dimensions, economic, environmental, firm, and social performance, highlighting the strategic value of environmentally responsible product and process design. Internal environmental management and reverse logistics also emerge as significant contributors, reinforcing the importance of internal practices and post-consumption logistics in sustainability advancement.

While green purchasing showed a weaker impact on economic and firm performance, its positive influence on environmental and social performance reflects a shift toward responsible sourcing. Interestingly, green distribution and packaging impacted economic and firm performance but lacked significance for environmental and social outcomes, indicating potential gaps in eco-packaging practices.

Overall, the study confirms that a well-integrated GSCB strategy enhances sustainability holistically. These insights provide a valuable foundation for policymakers and practitioners aiming to embed green practices into industrial ecosystems for long-term competitive and environmental advantage.

Limitations of the study

This study is limited to manufacturing firms in the Delhi NCR region, which may affect the generalizability of findings to other regions or sectors. Additionally, the cross-sectional design restricts causal inference, and reliance on self-reported data may introduce response bias despite methodological rigour.

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