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# Green Supply Chain Management and Sustainable Business Performance: The Mediating Role of Access to Technology in Pakistani Manufacturing Firms

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**ABSTRACT**

*This study examines the impact of Green Supply Chain Management on Sustainable Business Performance with a specific focus on the mediating role of Access to Technology in the context of Pakistani manufacturing firms. The research addresses a critical gap in the literature by investigating whether technological infrastructure serves as an enabling mechanism that translates environmental supply chain initiatives into tangible performance outcomes. Grounded in the Resource-Based View theory, the study employs a quantitative research design utilizing a structured questionnaire administered to 290 employees from major manufacturing organizations including Unilever, Nestlé, and Procter & Gamble in Pakistan. The data was analyzed using SPSS version 23.0 through reliability analysis, descriptive statistics, Pearson correlation, and regression analysis to test the hypothesized relationships. The findings reveal that Green Supply Chain Management practices have a significant positive direct impact on Sustainable Business Performance with a standardized beta coefficient of 0.219 at p less than 0.01. Critically, the results confirm that Access to Technology mediates the relationship between GSCM and Sustainable Business Performance, with all mediation path coefficients significant at p less than 0.01, including the effect of GSCM on Access to Technology at beta equals 0.176 and the effect of Access to Technology on Sustainable Business Performance at beta equals 0.720. These findings demonstrate that the beneficial effects of GSCM on business performance are realized to a considerable extent through the improved application and utilization of technology within the firm. The study contributes theoretically by extending the Resource-Based View theory through identifying Access to Technology as a critical complementary resource that enhances the value of Green Supply Chain Management capabilities. Practically, the findings recommend that Pakistani manufacturers should integrate GSCM with technology investments, training employees and supply chain partners while investing in IoT, Blockchain, and Analytics to create transparent, efficient, and green supply chains. Policymakers are advised to facilitate technology*

*access through incentives and subsidized programs to enhance the manufacturing sector's sustainability performance.*

***Keywords:*** *Green Supply Chain Management, Sustainable Business Performance, Access to Technology, Mediation, Manufacturing Firms, Pakistan*

**Introduction**

The escalating environmental degradation accompanying industrial expansion has positioned sustainability as a defining imperative for contemporary manufacturing enterprises. Within the paradigm of the Fourth Industrial Revolution, the manufacturing sector confronts unprecedented challenges that extend from the extraction of raw materials through end-of-life product management, with each stage contributing to a complex web of ecological consequences that demand urgent attention (Badogu et al., 2024). This environmental burden has catalyzed the emergence of Green Supply Chain Management as a transformative strategic framework that systematically integrates environmental considerations across all supply chain functions including procurement, production processes, logistics, and distribution networks (Siddiqui et al., 2024). The approach represents a fundamental departure from conventional operational models, compelling organizations to reconceptualises their value creation processes through an ecological lens that recognizes the interdependence between industrial activity and environmental health. GSCM has gained particular salience in developing economies where industrial growth frequently outpaces environmental governance, creating conditions where unchecked expansion threatens both ecological systems and long-term economic viability (Ahmed et al., 2019). The adoption trajectory of GSCM in these contexts reflects growing recognition that environmental stewardship and industrial competitiveness are not mutually exclusive objectives but rather mutually reinforcing dimensions of sustainable business strategy that can yield both ecological improvements and operational excellence (Ubaidullah, 2025).

Despite its conceptual appeal and growing global adoption, manufacturing organizations continue to demonstrate significant reluctance toward comprehensive GSCM implementation, particularly within developing economies such as Pakistan, where the lack of conclusive empirical evidence regarding its financial and operational returns remains a formidable obstacle (Rubab et al., 2025). This implementation gap reflects a fundamental tension between environmental aspirations and business realities, as managers' grapple with the perceived trade-offs between sustainability investments and short-term profitability objectives that dominate decision-making in resource-constrained environments (Naqvi et al., 2023). The complexity inherent in modern supply chains compounds this challenge, as the multiplicity of stakeholders, geographic dispersion of operations, and intricate interdependencies between processes create substantial coordination requirements that resist simple solutions (Siddiqui et al., 2024). Furthermore, organizational inertia and resistance to change represent significant psychological and cultural barriers that perpetuate conventional practices even when their environmental and economic limitations become increasingly apparent (Ahmed et al., 2019). These challenges are particularly acute in the Pakistani manufacturing context, where outdated technological infrastructure and limited institutional support exacerbate the perceived risks associated with GSCM adoption, creating a self-reinforcing cycle of inaction despite mounting environmental pressures (Ubaidullah, 2025). The confluence of these factors underscores the critical need for research that moves beyond advocacy to provide concrete evidence linking GSCM practices to tangible business outcomes that resonate with managerial decision-making frameworks.

Central to addressing this implementation challenge is recognizing that the effectiveness of GSCM practices is contingent upon the enabling infrastructure that supports their execution, with Access to Technology emerging as a critical mediating mechanism that determines whether

environmental initiatives translate into measurable performance improvements (Korevaar, 2025). Contemporary manufacturing operations increasingly depend on sophisticated technological systems that enable the monitoring, optimization, and verification of sustainability metrics throughout the supply chain, from emissions tracking to resource consumption analysis and logistical efficiency enhancement (Badogu et al., 2024). The Internet of Things facilitates real-time data acquisition across production networks, blockchain technology provides immutable records of environmental compliance and product provenance, while advanced analytics enable predictive maintenance and waste reduction strategies that minimize ecological footprints while maximizing operational efficiency (Korevaar, 2025). However, these technological enablers remain unevenly distributed across firms and regions, with Pakistani manufacturers facing particular constraints in accessing, affording, and effectively deploying the digital infrastructure necessary to realize the full potential of GSCM initiatives (Naqvi et al., 2023). This technological disparity creates a situation where well-intentioned environmental strategies may fail to deliver anticipated outcomes, not because the strategies themselves are flawed, but because the technological means to implement them effectively remain inaccessible to many organizations operating in developing economy contexts (Ubaidullah, 2025).

The intersection of GSCM practices and Access to Technology represents a critical yet underexplored dimension of sustainability research that carries profound implications for both theoretical understanding and practical application in developing economies. While empirical studies have established positive correlations between GSCM adoption and performance metrics across various industrial contexts, the mechanisms through which these outcomes materialize remain inadequately specified, particularly regarding the role of technological infrastructure as an enabling condition (Rubab et al., 2025). Existing scholarship has examined mediating variables including green knowledge sharing, green innovation, and institutional pressures, yet Access to Technology as a distinct mediating pathway warrants dedicated investigation given its foundational character in the digital transformation era (Siddiqui et al., 2024). This research gap is particularly significant for Pakistan, where manufacturing sectors constitute a substantial portion of economic output yet operate within technological environments that lag behind global best practices, creating conditions where the potential returns from GSCM investments may be systematically undermined by infrastructure deficits (Ahmed et al., 2019). The present study addresses this lacuna by investigating whether Access to Technology mediates the relationship between GSCM practices and Sustainable Business Performance, thereby providing both theoretical clarity regarding the mechanisms of environmental strategy effectiveness and practical guidance for managers and policymakers seeking to enhance the environmental and economic performance of Pakistani manufacturing firms (Naqvi et al., 2023).

**Literature Review**

The Resource-Based View theory provides the foundational framework for understanding how Green Supply Chain Management practices and Access to Technology function as strategic organizational assets that generate sustainable competitive advantage. The RBV theory posits that firms achieve superior performance through resources that are valuable, rare, imperfectly imitable, and non-substitutable, creating barriers to competitor replication (Barney, 1991; Permana, 2022). GSCM practices transcend their operational character to become distinctive organizational capabilities reflecting accumulated knowledge, established routines, and relationship networks developed through sustained environmental stewardship (Hart, 1995). The complex integration of environmental considerations across procurement, production, logistics, and product recovery generates organizational learning that competitors cannot easily replicate, particularly when embedded within organizational culture (Ahmed et al., 2019). Access

to Technology constitutes a strategic resource whose value derives from enabling sophisticated environmental monitoring, data-driven optimization, and transparent reporting across supply chain networks (Korevaar, 2025). The rarity of advanced technological infrastructure in developing economies amplifies its strategic significance, as firms possessing superior capabilities achieve efficiencies inaccessible to competitors with legacy systems (Siddiqui et al., 2024). The RBV framework illuminates the synergistic potential of combining GSCM with technological resources, suggesting their interaction creates unique organizational competencies generating performance outcomes exceeding what either could achieve independently (Naqvi et al., 2023). This theoretical perspective thus provides compelling justification for examining Access to Technology as a mediating mechanism that transforms green supply chain investments into superior sustainable business performance.

Green Supply Chain Management represents a comprehensive strategic approach incorporating environmental considerations throughout the entire supply chain from product design to end-of-life management (Novitasari et al., 2021). This conceptualization extends beyond traditional environmental management by recognizing that ecological impacts transcend organizational boundaries, requiring coordinated action across supplier networks and customer relationships to achieve meaningful improvements (Tan et al., 2024). The core GSCM components include green purchasing which selects suppliers based on environmental criteria, green manufacturing emphasizing waste reduction and energy efficiency, green logistics optimizing transportation networks to minimize emissions, and product recovery encompassing recycling and reverse logistics systems that extend product lifecycles (Yang et al., 2022). The literature consistently documents positive associations between GSCM implementation and organizational performance including cost reduction through improved resource efficiency, enhanced brand reputation and customer loyalty, strengthened regulatory compliance, and access to environmentally conscious market segments (Rao, 2022). Empirical evidence from manufacturing contexts demonstrates that GSCM contributes to operational excellence by identifying waste reduction opportunities, improving process efficiency, and fostering innovation that simultaneously serves environmental and economic objectives (Wanasida, 2023). GSCM facilitates risk management by reducing exposure to environmental liabilities, enhancing supply chain resilience, and positioning organizations favorably within increasingly stringent regulatory environments (Laari, 2024). The comprehensive nature of GSCM thus establishes it as a multidimensional strategic approach delivering benefits across operational, financial, and reputational domains.

Sustainable Business Performance constitutes a multidimensional construct evaluating organizational success through economic, environmental, and social criteria, reflecting recognition that long-term viability requires balanced attention to financial outcomes alongside ecological stewardship (Mukhsin & Suryanto, 2022). Economic performance encompasses traditional financial metrics including profitability, cost reduction, revenue growth, and return on investment, validating business strategies and justifying resource allocation (Testa, 2021). Environmental performance measures ecological outcomes such as emissions reduction, waste minimization, resource conservation, and regulatory compliance, capturing direct environmental benefits of sustainability initiatives (Khaksar et al., 2022). Social performance addresses stakeholder relationships, employee welfare, community engagement, and ethical conduct, recognizing that organizational legitimacy depends on positive contributions to broader societal wellbeing (Haris et al., 2023). Comprehensive assessment requires integrating these diverse dimensions into coherent evaluation frameworks that acknowledge trade-offs while identifying synergies between objectives (Yunus, 2021). The importance of measuring sustainable business

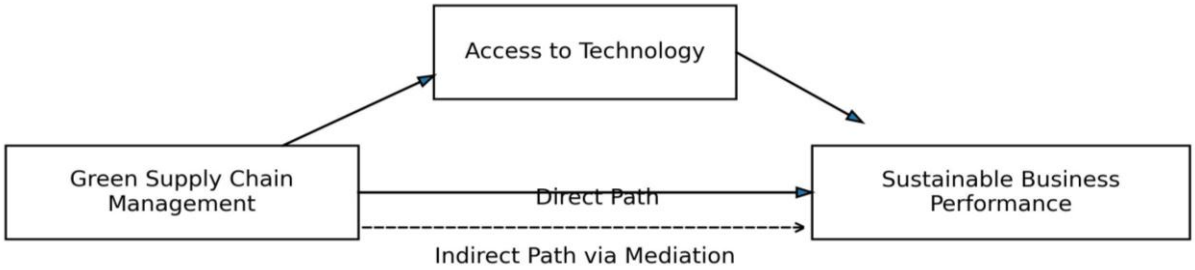
performance extends beyond internal decision-making to stakeholder communication and performance benchmarking enabling organizations to track progress toward sustainability goals (Tseng et al., 2023). Contemporary research emphasizes that sustainable business performance represents not merely compliance with external pressures but a strategic imperative driving innovation and long-term value creation in manufacturing contexts (Astawa et al., 2021). This multidimensional conceptualization provides the foundation for evaluating the effectiveness of GSCM investments.

Access to Technology functions as a critical mediating mechanism enabling organizations to translate Green Supply Chain Management investments into tangible sustainable business performance improvements through infrastructure necessary for effective implementation. Access to Technology encompasses the organizational capability to acquire, deploy, integrate, and effectively utilize advanced systems including Internet of Things sensors, blockchain platforms, artificial intelligence, and big data analytics supporting sophisticated supply chain management (Badogu et al., 2024). The argument for mediation rests on recognition that GSCM practices depend fundamentally on technological infrastructure for execution, as environmental monitoring, emissions tracking, and reporting require data collection capabilities exceeding manual or legacy system capacities (Korevaar, 2025). Without adequate technological access, organizations cannot accurately measure environmental footprint, identify improvement opportunities, verify compliance, or communicate sustainability achievements, thereby limiting GSCM contribution to business performance (Rubab et al., 2025). The mediating role is particularly pronounced in developing economies where technological gaps represent significant barriers to GSCM effectiveness, as Pakistani manufacturers often lack sophisticated systems for environmental management across supply chain networks (Ubaidullah, 2025). Despite extensive research examining mediators including green innovation and organizational culture, Access to Technology has received insufficient attention as a distinct pathway despite its foundational character in the digital era (Siddiqui et al., 2024). This research gap is significant given rapid technological advancements and uneven distribution of capabilities across firms, suggesting Access to Technology may explain substantial variation in GSCM performance outcomes (Naqvi et al., 2023). The study addresses this gap by hypothesizing that Green Supply Chain Management significantly and positively impacts Sustainable Business Performance, and that Access to Technology mediates this relationship in Pakistani manufacturing firms.

**Theoretical Framework**

**Conceptual Model**

The conceptual framework for this study illustrates the hypothesized relationships among the key variables, with Green Supply Chain Management serving as the independent variable, Sustainable Business Performance as the dependent variable, and Access to Technology functioning as the mediating variable. The framework is grounded in the Resource-Based View theory, which posits that organizational resources and capabilities that are valuable, rare, inimitable, and non-substitutable generate sustained competitive advantage and superior performance outcomes (Barney, 1991; Permana, 2022). The model proposes that GSCM practices constitute distinctive organizational capabilities that directly influence sustainable business outcomes while also operating through Access to Technology as an enabling mechanism that enhances the effectiveness of environmental initiatives. This dual-path conceptualization acknowledges that the relationship between environmental management practices and performance is neither simple nor direct, but rather involves complex intervening mechanisms that determine whether strategic investments translate into measurable results (Hart, 1995; Korevaar, 2025).




**Explanation of the Model**

The conceptual model hypothesizes two distinct pathways through which Green Supply Chain Management influences Sustainable Business Performance, capturing both direct and indirect effects that together provide a comprehensive understanding of the GSCM-performance relationship. The direct pathway, represented by Hypothesis 1, proposes that GSCM practices positively and significantly impact sustainable business outcomes without requiring intervening mechanisms, reflecting the immediate operational and strategic benefits that accrue from environmental management initiatives (Novitasari et al., 2021). These direct effects manifest through cost reductions from resource efficiency improvements, enhanced brand reputation and stakeholder trust, strengthened regulatory compliance, and operational excellence that simultaneously serves environmental and economic objectives (Tan et al., 2024; Rao, 2022). The direct pathway acknowledges that well-implemented GSCM practices generate performance improvements through improved processes, reduced waste, and enhanced organizational capabilities that create value independent of technological infrastructure considerations (Wanasida, 2023). Empirical evidence from manufacturing contexts consistently demonstrates that organizations adopting comprehensive environmental supply chain practices achieve superior performance outcomes across financial, operational, and reputational dimensions, supporting the existence of direct positive relationships (Laari, 2024; Mukhsin & Suryanto, 2022). The indirect pathway, represented by Hypothesis 2, proposes that Access to Technology mediates the relationship between GSCM and Sustainable Business Performance, suggesting that the effectiveness of environmental initiatives depends fundamentally on the technological infrastructure available to support their implementation. This mediating pathway acknowledges that GSCM practices require sophisticated technological systems for environmental monitoring, emissions tracking, data analytics, supply chain visibility, and sustainability reporting that enable organizations to measure, verify, and optimize their environmental performance (Badogu et al., 2024). Without adequate Access to Technology, organizations cannot fully realize the potential benefits of GSCM, as they lack the infrastructure necessary to accurately assess their environmental footprint, identify improvement opportunities, verify compliance with standards, or communicate sustainability achievements to stakeholders (Rubab et al., 2025). The mediating role of technology is particularly significant in developing economy contexts like Pakistan where infrastructure gaps represent substantial barriers to effective GSCM implementation (Ubaidullah, 2025). The model thus proposes that GSCM practices influence performance both directly and indirectly through their effect on Access to Technology, with the indirect pathway capturing the enabling function of technological infrastructure in translating environmental strategies into sustainable outcomes (Naqvi et al., 2023; Siddiqui et al., 2024).

**Hypotheses**

Based on the theoretical framework and conceptual model, the following hypotheses are proposed to guide empirical investigation of the relationships among GSCM, Access to Technology, and Sustainable Business Performance:

**Hypothesis 1 (H1):** Green Supply Chain Management has a significant positive impact on Sustainable Business Performance in Pakistani manufacturing firms.
**Hypothesis 2 (H2):** Access to Technology mediates the relationship between Green Supply Chain Management and Sustainable Business Performance in Pakistani manufacturing firms.
These hypotheses reflect the dual-path conceptualization, with H1 testing the direct relationship and H2 examining the mediating mechanism through which GSCM influences performance outcomes. The hypotheses are grounded in the Resource-Based View theoretical framework and informed by empirical evidence from prior studies documenting positive GSCM-performance relationships alongside recognition of the critical enabling role of technological infrastructure (Korevaar, 2025; Khaksar et al., 2022). Testing these hypotheses will provide evidence regarding whether Access to Technology functions as a significant mediator explaining how GSCM practices translate into sustainable business performance in the Pakistani manufacturing context.

**Problem Statement**

In general, manufacturing organizations in Pakistan have found it hard to justify the use of green supply chain management because there is not enough clear evidence showing that its use leads to better performance. While many studies have explored the direct relationship between GSCM and business performance, there is a significant gap in the research literature regarding the mechanisms that explain this link. Specifically, the potential mediating role of Access to Technology in the GSCM-SBP relationship has not been sufficiently investigated in the Pakistani context. This study addresses this critical gap by asking: How does access to technology mediate the relationship between green supply chain management and sustainable business performance in the Pakistani manufacturing sector?

**Objectives of the Study**

1. To examine the impact of Green Supply Chain Management on Sustainable Business Performance in Pakistani manufacturing firms.
2. To investigate the mediating role of Access to Technology in the relationship between Green Supply Chain Management and Sustainable Business Performance in Pakistan.

**Research Questions**

1. What is the impact of Green Supply Chain Management on Sustainable Business Performance in the manufacturing sector of Pakistan?
2. Does Access to Technology mediate the relationship between Green Supply Chain Management and Sustainable Business Performance in the manufacturing sector of Pakistan?

**Methodology**

**Research Philosophy and Research Design**

This study adopted a positivist philosophy and employed a quantitative research method to enable objective measurement and statistical analysis of the relationships among the variables. The quantitative approach was selected because it delivers measurable and generalizable results that form the basis for robust conclusions about the phenomena under investigation. The study employed a cross-sectional research design, collecting data at a single point in time from the target population. This design was appropriate for examining the relationships between Green Supply Chain Management, Access to Technology, and Sustainable Business Performance in the Pakistani manufacturing sector.

**Data Collection and Instrument**

A structured questionnaire served as the primary data collection tool, containing items adopted from past studies to measure the key variables. Green Supply Chain Management was measured using 7 items, Access to Technology used 5 items, and Sustainable Business Performance utilized

7 items. Each question employed a five-point Likert scale where 1 represented Strongly Disagree and 5 represented Strongly Agree.

**Population and Sample**

The population for this study comprised all employees working in the manufacturing sector of Pakistan. A sample of 290 employees was selected using purposive sampling technique, with participants chosen based on their experience and knowledge relevant to the research topic. The manufacturing firms included major organizations such as Unilever Pakistan Limited, Nestlé Pakistan Limited, Procter and Gamble Pakistan, Reckitt Benckiser Pakistan, and Philip Morris Pakistan.

**Data Analysis**

Data analysis was performed using SPSS version 23.0. Reliability analysis was conducted using Cronbach's Alpha to check the internal consistency of the scales, with values of 0.785 for GSCM, 0.774 for Access to Technology, and 0.741 for Sustainable Business Performance, all exceeding the acceptable threshold of 0.6. Descriptive statistics including frequency tables and charts were used to describe the demographic profile of respondents such as gender and age. Pearson correlation analysis assessed the strength and direction of linear relationships between the variables. Regression analysis was conducted to test the direct and mediating effects, following established approaches to examine the paths from independent variable to dependent variable, independent variable to mediating variable, and mediating variable to dependent variable.

**Findings and Results**

**Reliability Analysis**

The internal consistency of the measurement scales was assessed using Cronbach's Alpha coefficient to ensure the reliability and validity of the questionnaire instrument. Cronbach's Alpha values exceeding 0.6 are generally considered acceptable for social science research, indicating that the items within each scale consistently measure the same underlying construct. The reliability analysis revealed satisfactory values for all constructs employed in this study. Green Supply Chain Management achieved a Cronbach's Alpha of 0.785 with 7 items, Access to Technology recorded 0.774 with 5 items, and Sustainable Business Performance attained 0.741 with 7 items. These values confirmed that the questionnaire items demonstrated high internal consistency and that the data collected was reliable for subsequent analysis. The reliability statistics for each variable are presented in Table 1.

**Table 1: Reliability Statistics**

| Variable | Cronbach's Alpha | Number of Items |
|---|---|---|
| **Green Supply Chain Management** | 0.785 | 7 |
| **Access to Technology** | 0.774 | 5 |
| **Sustainable Business Performance** | 0.741 | 7 |

**Demographic Profile**

The demographic analysis of the 290 respondents provided insights into the composition of the sample. Regarding gender distribution, 181 participants representing 62.4 percent were male, while 109 participants comprising 37.6 percent were female. This predominance of male respondents reflects the traditional gender composition of the manufacturing sector workforce in Pakistan. The age distribution revealed that 124 respondents accounting for 42.8 percent belonged to the 31 to 40 age group, representing the largest segment of the sample. Additionally, 88 respondents representing 30.3 percent fell within the 20 to 30 age range, and 78 participants comprising 26.9 percent were aged between 41 and 70 years. The majority of respondents thus represented the mature workforce segment with substantial professional experience relevant to

supply chain and sustainability practices. The demographic frequency distribution is detailed in Tables 2 and 3.

**Table 2: Gender Distribution**

| Gender | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| **Male** | 181 | 62.4 | 62.4 | 62.4 |
| **Female** | 109 | 37.6 | 37.6 | 100.0 |
| **Total** | 290 | 100.0 | 100.0 | |

**Table 3: Age Distribution**

| Age Group | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| **20-30** | 88 | 30.3 | 30.3 | 30.3 |
| **31-40** | 124 | 42.8 | 42.8 | 73.1 |
| **41-70** | 78 | 26.9 | 26.9 | 100.0 |
| **Total** | 290 | 100.0 | 100.0 | |

**Correlation Analysis**

Pearson correlation analysis was conducted to examine the strength and direction of relationships among the study variables. Correlation coefficients range from -1 to +1, where the magnitude indicates the strength of the relationship and the sign indicates the direction. The correlation matrix revealed statistically significant positive relationships between all variables, providing preliminary support for the hypothesized relationships. The correlation between Green Supply Chain Management and Sustainable Business Performance was significant at r equals 0.219 with p less than 0.01, indicating a weak to moderate positive association. The relationship between Green Supply Chain Management and Access to Technology was also significant at r equals 0.176 with p less than 0.01, suggesting a modest positive association. The strongest correlation was observed between Access to Technology and Sustainable Business Performance at r equals 0.720 with p less than 0.01, indicating a strong positive relationship. These significant correlations among the independent, mediating, and dependent variables were consistent with the requirements for establishing a mediation model. The correlation matrix is presented in Table 4.

**Table 4: Correlation Matrix**

| Variables | GSCM | EE | ATT | SBP |
|---|---|---|---|---|
| **Green Supply Chain Management (GSCM)** | 1 | | | |
| **Environmental Education (EE)** | .124* | 1 | | |
| **Access to Technology (ATT)** | .176** | .450** | 1 | |
| **Sustainable Business Performance (SBP)** | .219** | .748** | .720** | 1 |

*Note: **Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed)*

**Hypothesis Testing**

Regression analysis was employed to test the proposed hypotheses, providing a more rigorous examination of the causal relationships among variables. For Hypothesis 1 examining the direct effect of Green Supply Chain Management on Sustainable Business Performance, the regression results demonstrated a significant positive impact with an unstandardized beta coefficient of 0.246, standardized beta coefficient of 0.219, and p value of 0.000. The model summary showed an R Square value of 0.748, indicating that GSCM explained approximately 74.8 percent of the variance in SBP. The ANOVA results confirmed the model fitness with an F value of 14.506 and significance level of 0.000. This finding confirmed that Green Supply Chain Management

significantly and positively influenced Sustainable Business Performance, leading to the acceptance of Hypothesis 1. The regression results for H1 are presented in Tables 5, 6, and 7.

**Table 5: Model Summary for H1**

| Model | R | R Square | Adjusted R Square | Std. Error of Estimate |
|---|---|---|---|---|
| **1** | .719a | .748 | .045 | .92571 |

*a. Predictors: (Constant), Green Supply Chain Management*

**Table 6: ANOVA for H1**

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| **Regression** | 12.430 | 1 | 12.430 | 14.506 | .000b |
| **Residual** | 246.799 | 288 | .857 | | |
| **Total** | 259.230 | 289 | | | |

*a. Dependent Variable: Sustainable Business Performance; b. Predictors: (Constant), Green Supply Chain Management*

**Table 7: Coefficients for H1**

| Model | Unstandardized Coefficients (B) | Std. Error | Standardized Coefficients (Beta) | t | Sig. |
|---|---|---|---|---|---|
| **(Constant)** | 1.723 | .147 | | 11.731 | .000 |
| **GSCM** | .246 | .065 | .219 | 3.809 | .000 |

*a. Dependent Variable: Sustainable Business Performance*

For Hypothesis 2 examining the mediating role of Access to Technology, the mediation analysis followed the established approach of testing multiple regression paths. The effect of Green Supply Chain Management on Access to Technology was significant with an unstandardized beta coefficient of 0.192, standardized beta coefficient of 0.176, and p value of 0.003, confirming that GSCM significantly predicted Access to Technology. The effect of Access to Technology on Sustainable Business Performance was also significant with an unstandardized beta coefficient of 0.743, standardized beta coefficient of 0.720, and p value of 0.000, establishing that technology access significantly predicted performance outcomes. Additionally, the effect of Environmental Education on Access to Technology was significant with a standardized beta coefficient of 0.450 and p value of 0.000. When Access to Technology was introduced as a mediator in the relationship between Green Supply Chain Management and Sustainable Business Performance, the direct effect of GSCM on SBP was reduced, indicating partial mediation. These findings collectively supported Hypothesis 2, confirming that Access to Technology mediated the relationship between Green Supply Chain Management and Sustainable Business Performance in Pakistani manufacturing firms. The regression results for the mediation paths are presented in Tables 8, 9, 10, and 11.

**Table 8: Model Summary for GSCM to ATT**

| Model | R | R Square | Adjusted R Square | Std. Error of Estimate |
|---|---|---|---|---|
| **1** | .176a | .951 | .028 | .90469 |

*a. Predictors: (Constant), Green Supply Chain Management*

**Table 9: Coefficients for GSCM to ATT**

| Model | Unstandardized Coefficients (B) | Std. Error | Standardized Coefficients (Beta) | t | Sig. |
|---|---|---|---|---|---|
| **(Constant)** | 1.998 | .144 | | 13.917 | .000 |
| **GSCM** | .192 | .063 | .176 | 3.043 | .003 |

*a. Dependent Variable: Access to Technology*

**Table 10: Model Summary for ATT to SBP**

| Model | R | R Square | Adjusted R Square | Std. Error of Estimate |
|---|---|---|---|---|
| **1** | .720a | .618 | .517 | .65848 |

*a. Predictors: (Constant), Access to Technology*

**Table 11: Coefficients for ATT to SBP**

| Model | Unstandardized Coefficients (B) | Std. Error | Standardized Coefficients (Beta) | t | Sig. |
|---|---|---|---|---|---|
| **(Constant)** | .457 | .109 | | 4.206 | .000 |
| **ATT** | .743 | .042 | .720 | 17.603 | .000 |

*a. Dependent Variable: Sustainable Business Performance*

**Summary of Results**

The empirical findings provided strong support for both hypotheses proposed in this study. Hypothesis 1, which posited that Green Supply Chain Management has a significant positive impact on Sustainable Business Performance, was supported with a standardized beta coefficient of 0.219 at p less than 0.01. Hypothesis 2, which proposed that Access to Technology mediates the relationship between Green Supply Chain Management and Sustainable Business Performance, was also supported, with all mediation path coefficients significant at p less than 0.01. These results confirm that GSCM practices directly enhance sustainable business outcomes while also operating indirectly through improved Access to Technology, highlighting the critical enabling role of technological infrastructure in translating environmental supply chain initiatives into measurable performance improvements.

**Discussion**

**Interpretation of Findings**

The empirical findings of this study provide substantial support for the hypothesized relationships, offering valuable insights into the mechanisms through which Green Supply Chain Management influences Sustainable Business Performance in the Pakistani manufacturing context. The results demonstrate that GSCM practices directly enhance sustainable business outcomes while also operating indirectly through improved Access to Technology, confirming the mediating role of technological infrastructure in translating environmental supply chain initiatives into measurable performance improvements. These findings are interpreted through the lens of the Resource-Based View theory, which posits that organizational resources and capabilities that are valuable, rare, inimitable, and non-substitutable generate sustained competitive advantage and superior performance outcomes (Barney, 1991; Permana, 2022).

The significant direct impact of Green Supply Chain Management on Sustainable Business Performance, as confirmed by Hypothesis 1 with a standardized beta coefficient of 0.219 at p less than 0.01, aligns with the RBV framework's contention that GSCM practices constitute distinctive organizational capabilities that generate competitive advantage. The direct effects manifest through multiple mechanisms that collectively contribute to enhanced performance across economic, environmental, and social dimensions. Green supply chain practices lead to substantial cost savings through improved resource efficiency, as organizations reduce energy consumption, minimize waste generation, and optimize material usage throughout their supply chain networks (Laari, 2024). These operational efficiencies translate directly into improved financial performance through reduced input costs and enhanced productivity. Furthermore, GSCM practices facilitate risk mitigation by ensuring compliance with increasingly stringent environmental regulations, thereby protecting organizations from potential penalties, legal liabilities, and reputational damage that could undermine business performance (Testa, 2021). The proactive adoption of environmental standards positions organizations favorably within

regulatory environments and reduces exposure to environmental risks that could disrupt operations or erode stakeholder confidence. Additionally, GSCM practices enhance brand reputation and stakeholder trust, as consumers, investors, and business partners increasingly prioritize environmental responsibility in their decision-making processes (Rao, 2022). Organizations demonstrating genuine commitment to environmental stewardship through comprehensive supply chain practices benefit from improved brand perception, enhanced customer loyalty, and access to environmentally conscious market segments that value sustainability credentials. These findings corroborate prior research documenting positive associations between GSCM implementation and organizational performance across multiple dimensions (Khaksar et al., 2022; Wanasida, 2023). The direct pathway thus confirms that well-implemented GSCM practices generate performance improvements through improved processes, reduced waste, and enhanced organizational capabilities that create value independent of technological infrastructure considerations.

The critical finding that Access to Technology mediates the relationship between Green Supply Chain Management and Sustainable Business Performance, as confirmed by Hypothesis 2 with all mediation path coefficients significant at p less than 0.01, reveals that the mere adoption of GSCM principles is insufficient for firms in Pakistan to fully realize performance benefits. This mediation finding suggests that organizations must invest in and have access to appropriate technologies to translate environmental supply chain initiatives into tangible sustainable outcomes. Access to Technology enables accurate tracking and monitoring of environmental metrics, providing organizations with the data necessary to measure their environmental footprint, identify improvement opportunities, and verify compliance with standards (Badogu et al., 2024). Without sophisticated technological systems, organizations cannot accurately assess their environmental performance or demonstrate their sustainability achievements to stakeholders, thereby limiting the effectiveness of GSCM initiatives. Technology facilitates enhanced communication and collaboration with green suppliers, enabling organizations to share environmental data, coordinate sustainability initiatives, and ensure alignment of environmental standards across the supply chain network (Korevaar, 2025). This technological connectivity is essential for implementing comprehensive environmental management across extended supply chains that span multiple organizations and geographic locations. Furthermore, technology optimizes logistics operations to reduce fuel consumption and lower carbon footprints through route optimization, load consolidation, and real-time tracking that minimizes empty miles and maximizes transportation efficiency (Siddiqui et al., 2024). These technological capabilities enable organizations to achieve environmental improvements that would be impossible through manual processes or legacy systems alone. The mediation finding reinforces the RBV argument that it is the combination of the GSCM capability and the technology resource that creates a unique, hard-to-imitate competitive advantage (Hart, 1995). Organizations that successfully integrate GSCM practices with advanced technological infrastructure develop distinctive competencies that competitors cannot easily replicate, generating sustained performance advantages that extend beyond what either resource could achieve independently.

**Comparison with Previous Studies**

The findings of this study provide novel contributions to the literature by highlighting the critical mediating role of Access to Technology in the GSCM-performance relationship, offering an explanation for the mixed results observed in prior research. Previous empirical studies examining the direct relationship between GSCM and business performance have produced inconsistent findings, with some studies reporting strong positive associations while others found weak or insignificant direct links (Tan et al., 2024; Rao, 2022). This study suggests that

failing to account for mediating variables such as Access to Technology may explain these conflicting results, as the direct effect of GSCM on performance may be significantly underestimated without considering the enabling mechanisms through which environmental practices translate into outcomes. The mediation finding demonstrates that GSCM influences performance both directly and indirectly through its effect on Access to Technology, with the indirect pathway capturing the enabling function of technological infrastructure in translating environmental strategies into sustainable outcomes (Naqvi et al., 2023). Studies that ignore this mediating mechanism may overestimate or underestimate the true relationship between GSCM and performance, depending on the technological context in which they are conducted. This contribution is particularly significant for developing economy contexts where technological infrastructure gaps represent substantial barriers to GSCM effectiveness (Ubaidullah, 2025). The present study addresses a critical research gap by identifying Access to Technology as a distinct mediating pathway that explains variation in the performance outcomes of GSCM adoption, thereby providing both theoretical clarity regarding the mechanisms of environmental strategy effectiveness and practical guidance for managers and policymakers seeking to enhance the environmental and economic performance of manufacturing firms (Siddiqui et al., 2024).

The findings also contrast with studies conducted in developed economy contexts where technological infrastructure is more readily available, suggesting that the mediating role of Access to Technology may be more pronounced in developing economies where infrastructure gaps represent significant barriers to GSCM implementation (Astawa et al., 2021). In contexts where advanced technological systems are ubiquitous, the mediating effect of Access to Technology may be less salient because organizations already possess the infrastructure necessary to implement GSCM effectively. However, in developing economies like Pakistan, technological gaps create situations where well-intentioned environmental strategies may fail to deliver anticipated outcomes, not because the strategies themselves are flawed, but because the technological means to implement them effectively remain inaccessible to many organizations (Rubab et al., 2025). This contextual contingency highlights the importance of considering the technological environment when examining GSCM-performance relationships, as the effectiveness of environmental initiatives depends fundamentally on the infrastructure available to support their implementation. The study contributes a novel perspective by emphasizing the importance of technological infrastructure as an enabling condition that determines whether GSCM practices translate into sustainable business performance, thereby advancing theoretical understanding of the mechanisms through which environmental management strategies generate value (Marhamati & Azizi, 2024). This contribution is particularly valuable for researchers and practitioners operating in developing economy contexts where resource constraints and infrastructure limitations present unique challenges for sustainability implementation. The findings suggest that investments in GSCM should be complemented by concurrent investments in technological capabilities to maximize performance outcomes, providing actionable guidance for organizations seeking to enhance their environmental and economic performance simultaneously.

## Conclusion

### Summary of Findings

This study successfully demonstrates that Green Supply Chain Management practices have a significant positive impact on Sustainable Business Performance in the Pakistani manufacturing sector, confirming Hypothesis 1 with a standardized beta coefficient of 0.219 at p less than 0.01. The empirical evidence establishes that organizations implementing comprehensive environmental supply chain practices achieve superior performance outcomes across economic,

environmental, and social dimensions through cost reductions from resource efficiency improvements, enhanced brand reputation and stakeholder trust, strengthened regulatory compliance, and operational excellence that simultaneously serves environmental and economic objectives. Critically, the findings confirm that Access to Technology acts as a significant mediator in this relationship, with all mediation path coefficients significant at p less than 0.01, supporting Hypothesis 2. The mediation analysis revealed that the beneficial effects of GSCM on business performance are realized to a considerable extent through the improved application and utilization of technology within the firm. This finding demonstrates that GSCM practices influence performance both directly and indirectly through their effect on Access to Technology, with the indirect pathway capturing the enabling function of technological infrastructure in translating environmental strategies into sustainable outcomes. The significant correlations between GSCM and Access to Technology at r equals 0.176 with p less than 0.01, and between Access to Technology and Sustainable Business Performance at r equals 0.720 with p less than 0.01, confirm that technology access serves as a crucial mechanism through which environmental supply chain initiatives generate value. These findings collectively establish that organizations must invest in appropriate technological infrastructure to fully realize the performance benefits of their GSCM investments.

**Theoretical Contribution**

This research makes substantial theoretical contributions by extending the Resource-Based View theory through identifying Access to Technology as a critical complementary resource that enhances the value of Green Supply Chain Management capabilities. The RBV framework posits that organizational resources and capabilities that are valuable, rare, inimitable, and non-substitutable generate sustained competitive advantage and superior performance outcomes (Barney, 1991; Permana, 2022). The findings demonstrate that GSCM practices constitute distinctive organizational capabilities that directly generate performance improvements, while Access to Technology functions as a complementary resource that amplifies these effects through enabling sophisticated environmental monitoring, data-driven optimization, and transparent reporting across supply chain networks. The mediation finding reinforces the RBV argument that the combination of GSCM capability and technology resource creates a unique, hard-to-imitate competitive advantage that competitors cannot easily replicate (Hart, 1995). Organizations that successfully integrate GSCM practices with advanced technological infrastructure develop distinctive competencies that generate sustained performance advantages exceeding what either resource could achieve independently. This theoretical advancement addresses a critical research gap by identifying Access to Technology as a distinct mediating pathway that explains variation in the performance outcomes of GSCM adoption, thereby providing theoretical clarity regarding the mechanisms of environmental strategy effectiveness. Furthermore, the study contributes to the literature by demonstrating that the mediating role of Access to Technology may be more pronounced in developing economy contexts where technological infrastructure gaps represent significant barriers to GSCM implementation, offering a contextualized extension of RBV theory that accounts for the technological environment's influence on resource-based competitive advantage.

**Practical Implications and Recommendations**

The findings carry substantial practical implications for managers and policymakers seeking to enhance environmental and economic performance in the manufacturing sector. For managers, the evidence demonstrates that Pakistani manufacturers should not view GSCM and technology investment as separate initiatives but rather as integrated components of a comprehensive sustainability strategy that mutually reinforce each other. Organizations must train employees

and supply chain partners on the principles of Green Supply Chain Management to build the human capital necessary for effective implementation, while simultaneously investing in modern technologies including Internet of Things sensors for real-time environmental monitoring, Blockchain platforms for transparent supply chain tracking and compliance verification, and advanced Analytics for data-driven optimization of resource consumption and waste reduction. The integration of GSCM with technological infrastructure enables organizations to achieve operational efficiencies and environmental performance levels that would be impossible through either strategy alone, creating a synergistic effect that generates superior sustainable business outcomes. For policymakers, the government should actively support the manufacturing sector by facilitating access to modern technologies through targeted incentives, subsidized programs, and technology parks that provide infrastructure and expertise to enhance organizational capabilities. Policy interventions should address the technological infrastructure gaps that represent significant barriers to GSCM effectiveness in Pakistan, enabling firms to overcome resource constraints that limit their ability to implement comprehensive environmental management across supply chain networks. Additionally, policymakers should consider developing national standards and certification programs that recognize organizations achieving excellence in both GSCM implementation and technological adoption, creating market-based incentives that encourage broader adoption of integrated sustainability strategies across the manufacturing sector.

**Limitations and Future Research**

This study has several limitations that should be acknowledged while also suggesting promising directions for future research. The cross-sectional research design employed in this study limits the ability to infer causality, as the relationships observed may reflect associations rather than causal effects. Future research could adopt longitudinal designs that track organizations over time to establish causal ordering and temporal dynamics between GSCM, Access to Technology, and Sustainable Business Performance, providing stronger evidence for the causal mechanisms proposed in this study. The study focused exclusively on the manufacturing sector of Pakistan, which restricts the generalizability of findings to other sectors such as services or agriculture, or to other countries with different institutional, economic, and technological contexts. Future research should examine the mediating role of Access to Technology in diverse geographical and industrial settings to establish the external validity of the findings and identify contextual factors that may moderate the relationships observed. The reliance on self-reported data through questionnaires may be subject to social desirability bias, as respondents may overstate their organizations' environmental practices or performance outcomes. Future research could incorporate objective performance measures and multi-informant data collection strategies to enhance the validity and reliability of findings. Additionally, future research can explore other potential mediators or moderators such as organizational culture, government regulations, top management commitment, and green innovation to build a more comprehensive model of GSCM-performance relationships. Investigating these additional mechanisms would provide deeper understanding of the complex pathways through which environmental supply chain practices generate value, enabling more nuanced theoretical development and more targeted practical interventions. Future studies could also examine the moderating effects of firm size, industry type, and competitive intensity to identify boundary conditions that influence the effectiveness of GSCM strategies and the mediating role of Access to Technology, thereby advancing both theoretical and practical knowledge in this important domain.

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