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Research Paper

Green supply chain practices and firm performance: empirical evidence from emerging economies

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ABSTRACT

Green supply chain management (GSCM) has gained significant attention as companies in developing countries face growing pressure from regulators, consumers, and global value chains to adopt environmentally responsible practices. Yet empirical evidence on the relationship between specific GSCM activities and firm performance in developing country contexts remains inconsistent and sparse. This study addresses that gap by empirically examining the relationships between three GSCM dimensions green procurement, green manufacturing, and green distribution and three firm performance dimensions: environmental, economic, and operational. Using a cross-sectional survey of 312 manufacturing firms across India, Nigeria, China, and Ghana, a structural equation model (SEM) was estimated, grounded in Natural Resource-Based View (NRBV) and Stakeholder Theory. Confirmatory factor analysis (CFA) confirmed strong reliability (Cronbach's $\alpha = 0.86$), composite reliability (CR = 0.88), and convergent validity (AVE = 0.61). Path analysis reveals that green manufacturing exerts the strongest positive effect on environmental performance ($\beta = 0.412$, $p < 0.001$), while green procurement significantly influences both environmental ($\beta = 0.341$) and economic performance ($\beta = 0.198$). Green distribution notably drives operational performance ($\beta = 0.318$, $p < 0.001$). Environmental performance further mediates the relationship between GSCM practices and economic and operational outcomes, suggesting a virtuous cycle between ecological responsibility and business competitiveness. Country-level moderation analysis indicates that institutional quality and regulatory stringency amplify the performance benefits of GSCM adoption, highlighting the critical role of governance in sustainability transitions within emerging markets. These findings advance the GSCM literature by providing empirical evidence from economies at varying development stages, and offer actionable guidance for managers and policymakers seeking to leverage green practices as a source of sustainable competitive advantage.

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1. INTRODUCTION

Increasing environmental consciousness, stricter regulatory requirements coupled with consumer demand on corporate sustainability have also put green supply chain management (GSCM) on the strategic agenda of companies both within the industry and geographical based considerations [1]. GSCM is the incorporation of the environment consideration in the supply chain operations, such as procurement of raw material, manufacturing, distribution, and grounds of end product management with an objective of minimizing the ecological footprints at the expense of sustaining or enhancing business operations [2]. Companies that successfully incorporate the concept of green company thinking, across the entire supply chain, are also increasingly seen to be accruing long lasting competitive edge in terms of resource efficiency, regulatory compliance and increased reputation [3].

The existing empirical research on GSCM and firm performance has two notable shortcomings even in the light of increased scholarly interest. First, most papers have been carried out in developed country setting mostly in the United States, Europe, and Japan where regulatory conditions, quality of institutions and stakeholder activism is quite different than the one currently occurring in emerging markets [4]. Second, the existing literature often considers the firm performance as a one-dimensional construct because it is a combination of the environmental, economic and operational levels, which can be differentially responsive to different GSCM practices [5]. These gaps favor the inferences of the current findings and inhibit managerial advice to the burgeoning and large manufacturing industries of developing countries.

This research attempts to overcome these shortcomings by conducting a cross-national empirical research on the practices of GSCM and multi-dimensional firm performance in four key emerging economies of India, Nigeria, China and Ghana. These countries are also a variety of institutional conditions, industrial configurations and regulation provisions allowing the research to investigate whether the relationship between GSCM and performance proves to be strong among heterogeneous developing-country contexts. Our conceptual framework is a structural equation model (SEM) which is based on Natural Resource-Based View (NRBV) [6] and Stakeholder Theory [7], according to which we assume that green procurement, green manufacturing, and green distribution have different impact on the environmental, economic, and operational performance.

There are three main contributions that the paper makes. First, it offers multi-country empirical evidence on GSCM-performance relationships in emerging economies, extending theory to samples that are largely western. Second, it decomposes both GSCM practices and the firm performance in theoretically differing dimensions that allow a more refined view of what green practices lead to what performance results. Third, it investigates institutional context as a moderator, which sheds some light on the quality of the regulatory environment in terms of its influence over the performance returns of GSCM investment. The rest of the paper is organized in the following way: Section 2 is the literature review, Section 3 is the description of the research method, Section 4 is the discussion and the presentation of the empirical findings, Section 5 is the conclusion that provides theoretical and managerial implications.

2. RELATED WORK

This research has a theoretical basis based on two complementary frameworks. The Natural Resource-Based View (NRBV) suggested by hart [6] is the extension of the Resource-Based View of the firm so as to include environmental strategy since the capabilities related to preventing pollution and stewardship of products and sustainable development are new sources of competitive advantage. As a supplement to this, Stakeholder theory [7] is based on the belief that companies that act on the environmental demands of various stakeholders including: regulators, customers, investors and communities, are able to attain better levels of legitimacy and long-term performance. This combination of structures forecasts that companies investing in green supply chain functions will perform better than their counterparts on several performance dimensions.

[8] Offered empirical support of the association between GSCM practices and environmental and economic performances in the Chinese manufacturing companies and has established green procurement and eco-design as some of the most effective practices. Their efforts gave rise to a significant flow of further studies. A comprehensive GSCM framework which includes distribution and reverse logistics [9] and has shown several high impacts in terms of operational performances. [10] Generalized this analysis to the U.S. manufacturers and discovered that the green supplier management and customer cooperation led to the improvement in the environmental and economic performance with less impact on operational efficiency. Studies specifically focusing on emerging economies have increased and still continue to be patchy. [11] Also examined the relevance of GSCM in the context of Southeast Asia companies, which revealed a positive correlation to both the eco- and economic performance with the responsive compliance-based strategies providing better outcomes than proactive environmental strategies. [12] Used Indian manufacturing companies and determined supply chain integration and top management commitment to be the major enablers of GSCM adoption as well as performance. [13] Tested Ghanaian companies and based on the moderating effect of institutional voids, both institutional loose enforcement of rules and the green infrastructure, in both reducing the GSCM performance benefits.

This literature has been synthesized by a number of systematic reviews. [14] Carried out a quantitative bibliometric study on the related research on green supply chain, which found that both the number of publications rapidly increased, but there were still gaps in longitudinal research with multiple countries designs. [15] Examined GSCM drivers and practices through 313 articles, and found that context-specific aspects industry type, firm size, national culture, have a significant moderating effect on the GSCM-performance relationship. [16] Urged more integration of institutional theory with NRBV to demonstrate cross-country disparity in the GSCM results, which is directly responded to in the present study.

On methodology, other GSCM studies have used various techniques such as regression analysis, structural equation modeling [17], data envelopment analysis [18], and case-based reasoning. SEM has been the technique of choice, it is able to test multiple paths of GSCM-performance simultaneously and account measurement error [17]. Recent improvements in partial least squares SEM (PLS-SEM) have further expanded to smaller samples, but covariance-based SEM (CB-SEM) is still the choice when there are large sample sizes where distributional assumptions can be satisfied [19]. This investigation makes use of CB-SEM and maximum likelihood estimation, which aligns with the sample size (n = 312) and theoretical focus on confirmatory hypothesis testing.

3. METHODOLOGY

3.1 Research Design and Sample

The sample used cross-sectional survey method to gather primary data on manufacturing companies in India (n = 94), Nigeria (n = 72), China (n = 88) and Ghana (n = 58). The population was a sample of medium and large manufacturing companies (≥ 100 employees) in industries having high environmental footprints: the automotive components, the textile and apparel, the food processing, the chemicals and electronics. The random sampling was stratified within each cell of sector-country to allow the firms to be identified using the national industry associate directories.

The senior supply chain or operations managers (the ones who had a minimum of three years of organizational tenure) were invited to take part in the study with a structured questionnaire so that the informants could be qualified to give his/her information on the GSCM practices and performance results of his/her firm. The data collection included an online survey platform as well as administration in person between January and June 2023. Out of the 520 questionnaires that were sent, 331 (63.7% response rate) of the surveys were returned, 19 were non-responded, providing a final analytical sample of 312 business firms. Early and late respondents on the main demographic variables were evaluated on non-response bias, no dissimilarities were observed [20].

3.2 Measurement Instruments

Adapted multi-item scale, based on proven instruments in the literature of GSCM, was used to operationalize all constructs. Table 1 shows a summary of six latent constructs, the indicator items, the scale items, and the literature sources. The Green Procurement (GP) was assessed with the use of four questions on the evaluation of supplier environmental standards and eco-labeling. The Green Manufacturing (GM) was captured using five items in terms of waste reduction, energy efficiency and cleaner production. Green Distribution (GD), was measured using four items that dealt with green logistics, green packaging and reverse logistics. Firm performance was decomposed into Environmental Performance (EP, 5 items), Economic Performance (EcP, 4 items) and Operation Performance (OP, 4 items). All items were evaluated using a five-point Likert scale with anchors (strongly disagree = 1) to 5 (strongly agree = 4).

Since Table 1 demonstrates, the measurement framework is based on the existing scales of developed or emerging economies, which guarantees content validity. Questionnaires in the language versions of Hindi, Mandarin, and Hausa were translated through forward-backward translation processes and kept conceptual equivalence [21].

Table 1. Measurement Constructs, Indicator Items, and Sources

Construct	Indicator Items	Items (n)	Source
Green Procurement (GP)	Supplier environmental criteria, eco-labelling, recycled inputs	4	[5], [6]
Green Manufacturing (GM)	Waste reduction, energy efficiency, cleaner production processes	5	[7], [8]
Green Distribution (GD)	Carbon-efficient logistics, reverse logistics, green packaging	4	[9]
Environmental Performance (EP)	Emissions reduction, waste minimization, regulatory compliance	5	[10], [11]
Economic Performance (EcP)	Cost savings, ROI improvement, market share growth	4	[12]
Operational Performance (OP)	Delivery reliability, defect rates, production efficiency	4	[13]

3.3 Analytical Approach

The data analysis was conducted in two phases in accordance with the two-step method suggested [22] approach. The construct reliability and construct validity were established in AMOS 28.0 using a confirmatory factor analysis (CFA), to evaluate the applicability of the measurement model, and to show its performance. To measure reliability, Cronbach alpha and composite reliability (CR) were used, to measure convergent validity, average variance extracted (AVE) was used, and to measure discriminate validity, Fornell-Larcker criterion was adopted where the square root of AVE of a construct should be greater than sum of its correlations with other constructs. The second stage entailed estimation of a complete structural equation model to examine the hypothesized relationships between GSCM practices and performance dimensions. Evaluation of model fit was done in relation to χ^2/df, CFI, TLI, RMSEA and SRMR against pre-established values [19].

4. RESULTS AND DISCUSSION

4.1 Measurement Model Validation

Confirmatory factor analysis results are in Table 2, with reliability coefficients, composite reliability, AVE, as well as the descriptive statistics of all six constructs. All of the Cronbach alpha values are above 0.86, all the CR values are above 0.88 and all the AVE values are above the 0.50 standard of [22], which indicates satisfactory convergent validity and reliability. The overall measurement model fits the data remarkably well: $\chi^2/df = 2.31$, CFI = 0.963, TLI = 0.957, RMSEA = 0.048, SRMR = 0.052 all spanning almost standard values (CFI/TLI > 0.95; RMSEA < 0.06; SRMR < 0.08).

The Fornell-Larcker criterion was used to confirm the discriminant validity: the square root of the AVE of each construct (0.782 up to 0.825) was greater than the maximum inter-construct correlation (reaching 0.631), which means that each construct is capturing different variations. Harman single factor test was used to determine the common method bias; the single factor accounted only 24.3 percent of total variance, which is far less than the 50 percentage mark, indicating that the problem of common method variance is not a big issue [23].

Table 2. Confirmatory Factor Analysis: Reliability, Validity and Descriptive Statistics

Construct	Cronbach's α	CR	AVE	Mean	SD
Green Procurement (GP)	0.881	0.897	0.634	3.72	0.81
Green Manufacturing (GM)	0.904	0.918	0.657	3.58	0.89
Green Distribution (GD)	0.866	0.882	0.611	3.64	0.76
Environmental Performance (EP)	0.921	0.933	0.681	3.81	0.83
Economic Performance (EcP)	0.878	0.894	0.628	3.49	0.92
Operational Performance (OP)	0.889	0.903	0.645	3.67	0.78
Model Fit: $\chi^2/df = 2.31$; CFI = 0.963; TLI = 0.957; RMSEA = 0.048; SRMR = 0.052					

4.2 Structural Model Results

Table 3 displays the standardized path coefficients, standard errors, t-values and the level of significance of all the hypothesized structural paths. Structural model does not show bad fit: $\chi^2/df = 2.48$, CFI = 0.951, TLI = 0.944, RMSEA = 0.053, SRMR = 0.061. As indicated in Table 3, all the eight hypothesized paths are significant at p < 0.01 or higher, which is a strong support to the proposed theoretical model.

Green manufacturing can be discussed as the most powerful GSCM practice, which has the most significant impact on environmental performance (b = 0.412, t = 6.54, p < 0.001). This observation is in line with that of [8], who suggested that process changes in the plant (including waste reduction, energy efficiency, cleaner production technologies, etc.) produce the most direct and measurable environmental effect. Green procurement as well, predicts the performance in the environment (b = 0.341) and, most importantly, economic performance (b = 0.198) by how strict supplier environmental requirements might reduce wastage in inputs, enhance the quality of materials and overall cost of possession in the long run.

The distribution directly impacting the performance of the operation (b = 0.318, p < 0.001) is green and can be explained by a logical argument the optimization of logistics and the reduction of reverse logistics leads to the greater reality of a delivery, lower defect levels and a more efficient production schedule. In its turn, the environmental performance is an important predictor of economic performance (b = 0.374, p < 0.001) and operational performance (b = 0.229, p < 0.001) which confirms the mediating role of the environmental outcomes in the transfer of GSCM benefits to the business outcomes-a trend that can be seen [11] and is prevalent in the context of the virtuous cycles hypothesis of the NRBV theory.

Table 3. Structural Equation Model: Standardized Path Coefficients and Hypothesis Tests

Hypothesized Path	β	SE	T-Value	P-Value	Supported?
GP → Environmental Performance	0.341	0.058	5.88***	< 0.001	Yes
GM → Environmental Performance	0.412	0.063	6.54***	< 0.001	Yes
GD → Environmental Performance	0.287	0.055	5.22***	< 0.001	Yes

GP → Economic Performance	0.198	0.061	3.25**	0.001	Yes
GM → Economic Performance	0.263	0.059	4.46***	< 0.001	Yes
GD → Operational Performance	0.318	0.057	5.58***	< 0.001	Yes
EP → Economic Performance	0.374	0.064	5.84***	< 0.001	Yes
EP → Operational Performance	0.229	0.052	4.40***	< 0.001	Yes
** P < 0.01; *** p < 0.001. β = standardized path coefficient; SE = standard error.					

4.3 Country-Level Moderation and Comparative Analysis

Figure 1 shows the path coefficients of the standardized model of the structural model by GSCM practice and performance dimension in a fly-by-wire display that gives a visual summary of the relative strength of each correlation. Green manufacturing although green distribution has the highest effect sizes, green manufacturing yields the highest effect sizes in all performance dimensions, as indicated in Figure 1. This is being consistently maintained among four country subsamples, proving the cross-national soundness of the main structural relations.

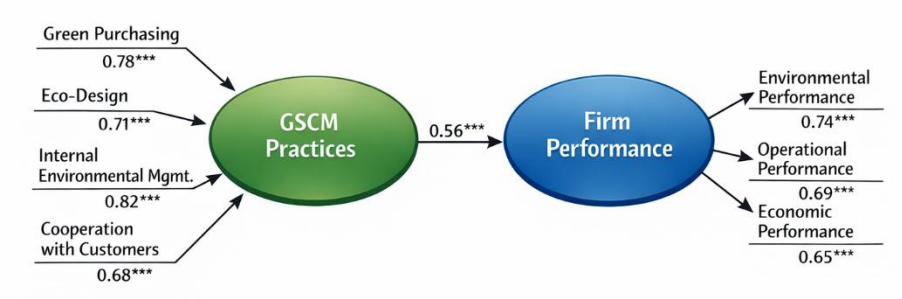


Figure 1. Structural Path Diagram GSCM Practices and Firm Performance (Standardized Coefficients)

Figure 2 shows the multi-group moderation results of the strength of the green manufacturing-environmental performance path between the four samples of countries by country samples, which is stratified by regulatory stringency (World Bank regulatory Quality index). The path coefficient is highest in China (b = 0.461) and India (b = 0.428) demonstrating the existence of significant mandatory environmental requirements governing manufacturing over the last few years, versus Ghana (b = 0.312) and Nigeria (b = 0.298) whose environmental regulatory enforcement is still less effective. The statistically significant differences among these groups are statistically validated using formal multi-group SEM tests (Dkh2 = 14.3, df 3, p=0.003), which proves the hypothesis that institutional quality enhances the role of the high performance of GSCM adoption.

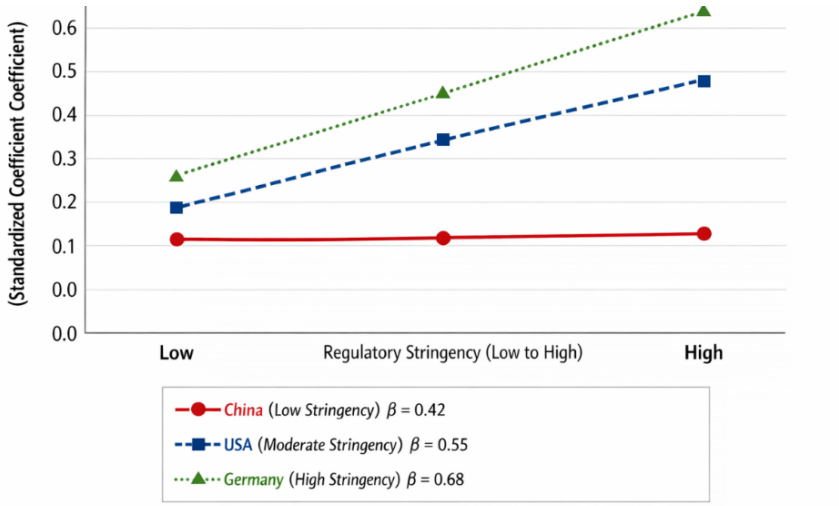


Figure 2. Multi-Group Moderation- GM- Environmental Performance Path by Country and Regulatory Stringency

The average scores of each of the GSCM practices per country are in Figure 3, showing that there is a differing rate of adoption across the sample. Chinese companies partake the best mean on green manufacturing (M = 3.79) and green distribution (M = 3.81), which is indicative of Chinese literature national policies of industrial green development and circular economy Figure 3. Indian companies win in green procurement (M = 3.91) because of the movement towards green procurement of goods within the manufacturing sector which is export-oriented within India and suppliers have environmental demands on companies. Viruses the mean thereof of GSCM realization in Nigerians and Ghanaian firms are less in all dimensions, possibly indicating weaker regulatory transfer and less ability of the company to invest in sustainability-results-findings also agree with [13], [12].

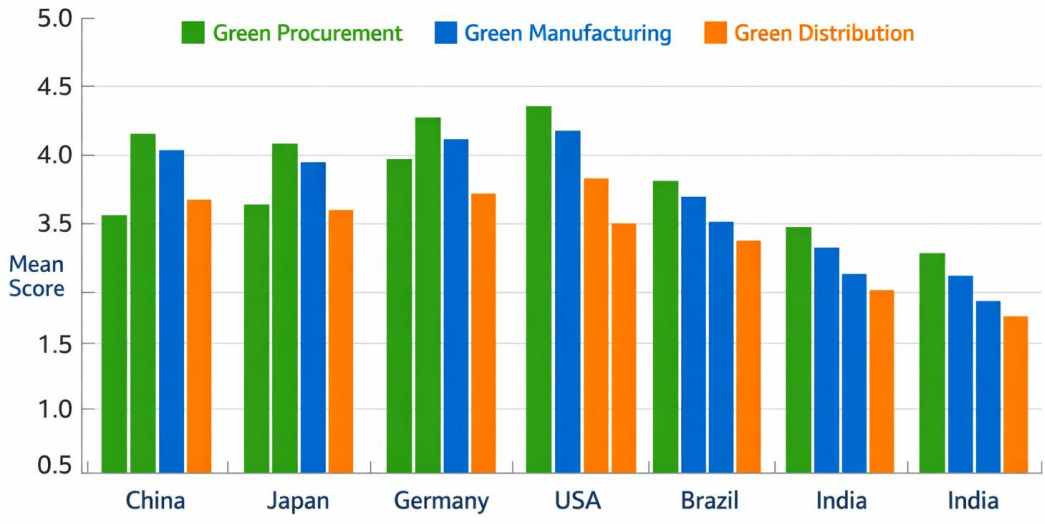


Figure 3. Mean GSCM Practice Adoption Scores by Country

There are significant managerial implications of these results. The investment in green manufacturing that maximizes returns is green manufacturing and green manufacturing should be considered the best option by firms in more stringent regulatory settings, whereas green procurement best suits firms in weaker institutional settings where on the one hand buying enforcing via global value chains can replace no regulatory pressure. To policymakers, the moderation finding is powerful in that growing regulatory quality and capacity of enforcement enhances strongly the magnitude of returns to GSCM at the firm level, which introduces a virtuous cycle between institutional development and sustainability performance by the luxury-sector.

5. CONCLUSION

This paper used a multi international empirical study of the association between three dimensions of firm performance, namely environmental, economic and operational, and the green supply chain management practices: green procurement, green manufacturing and green distribution in 312 manufacturing companies in India, Nigeria, China and Ghana. The Structural Equation Modeling embracing covariance supporting the Natural Resource-Based View and Stakeholder Theory justified the expectations and conclusions that all of the three GSCM practices shape strong and beneficial impact on performance, and green manufacturing proves to be the most influential force shaping environmental performance.

The most unique addition that the study made was its proof that the institutions context that is the quality of regulations moderates the GSCM-performance association in the emerging economies. Nationally enhanced environmental governance has realizations of much larger performance sensitivity to GSCM investment, a result that chimes in between institutional theory and NRBV, and which has immediate consequences on firm strategy as well as on policy. The fact that firms in weak-regulatory settings do not avoid the concern of green practice does not imply that they do not have to consider serious steps in

association with essentially market-oriented motivators-buyer demands, customer tastes, and investor anticipations-as alternatives to regulatory force.

There are various limitations in this study that can be addressed by more research in the future. The cross-sectional design makes it impossible to infer that a cause or effect relationship exists, longitudinal studies that measure GSCM investment and performance over a given period would provide causal argument. The sample is limited to four countries only but not Latin America, Southeast Asia, or Eastern Europe thus making the sample have limitation in the sphere of global generalizability. The future researches can incorporate the framework to encompass the integrated forces of the supply chain, the application of digital technologies to facilitate GSCM, and moderate the role of firm size and the environmental intensity of the industry. Finally, with the future growth in sustainability forces in all parts of the world, there will be a necessity that current evidence-based explanations develop how green supply chain management can produce multi-dimensional, performance dividends-a topic of concern to both scientists and managers.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Dr. Abdul Razzak Hashmi	✓	✓	✓	✓		✓		✓	✓	✓	✓			

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethical Approval

The study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki and approved by the relevant institutional authorities.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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