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Environmental effect for a complex green supply chain management to control waste: a sustainable approach

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ABSTRACT

Organizations are compelled to implement corporate environmental practices like green innovation and supply chain management (GSCM) due to the public's growing awareness of the issue. As a result, professional improvement in these organizations' environmental performance necessitates both practices. However, little research has been done on the connection between GSCM, green innovation, and environmental performance. As a result, the goal of this study is to empirically demonstrate that green innovation practices and GSCM significantly improve environmental performance and encourage businesses to implement these practices. In addition, this study investigates the connection between green innovation practices and GSCM, as well as the impact of these practices on the environmental performance of 123 ISO 14001-certified manufacturing organizations. According to the findings of PLS-SEM, there is a significant and favorable connection between environmental performance, green innovation, and GSCM. Furthermore, environmental performance benefited from green innovation. Green innovation also served as a mediator between environmental performance and GSCM. As analyzed, the findings of this study unveiled a positive and substantial impact of GSCM, Green Innovation, on environmental performance. Waste management policy and strategy components have a lesser effect on EP and need to be investigated more. As a result, the current study demonstrated that GSCM significantly impacts healthcare organizations' green innovation, which ultimately benefits the environment. To put it succinctly, the findings of this study provide a deeper comprehension of the significant role that green innovation plays in the hospital sector when it comes to enhancing the environmental performance of their GSCM and organizations as a whole.

Keywords: Environmental Performance, Green Supply Chain Management, Green Innovation, Environmental, Waste Management.

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Environmental effect for a complex green supply chain management to control waste: a sustainable approach

1. Introduction

1.1 Background of the Study

Green Supply Chain Management (GSCM) is an approach to designing and/or redesigning the supply chain (SC) to incorporate practices that enhance long-term business performance while minimizing environmental impact. This approach extends not only throughout the entire supply chain but also across the entire life cycle of a product (Baloch & Rashid, 2022; Green et al., 2008; Rashid, 2016). According to Vachon and Klassen (2007) and Rashid and Amirah (2017), public awareness of environmental issues and global warming has significantly increased over the past two decades. As a result, businesses are now expected to address concerns regarding the environmental sustainability of their manufacturing processes, carbon footprint, and recycling practices for finished goods after use. Consequently, companies in both the manufacturing and service sectors must consider how their environmental strategies influence both environmental and business performance. Rashid et al. (2019) and Flint et al. (2020) emphasize that success at the supply chain level translates into success at the organizational level. Given the rising demand from customers and government agencies for environmentally responsible processes, products, and services, managers must identify and implement sustainable practices throughout the supply chain. With increasing global focus on environmental issues, consumer purchasing behavior is shifting, as more customers are willing to pay a premium for eco-friendly products. Stakeholder pressure has become a key driver in business decision-making, further underscoring the necessity of GSCM practices. The performance of a supply chain can be evaluated based on several factors, including cost, quality, lead time, and customer service. Additionally, compliance with environmental regulations such as the Kyoto Protocol, corporate social responsibility initiatives, and government policies has made environmental strategy development a growing priority for organizations. Performance, in this context, can be defined as the completion of tasks in accordance with predetermined standards of accuracy, completeness, cost, and speed.

1.2 Problem Statement

Supply chain performance measurement is a formal, ongoing, and systematic process used to determine whether achievements align with or deviate from pre-established standards. However, research on GSCM in the healthcare sector remains limited. As environmental sustainability becomes a top priority, industries must adopt strategies to reduce pollution and minimize their carbon footprint. Enhancing environmental consciousness is crucial not only for reducing pollution but also for lowering associated costs. Growing awareness of environmental issues has recently drawn significant attention from researchers, prompting increased focus on GSCM across various fields and disciplines (Rashid et al., 2020). Khan et al. (2017) emphasized the importance of understanding GSCM to develop a robust framework that supports green logistics worldwide. However, the adoption of green practices in healthcare supply chain management is still in its early stages, necessitating further research to address existing gaps in the literature. Implementing GSCM in healthcare presents complex challenges, requiring innovative solutions to improve efficiency and sustainability. Green Healthcare Supply Chain Management (GHSCM) offers potential solutions to enhance service delivery within the healthcare sector. Furthermore, green practices in supply chain management (SCM) are often overlooked, particularly when dealing with perishable products. Reuse, recovery, and recycling practices must be integrated into healthcare SCM to maximize sustainability efforts (Hashmi & Mohd, 2020; Hashmi 2020a, b).

This study also contributes to innovation efforts that can enhance green initiatives within organizations. It provides a comprehensive evaluation of green innovation in different stages of the supply chain, including green process innovation and green managerial innovation. Green marketing innovation has been less emphasized in previous studies, leading to a lack of definitive metrics for its implementation in hospital operations (Hashmi et al., 2021a, b). The methodology for this study is adapted from previous research on marketing innovation and green marketing to assess green innovations within the framework of green process innovation and green managerial innovation. Specifically, this study aims to explore the mediating role of green innovation between GSCMP and environmental performance. Additionally, it examines the interconnections among environmental performance, green innovation practices, and GSCMP (Rashid et al., 2022a, b). Furthermore, this study investigates the relationship between green innovation, environmental performance, waste management policies and strategies, and GSCMP. The research concludes with an analysis of the findings, highlighting the impact of GSCMP, green innovation, and waste management on environmental performance (Rashid & Rasheed, 2022).

To identify gaps in the literature, we categorized the relevant studies into two sections:

a) Research on supply chain management (SCM) of fresh produce.

b) Research on sustainability in supply chains.

1.3 Objectives

The objectives of this study are as follows:

a) To identify the various Green Supply Chain Management (GSCM) practices currently implemented in private and government hospitals in Pakistan.

b) To evaluate the performance of hospitals in Pakistan with respect to Green Supply Chain Management.

c) To examine the challenges faced by hospitals in Pakistan in implementing GSCM practices and their impact on environmental performance.

The findings of this study contribute to the existing academic research on GSCM by identifying research gaps that can guide future studies. Academics will benefit from these insights, which may enhance their understanding and encourage further exploration in this field.

1.4 Value

The findings of this study offer valuable insights to hospital management and employees in the healthcare sector. By understanding how to effectively adopt and manage GSCM practices, organizations can improve their overall performance, enhance their competitiveness in the health sector, and positively impact environmental sustainability. Policymakers, particularly those in government ministries and agencies responsible for environmental regulations, can use this study to develop targeted policies and programs that foster the sustainable growth of the healthcare sector. Additionally, the study provides insights that support the formulation and implementation of appropriate regulations and guidelines for GSCM adoption in hospitals. Furthermore, individuals and organizations looking to establish hospitals can benefit from understanding the advantages of implementing GSCM practices, ensuring both environmental sustainability and operational efficiency.

1.5 Definition of Terms

1.5.1 Environmental performance (EP)

Environmental Performance refers to an organization's effectiveness in managing and reducing its environmental impacts, encompassing metrics such as emissions, resource consumption, and waste generation (Hashmi, 2022; Seman, 2012).

1.5.2 Green supply chain management (GSCM)

Green Supply Chain Management involves integrating environmental considerations into supply chain operations, including product design, material sourcing, manufacturing processes, delivery, and end-of-life management, to minimize ecological footprints (Lerman et al., 2022).

1.5.3 Green innovation (GI)

Green Innovation pertains to the development and implementation of new or improved products, processes, or practices that result in environmental benefits, such as reducing pollution, conserving resources, or enhancing energy efficiency (Chen et al., 2022).

1.5.4 Environmental

In organizational contexts, "environmental" relates to factors or initiatives aimed at protecting or improving the natural environment, including efforts to reduce pollution, conserve resources, and promote sustainability (Azevedo et al., 2012).

1.5.5 Waste management

Waste Management encompasses the collection, transportation, processing, recycling, and disposal of waste materials, aiming to reduce environmental impact, promote resource recovery, and ensure public health and safety (Kumar et al., 2022).

2. Literature Review

2.1 Green Supply Chain Management (GSCM)

Green Supply Chain Management (GSCM) refers to the practice of minimizing environmental impact throughout the production process of the final product in manufacturing and service organizations (Jabbour & de Sousa, 2016; Teixeira et al., 2016; Sharma et al., 2017). GSCM plays a critical role in enhancing sustainability by addressing environmental concerns across supply chain operations. Research on GSCM encompasses various topics, including organizational implementation and GSCM best practices (Xing et al., 2016; Laari et al., 2017; Scur & Barbosa, 2017; Sharma et al., 2017). Despite the growing body of literature on GSCM, some aspects remain inconclusive due to the relatively recent development of green supply chain theories. Researchers continue to refine theoretical frameworks to facilitate the successful adoption of GSCM practices (Kusi-Sarpong et al., 2016). The primary objective of GSCM is to mitigate negative environmental impacts, such as pollution, unsustainable resource consumption, and improper product disposal (Hervani et al., 2005; Kuei et al., 2015; Laari et al., 2016; Rasheed & Rashid, 2023; Sharma et al., 2017). Srivastava (2007) highlights that discussions on the GSCM concept date back to the supply chain revolution of the 1990s and the quality management revolution of the 1980s. GSCM integrates green purchasing, reverse logistics, and supply chain processes involving suppliers, manufacturers, and consumers. These processes encompass both forward and reverse supply chain operations, often referred to as "closing the loop," which helps mitigate environmental degradation.

Weraikat et al. (2019) notes that beyond its environmental benefits, GSCM positively impacts business operations by improving profitability. Various empirical studies have examined GSCM adoption, including internal environmental management, green purchasing, customer environmental cooperation, and reverse logistics (Eltayeb et al., 2011; Rasheed et al., 2023). GSCM practices enable organizations to address growing environmental pressures from governments, consumers, and other stakeholders. Moreover, GSCM encourages green innovation, which can enhance overall organizational performance. However, empirical evidence on the direct relationship between green innovation and GSCM remains limited. To effectively meet stakeholder expectations and drive sustainability, continuous innovation in green supply chain practices is essential (Pidcoke et al., 2020; Rashid & Rasheed, 2023).

2.2 Sustainable Supply Chain Management (SCM)

Sustainable SCM aims to address various challenges by incorporating mathematical models to evaluate supply chain sustainability (Ahi & Searcy, 2015; Hashmi, 2023; Rashid et al., 2023). Enhancing sustainable SCM involves identifying key aspects and criteria for supplier prioritization through innovative hierarchical decision-making processes (Su et al., 2016). Hussain et al. (2016) proposed an integrated approach for evaluating alternatives in efficient SCM, utilizing interpretive structural modeling and analytical network processes. Similarly, Dubey et al. (2017) emphasized the significance of interpretive structural modeling in sustainable SCM. Saxena et al. (2017) explored the dynamics of sustainable SCM, focusing on drivers and alternative solutions for sustainability challenges. The study suggested using fully interpretable structural modeling and mutual influence matrix multiplication for analytical testing. However, corruption factors were not considered in the proposed model. Genovese et al. (2017) examined green supply chain integration for manufacturing new products and reusing returnable goods, particularly in scenarios where sellers offer deferred payment options to buyers.

Eskandari-Khanghahi et al. (2018) analyzed sustainability-related challenges in blood SCM by developing a mixed-integer multi-objective mathematical model aimed at reducing overall costs and environmental impacts. Additionally, the authors introduced an optimization model for Green Blood SCM to address uncertainties during and after disasters (Rasheed & Rashid, 2024a; 2024b). Sauer and Seuring (2018) designed a three-dimensional framework for managing multi-tier sustainable SCM, presenting a conceptual study to improve performance by considering multi-layer SCM properties under uncertainty. Modak et al. (2018) examined supply chain models between manufacturers and retailers, incorporating greenhouse gas emission costs throughout the manufacturing cycle. Their study recommended strategies for managers to mitigate emissions, including price adjustments and operational modifications. Nouri et al. (2019) conducted a real-world case study, formulating a mathematical model to minimize product expiration. Their proposed strategy demonstrated a reduction in drug waste while enhancing manufacturers' reputations in the industry. Tiwari et al. (2019) addressed green inventory models, incorporating carbon pollution costs and scenarios with varying late payment allowances. Sarkar et al. (2019) studied intelligent production systems managing carbon footprints and optimizing the net present value of commodities across four interconnected logistics subsystems. Bhattacharyya and Sana (2019) developed a mathematical model for green manufacturing industries, constructing a demand-profit function based on service levels and random variables while implementing green technologies to reduce greenhouse gas emissions (Rashid & Rasheed, 2024).

Taleizadeh et al. (2019) formulated two economic production quantity (EPQ) models for single-machine, multi-product systems, considering imperfect goods. Their study proposed two approaches for defective products: discount sales and post-processing methods. In a subsequent study, Taleizadeh et al. (2020) developed a two-tier green supply chain model between manufacturers and retailers, optimizing pricing and manufacturing strategies. Saxena et al. (2017) explored policies for minimizing lead time, identifying optimal conditions for its reduction. This study primarily focuses on optimizing blood service site allocation to improve supply chain transportation efficiency (Rashid et al., 2024a). Given that platelets, the blood component with the highest mortality rate, are the central concern, the study also assesses the impact of CO_2 emissions from transportation activities across SCM nodes. A comprehensive Healthcare SCM (HSCM) model is developed to account for platelet aging rates and transport distances, ensuring carbon emission efficiency. The study further determines optimal facility site allocations to minimize economic and environmental impacts. The proposed model is solved using the ε-constraint method (Rashid et al., 2024b). Table 1 below presents a comparison of existing and proposed studies, highlighting the contributions of the current research. By integrating economic and environmental considerations, implementing the ε-constraint approach, and applying it to real-world scenarios, this study verifies the effectiveness of the formulated model.

2.3 Green Innovation

The implementation of green innovation has led to significant improvements in organizations' environmental performance. Green innovation, also known as revolutionary environmental innovation, encompasses sustainable practices, processes, managerial strategies, and marketing approaches (Tseng et al., 2013; Cuerva et al., 2014; Lin et al., 2014; Zailani et al., 2015). Green innovation is a crucial corporate environmental management concept that manufacturing companies adopt to enhance sustainability (Zailani et al., 2015). It shares many similarities with the Green Supply Chain Management (GSCM) approach and contributes to improved environmental management in alignment with regulatory requirements (Rashid et al., 2024c; Su et al., 2006). Additionally, green innovation not only reduces production costs but also enhances resource efficiency, product quality, and consistency (Pidcoke et al., 2020; Rashid et al., 2024d; Su et al., 2006). In the context of competitive and dynamic markets, green innovation is essential for effective supply chain management (SCM), particularly in response to emerging environmental challenges and increasing pressure from competitors, consumers, and regulators (Chen, 2008; Pidcoke et al., 2020). Both internal and external GSCM practices can trigger green innovation, requiring strong managerial commitment (Rashid et al., 2024e; Zailani et al., 2015). Effective internal management enables organizations to mobilize resources for adopting new technologies and acquiring relevant knowledge (Eltayeb et al., 2011). Green innovation is typically evident in process, product, and marketing enhancements, which contribute to product differentiation and successful GSCM implementation (Rashid et al., 2024f).

2.4 Waste Management

Waste management plays a critical role in minimizing general and hazardous waste, improving environmental performance through lean methods. Since GSCM focuses on reducing waste linked to environmental sustainability, its implementation can lead to cost savings and improved organizational performance (Rao, 2002). Rao (2002) demonstrated a strong link between GSCM practices and economic performance, finding that GSCM enhances competitiveness. Klassen and McLaughlin (1996) examined how organizations' announcements of environmental awards impact stock prices. Their study found that the market values such recognition, leading to higher stock valuations. Furthermore, the cost-saving nature of environmental performance results in improved economic outcomes by reducing expenses related to raw materials, energy consumption, waste treatment, and regulatory penalties. Environmental performance improvements also stem from organizations' ability to minimize air emissions, solid waste, and hazardous material consumption (Rao, 2002). Adopting GSCM practices across industries establishes a strong correlation between waste management strategies and overall organizational performance.

2.5 Environmental Performance

Environmental performance measures the positive effects of GSCM and green innovation on the natural environment (Jabbour & de Sousa Jabbour, 2016; Luthra et al., 2016; Sharma et al., 2017; Sharma & Vredenburg, 1998). These practices influence both internal and external environmental outcomes for organizations (Eltayeb et al., 2011; Rashid et al., 2024g). Green innovation and environmental management strategies, such as GSCM, have a significant potential to enhance the environmental performance of industries, including healthcare. By implementing sustainable practices, businesses can improve their resilience, achieve cost reductions, comply with regulatory requirements, and explore new market opportunities. Sustainability-driven organizations are more adaptable to changing environmental conditions, ensuring long-term economic success (Albhirat et al., 2024). Environmental management systems (EMS) play a crucial role in monitoring and improving environmental performance through key performance indicators (KPIs) and audits (Dubey et al, 2017). However, many businesses are reluctant to disclose environmental performance data. Additionally, standardized reporting metrics remain unclear, making cross-comparisons of facilities, businesses, products, services, and even nations challenging. This study highlights the relationship between GSCM, green innovation, waste management, and environmental performance. The findings indicate that GSCM implementation significantly enhances environmental outcomes. However, due to the lack of consistent reporting methodologies, evaluating and benchmarking environmental performance remains a complex task.

2.6 Research Framework & Hypotheses Development

Below figure 1 represent the conceptual framework.

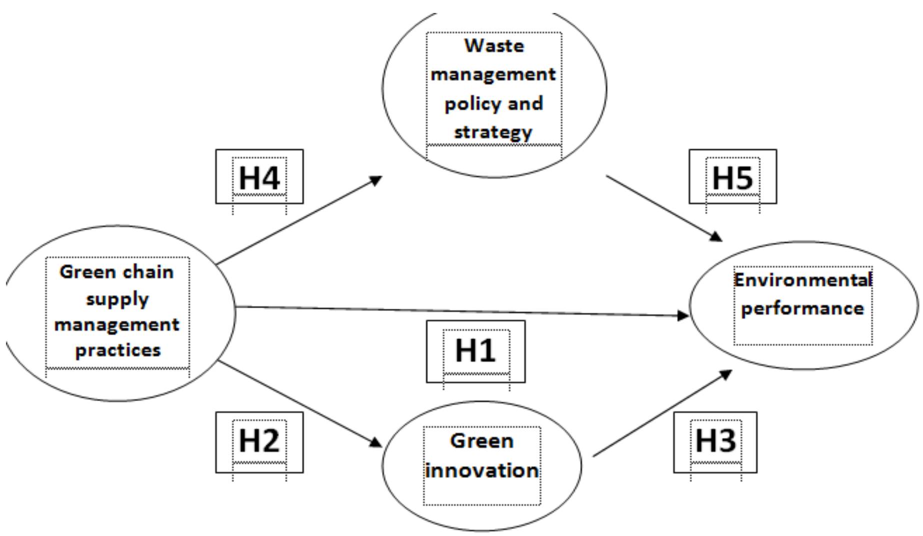


Figure 1: Conceptual Framework

2.7 GSCM and Environmental Performance

The relationship between environmental performance and Green Supply Chain Management (GSCM) practices has been widely studied (Ninlawan et al., 2010). However, the literature also contains studies that question the strength of this connection (Eltayeb et al., 2011). Consequently, whether GSCM practices positively or negatively impact environmental performance remains a subject of debate. To enhance environmental performance, organizations are encouraged to strengthen and maintain their relationships with suppliers and customers by implementing GSCM practices. Companies must ensure that their suppliers provide environmentally friendly materials to minimize the environmental impact of production processes. Additionally, businesses should operate in ways that meet or exceed customer expectations for environmentally friendly products. Collaborative research and development, along with active engagement with partners, customers, and suppliers, can further enhance environmental performance. Implementing GSCM practices not only ensures compliance with environmental regulations but also improves overall environmental performance (Chien & Shih, 2007). In summary, adopting a sustainable strategy like GSCM helps organizations adhere to environmental regulations, reduce waste and hazardous materials, lower transaction and operational costs, promote the reuse and recycling of raw materials, and enhance resource efficiency. Consequently, the following hypothesis is proposed (Seman et al., 2019):

H1. There is a positive and direct relationship between GSCM and environmental performance.

2.8 GSCM and Green Innovation

Two theoretical perspectives, the evolutionary approach (Nelson & Winter, 1977) and the innovation through co-creation model (Prahalad & Ramaswamy, 2004), support the link between GSCM practices and green innovation. These theories suggest that collaboration among stakeholders involved in the supply chain fosters environmental innovation, driven by external pressures such as government regulations and regulatory bodies. According to Rao (2002), GSCM practices serve as key drivers of green innovation since green suppliers contribute to environmentally friendly innovations. Although numerous studies have established the role of GSCM in promoting green innovation, its full impact has not yet been comprehensively analyzed. Research by Lee and Kim (2011) suggests that fostering environmental cooperation between businesses and their key suppliers can catalyze the development of new green products. Similarly, studies by Chiou et al. (2011) and Rao (2002) indicate that greening suppliers positively influences green innovation. Additional research (Pidcoke et al., 2020; Chen , 2008; Van den Bergh et al., 2013) supports this assertion. A study conducted in Taiwan by Chen and Chang (2013) also found a positive correlation between green product and process innovation and business environmental management (GSCM). Given the increasing concerns of stakeholders including suppliers, customers, and communities—regarding environmental issues and regulations, businesses are prompted to collaborate closely with them during product development (Chiou et al., 2011). This collaboration enhances innovation, improves product design and manufacturing processes, and strengthens environmental compliance (Chiou et al., 2011). The concept of green innovation facilitates GSCM implementation by introducing novel strategies, approaches, and technologies for developing new products. Ultimately, green innovation is expected to drive continuous advancements throughout the supply chain, providing a competitive advantage while reducing environmental impact (Zailani et al., 2015).

H2. There is a positive and direct relationship between GSCM and green innovation.

2.9 Green Innovation and Environmental Performance

There are limited studies examining environmental performance as an outcome variable of green innovation. For instance, Kuei et al. (2015), Chen (2008), and Chen and Chang (2013) focused primarily on the impact of green innovation in both product and process on an organization's green image and competitive advantage. As a result, these empirical studies did not consider how green product innovation and green process innovation influence environmental performance. Furthermore, they did not explore the extent to which green managerial innovation affects environmental performance. However, Chiou et al. (2011) incorporated all three dimensions of green innovation in their study. Their findings indicated that green process innovation and green product innovation positively influenced environmental performance, whereas managerial innovation had no significant impact. Additionally, green innovation is a crucial driver of environmental performance, particularly in reducing toxic pollution. This, in turn, reduces the cost of stricter negotiations between businesses and regulatory bodies, consumers, or non-governmental organizations, aiming to achieve effective environmental performance standards (Carrion-Flores & Innes, 2010). The relationship between green innovation and environmental performance remains inconclusive. Existing literature does not sufficiently establish this connection. Given that previous research has shown that the implementation of green innovation enhances firms' competitive advantage and green image (Chen, 2008; Chiou et al., 2011; Chen & Chang, 2013), it is reasonable to assert that green innovation could significantly improve environmental performance in practice. Organizations that prioritize green product innovation, green process innovation, and green managerial innovation are likely to achieve competitive advantages. This leads to cost savings, improved environmental efficiency, higher productivity, and enhanced product quality (Pidcoke et al., 2020; Kuei et al., 2015; Chiou et al., 2011). Moreover, green innovation can help reduce pollution, hazardous waste, and disposal costs while enabling firms to effectively respond to external environmental pressures from stakeholders such as customers and suppliers, in compliance with environmental regulations (Pidcoke et al., 2020; Kuei et al., 2015; Chiou et al., 2011). Based on this, the following hypothesis is proposed (Seman et al., 2019):

H3. There is a positive relationship between green innovation practices and environmental performance.

2.10 GSCM and Waste Management

Effective waste management plays a critical role in improving environmental performance. Lean management techniques help minimize both general and hazardous waste, thereby enhancing environmental sustainability. Since GSCM practices aim to eliminate waste related to environmental sustainability, they contribute to cost savings and overall organizational performance (Rao, 2002). Rao and Holt (2005) identified a positive correlation between GSCM practices and economic performance, demonstrating that GSCM enhances both economic competitiveness and environmental sustainability. In a study examining the impact of organizations' environmental award announcements on stock prices, Klassen and McLaughlin (1996) found that the market valued such recognition. Consequently, companies receiving these awards experienced higher stock valuations, reflected in increased stock prices. The cost-saving nature of improved environmental performance translates into better economic performance. Waste management influences economic performance by reducing costs associated with purchasing materials, energy consumption, waste treatment, waste discharge, and fines for environmental violations. Furthermore, environmental performance is linked to a manufacturing facility's ability to reduce air emissions, solid waste, effluent waste, and hazardous material consumption (Chege, 2012).

H4. There is a positive and direct relationship between GSCM and waste management policy & strategy.

2.11 Waste Management Policy & Strategy and Environmental Performance

Waste management policies and strategies play a vital role in reducing costs related to material procurement, energy consumption, waste treatment, waste discharge, and penalties for environmental infractions. Environmental performance is directly related to a manufacturing facility’s capability to minimize air emissions, solid waste, effluent discharge, and the consumption of hazardous and toxic materials (Chege, 2012).

H5. There is a positive and direct relationship between waste management policy & strategy and environmental performance.

3. Research Methods

3.1 Research Design

This study employed a descriptive survey research design, as it was deemed appropriate for examining the relationship between GSCM practices and performance (Rashid et al., 2021). This design allowed the researcher to systematically analyze and interpret the data while capturing insights into the impact of GSCM on supply chain and environmental performance (Amirah et al., 2024).

3.2 Data Collection

The study utilized both primary and secondary data sources. Primary data was collected through a structured questionnaire (Rahi et al., 2025), which was distributed to procurement managers or their equivalents using a drop-and-pick approach. The questionnaire comprised three sections:

Part A: Respondent demographic information

Part B: GSCM practices and supply chain performance

Part C: Waste management and environmental performance

A questionnaire was chosen as the primary data collection tool because it allowed respondents to express their views clearly and comprehensively, making it an effective method for gathering insights.

Secondary data was sourced from books, academic journals, magazines, and online databases to support and validate the primary findings. To ensure comprehensive analysis, the survey included a total of 62 items in which 24 items related to GSCM practices and 38 items covering waste management, green innovation, and sustainable environmental performance. These items, adapted from previous studies. were measured using a five-point Likert scale, with varying measurement scales for different sections. The Likert scale included response options ranging from "Strongly Disagree" to "Strongly Agree" to assess the level of agreement with each statement. The collected data underwent preliminary analysis using descriptive statistics, such as means and frequencies, with the help of Predictive Analytics Software (formerly IBM SPSS Statistics, Version 22). As you can see in table 1.

Table 1: Item Statistics

	Mean	Std. Deviation
GD	14.0600	4.77182
GO	7.2100	2.61728
RL	5.2500	1.84241
PR	6.9450	2.25998
GL	8.6750	2.99906
WM	7.0900	2.45807
WMP	6.3300	2.19664
WS	8.1450	2.72785
WT	9.2850	3.04799
SP	6.3200	2.10470
EP	19.3750	6.35502
GPI	7.0700	2.66846

GMI	7.0050	2.53716

Source*: SPSS output*

4. Data Analysis & Interpretation of Results

4.1 Data Analysis

This part presents examination and discoveries of the concentrate as set out in the exploration philosophy. The various GSCM practices, waste management and green innovation and how they affect environmental performance are shown in the results. The questionnaire that served as the research instrument was the sole source of the data (Rasheed et al., 2025a, b). The survey was planned in accordance with the targets of the review. In order to improve the quality of the data that was collected, Likert type questions were included. In these questions, respondents were asked to rate how much they used the variables on a five-point Likert scale (Jais et al., 2024).

4.2 Response Rate

The questionnaire was selected from 200 out of 250 sampled respondents and they were from different government and private hospitals in Karachi Pakistan, resulting in an 80% response rate. This estimable reaction rate was made a reality after the researcher made individual visits to remind the respondent to fill-in and return the surveys.

4.3 Correlation Analysis

Table 2: Correlation Analysis

	GD	GO	RL	PR	GL	WM	WMP	WS	WT	SP	EP	GPI	GMI
GD	1												
GO	.806**	1											
RL	.772**	.781**	1										
PR	.751**	.773**	.809**	1									
GL	.774**	.764**	.741**	.809**	1								
WM	.784**	.735**	.756**	.710**	.718**	1							
WMP	.441**	.549**	.589**	.602**	.505**	.558**	1						
WS	.268**	.260**	.156*	.187**	.228**	.284**	.092	1					
WT	.328**	.306**	.274**	.339**	.337**	.370**	.180*	.648**	1				
SP	.447**	.479**	.530**	.605**	.564**	.528**	.657**	.139*	.264**	1			
EP	.712**	.707**	.727**	.760**	.737**	.777**	.601**	.250**	.367**	.650**	1		
GPI	.683**	.666**	.701**	.733**	.725**	.705**	.500**	.225**	.328**	.544**	.806**	1	
GMI	.604**	.577**	.562**	.669**	.690**	.653**	.453**	.221**	.298**	.496**	.759**	.803**	1

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).

Source*: SPSS output*

As per table 2, A correlation coefficient of 0.806 was found for green operations (GO), while 0.772 for green reverse logistics (RL), 0.751 for green purchasing (PR), 0.774 for green logistics (GL), 0.784 for waste management (WM), 0.441 for waste management policy and strategy (WMP), 0.268 for waste storage (WS), 0.328 for waste treatment (WT), 0.447 for segregation practice (SP), 0.712 for environmental performance (EP), 0.638 for green process innovation and 0.604 for green managerial innovation. Thus, all the factors showed a high significance level except WS, WT and SP have low significant impact as compare to other variables.

4.4 Regression Analysis

Table 3 provides a summary of the regression model's performance. The R-value (0.893) indicates a strong positive correlation between the dependent variable (EP) and the predictors. The R Square value (0.797) suggests that approximately 79.7% of the variance in EP is explained by the independent variables. The Adjusted R Square (0.784) accounts for the number of predictors in the model, slightly lowering the explanatory power. The standard error of the estimate (2.95636) reflects the average deviation of observed values from the regression line. The change statistics confirm that the model is statistically significant (p = 0.000), indicating that the predictors significantly contribute to explaining EP. The Durbin-Watson value (1.631) suggests that there is no serious autocorrelation in the residuals.

Table 3: Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.893[a]	0.797	0.784	2.95636	0.797	61.045	12	187	0.000	1.631

a. Predictors: (Constant), GMI, WS, WMP, GD, WT, SP, RL, GL, WM, GO, GPI, PR
b. Dependent Variable: EP

Source: *SPSS output*

4.5 ANOVA

Below table 4 presents the ANOVA results, assessing the overall fit of the regression model. The regression sum of squares (6402.485) represents the explained variance, while the residual sum of squares (1634.390) represents the unexplained variance. The total sum of squares (8036.875) is the sum of both. The F-statistic (61.045) tests whether the independent variables collectively explain a significant portion of the variance in the dependent variable. Given the significance value (p = 0.000), the model is statistically significant, meaning that at least one of the independent variables significantly impacts EP.

Table 4: ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression 6402.485		12	533.540	61.045	.000[b]
	Residual	1634.390	187	8.740		
	Total	8036.875	199			

a. Dependent Variable: EP

b. Predictors: (Constant), GMI, WS, WMP, GD, WT, SP, RL, GL, WM, GO, GPI, PR

Source: *SPSS output*

4.6 Coefficients Results

Below table 5 presents the coefficients of the regression model, indicating the individual contribution of each predictor to EP. The unstandardized coefficients (B) show the effect of each predictor variable on EP, while the standardized coefficients (Beta) allow for comparison of the relative importance of predictors. Significant predictors ($p < 0.05$) include WM (B = 0.514, p = 0.002), SP (B = 0.516, p = 0.001), GPI (B = 0.559, p = 0.000), and GMI (B = 0.515, p = 0.001), indicating that these variables have a significant positive impact on EP. The Variance Inflation Factor (VIF) values are within an acceptable range, suggesting that multicollinearity is not a major concern. The correlations column further supports the relationships between independent variables and EP.

Table 5: Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-0.384	0.946		-0.406	0.685					
	GD	0.055	0.093	0.042	0.596	0.552	0.712	0.044	0.020	0.224	4.464
	GO	0.132	0.162	0.055	0.819	0.414	0.707	0.060	0.027	0.245	4.077
	RL	0.200	0.240	0.058	0.834	0.405	0.727	0.061	0.027	0.225	4.435
	PR	0.132	0.205	0.047	0.642	0.521	0.760	0.047	0.021	0.205	4.888
	GL	-0.021	0.142	-0.010	-0.145	0.885	0.737	-0.011	-0.005	0.241	4.145
	WM	0.514	0.164	0.199	3.125	0.002	0.777	0.223	0.103	0.269	3.721
	WMP	0.156	0.144	0.054	1.087	0.278	0.601	0.079	0.036	0.442	2.264
	WS	-0.002	0.104	-0.001	-0.022	0.982	0.250	-0.002	-0.001	0.549	1.822
	WT	0.088	0.096	0.042	0.917	0.360	0.367	0.067	0.030	0.517	1.933
	SP	0.516	0.146	0.171	3.531	0.001	0.650	0.250	0.116	0.465	2.153
	GPI	0.559	0.157	0.235	3.560	0.000	0.806	0.252	0.117	0.250	3.994
	GMI	0.515	0.150	0.205	3.438	0.001	0.759	0.244	0.113	0.304	3.285

a. Dependent Variable: EP

Source*: SPSS output*

Using SmartPLS (version 4.0.9.3), this study also carried out partial least square structural equation modeling (PLE-SEM) to test the hypotheses that were stated earlier. In addition, the two-step method was used in this study to analyze and interpret the PLS results in relation to the hypotheses: 1) evaluating the measurement (outer) model's reliability and validity; and 2) evaluating the structural (inner) model. Cronbach's alpha coefficients and composite reliability were used in the reliability analysis for this study, while convergent validity and discriminant validity were used in the validity analysis (Nazri et al., 2024). GSCM, green innovation, waste management and environmental performance were identified as the reflective constructs and reflective indicators for this study's path model after a comprehensive review. The reflective constructs were regarded as the higher-order constructs in this study.

In the meantime, the molecular approach, or general concept, was established based on a number of specific dimensions. Development of GSCM is operationalized as the intelligent second-request estimation model with four intelligent aspects as first-request develops: Green design (GD), Green operation (GO), Reverse logistics (RL), and green purchasing (PR) and Green Logistics (GL). The builds of green innovation were likewise demonstrated as the intelligent second-request estimation model, with two intelligent aspects: Green process innovation (GPI) and Green managerial innovation (GMI). Development of waste management policy & strategy is operationalized as the intelligent second-request estimation model with three intelligent aspects as first-request develops: Waste Management (WM), Waste storage (WS), Waste treatment (WT) and Segregation practice (SP). The fundamental assumption of the reflective measurement model is that the indicators or measures function as reflections of the theoretical construct. As a result, this study also considered environmental performance (EP) as a reflective construct and reflective measurement items and directly relating to environmental performance.

4.7 Reliability and Validity

Table 6: Reliability & Validity

	Cronbach's alpha	Composite reliability (rho_ a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Environmental performance	0.931	0.932	0.942	0.595
GI-Green Managerial Innovation	0.85	0.853	0.899	0.691
GI-Green Process Innovation	0.877	0.882	0.916	0.731
GSCMP-Green Design	0.904	0.91	0.923	0.6
GSCMP-Green Logistics	0.876	0.878	0.91	0.669
GSCMP-Green Operation	0.845	0.846	0.896	0.682
GSCMP-Green Purchasing	0.815	0.83	0.878	0.644
GSCMP-Reverse logistics	0.783	0.784	0.873	0.697
Segregation Practice	0.837	0.837	0.891	0.672
Waste Management	0.813	0.817	0.877	0.641
Waste Management policy and strategy	0.806	0.813	0.873	0.632
Waste Storage	0.544	-0.045	0.167	0.335
Waste treatment	0.62	0.476	0.607	0.351

Source*: SPSS output*

Prior to evaluating the measurement model, this study evaluated the validity of individual measures (such as convergent validity and discriminant validity) and the reliability of individual measures, internal consistency reliability, and the reliability for the composite of measures for each construct. The internal consistency reliability, which contained both Cronbach's alpha coefficients and composite reliability to determine the suitability of the measurement model, was the first considered criterion for this work. The resulting Cronbach's alpha values (ranging between 0.544 and 0.931) exceeded the threshold value of 0.70, which showed strong internal consistency except WS (0.544) and WT (0.62) so these two variables have less impact on environmental performance, as advised by (Ngah et al., 2024a, b; Nunnally et al., 2014). Additionally, the composite reliability values were above the criterion of 0.70, ranging from 0.798 to 0.951, indicating a good dependability. Aside from that, the values of the average variance extracted (AVE) were used to assess the convergent validity in this study. This study's AVE values, which ranged from 0.335 to 0.731, all exceeded the 0.50 threshold indicating high convergent validity except WS (0.335) and WT (0.351). As mentioned, WS and WT has less than 0.5 AVE indicating as low convergent validity in the model and less impact on environmental perform as per analysis performed as shown in above table 6.

4.8 Discriminate Validity: Fornell Larcker Criterion

Table 7: Discriminant Validity: Fornell Larcker Criterion

	EP	GMI	GPI	GD	GL	GO	PR	RL	SP	WM	WMP	WS	WT
Environmental performance	0.772												
GI-Green Managerial Innovation	0.762	0.831											

GI-Green Process Innovation	0.808	0.807	0.855										
GSCMP-Green Design	0.717	0.611	0.69	0.774									
GSCMP-Green Logistics	0.735	0.692	0.726	0.773	0.818								
GSCMP-Green Operation	0.709	0.583	0.671	0.809	0.769	0.826							
GSCMP-Green Purchasing	0.762	0.673	0.738	0.754	0.811	0.777	0.802						
GSCMP-Reverse logistics	0.727	0.563	0.701	0.772	0.745	0.781	0.813	0.835					
Segregation Practice	0.646	0.489	0.543	0.444	0.558	0.474	0.599	0.527	0.82				
Waste Management	0.775	0.658	0.7	0.785	0.717	0.732	0.714	0.757	0.534	0.801			
Waste Management policy and strategy	0.607	0.456	0.502	0.448	0.508	0.55	0.604	0.593	0.655	0.568	0.795		
Waste Storage	0.391	0.335	0.298	0.41	0.396	0.471	0.435	0.447	0.523	0.42	0.571	0.578	
Waste treatment	0.559	0.493	0.467	0.424	0.482	0.407	0.543	0.48	0.555	0.571	0.462	0.366	0.593

Source*: SPSS output*

In table 7, based on the correlation matrix, this study also evaluated the discriminant validity, as shown in table 7. The square root of the AVEs of the reflective constructs in the diagonal column and the correlations between these variables in the lower left triangle region of table 7 are the outcomes of the Fornell-Larcker criterion assessment. EP (0.772), GMI (0.831), GPI (0.855), GD (0.774), GL (0.818), GO (0.826), PR (0.802), RL (0.835), SP (0.82), WM (0.801), WMP (0.795), all had higher square roots than their correlations with other latent variables in the path model. WS (0.57) and WT (0.593) Because of this, the study's the Fornell-Larcker criterion, reiterating these constructs' convergent and discriminant validity (Rahi et al., 2024; Tunio et al., 2024). As a result, the measurement model used in this study was found to be valid and reliable.

4.9 Hypotheses Testing

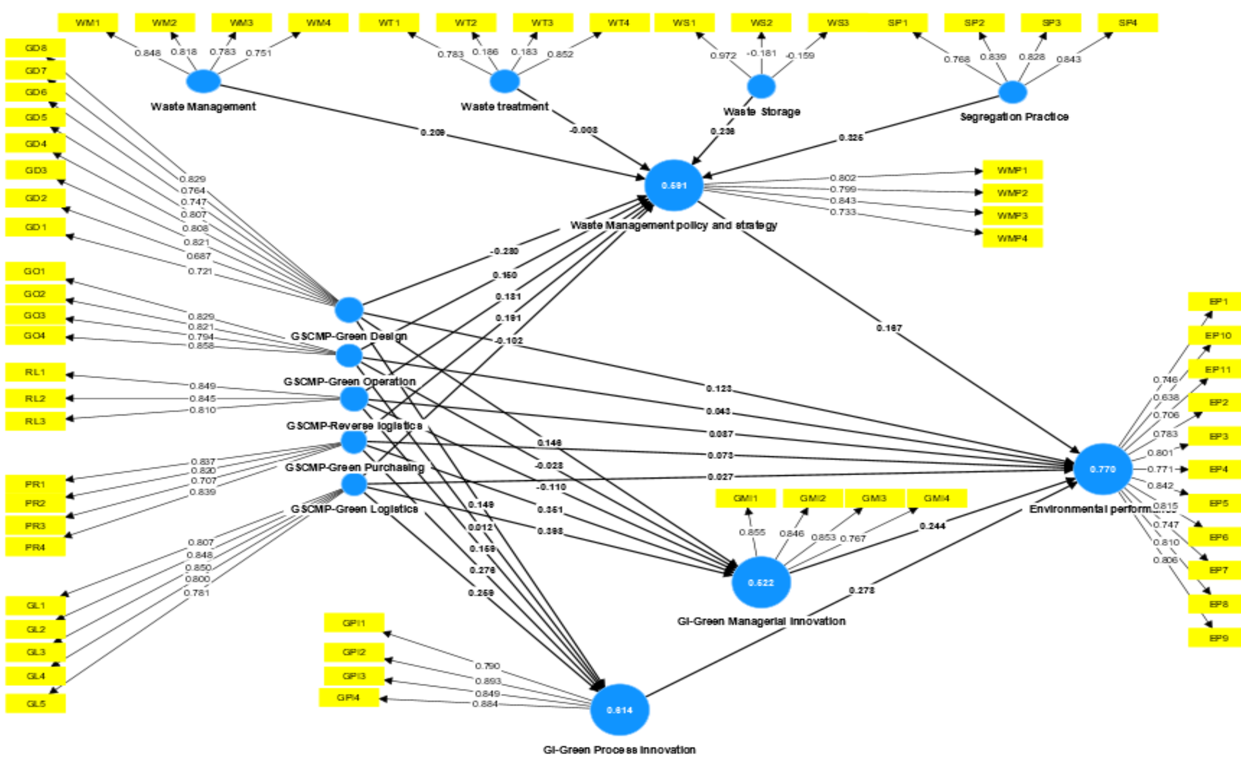
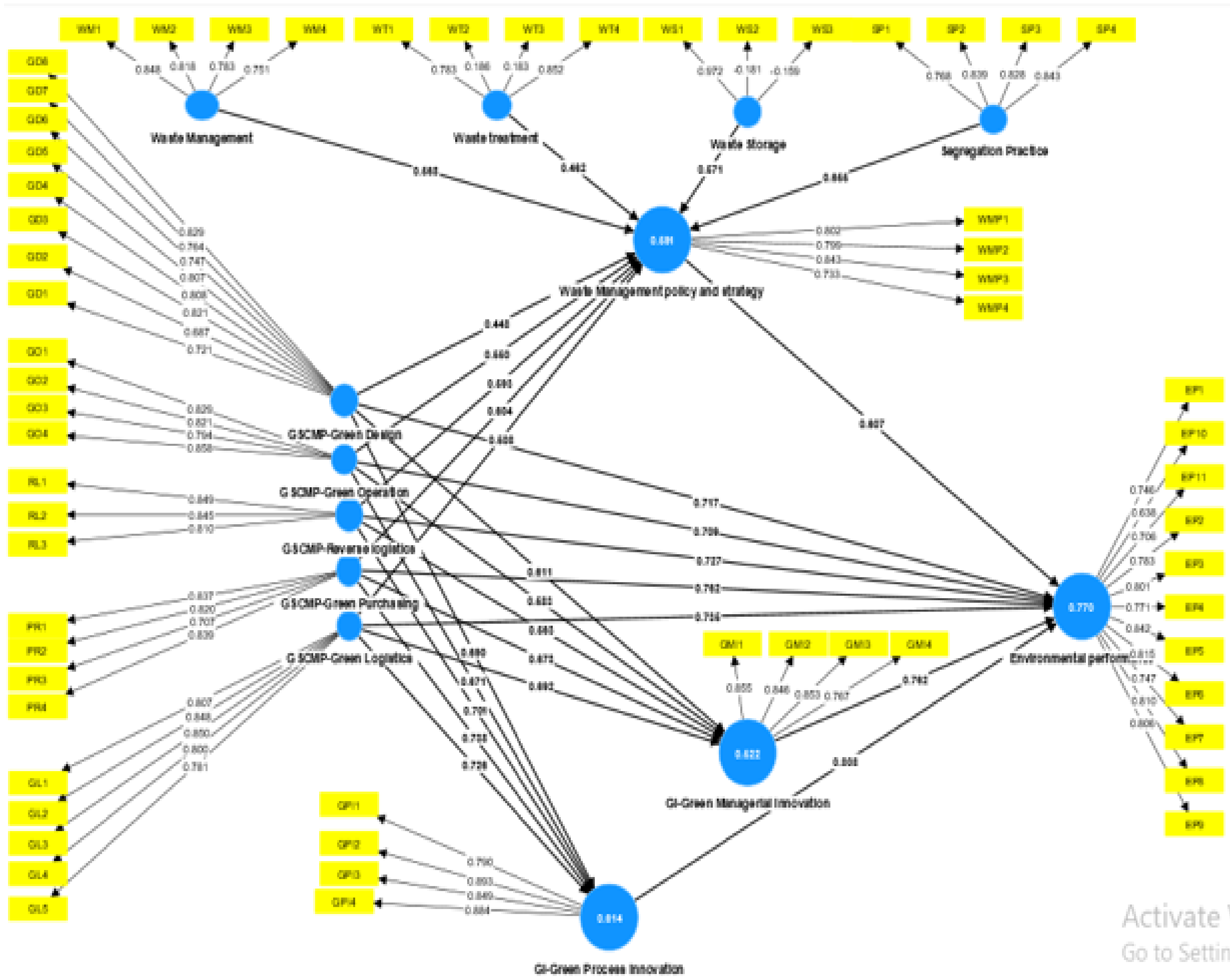


Figure 2: PLS-SEM model
Source: *SPSS output*

The Partial Least Squares Structural Equation Modeling (PLS-SEM) Model in figure 2 represents



the relationships between latent variables and their observed indicators. This model is used to test hypotheses and measure the structural relationships between independent and dependent variables.

Figure 3: Correlation model
Source: *SPSS output*

The Correlation Model in figure 3 displays the relationships between different variables based on their correlation coefficients. It helps in identifying the strength and direction of associations among constructs, typically ranging from -1 to +1.

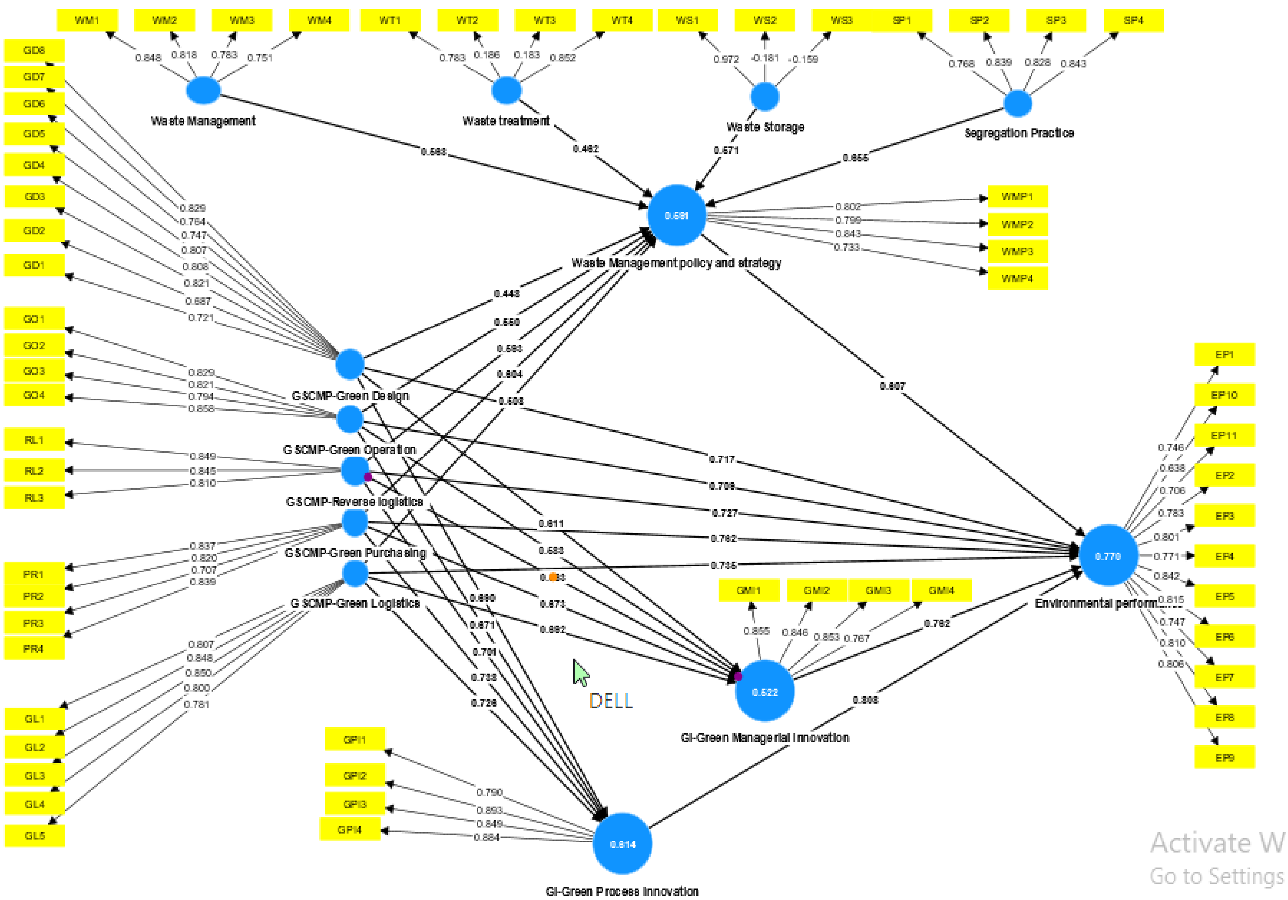


Figure 4: Covariance model
Source: *SPSS output*

Figure 4 illustrates the covariance model, which represents the statistical relationship between variables by measuring how changes in one variable correspond to changes in another. This model helps in understanding dependencies and correlations within the dataset

4.10 Hypothesis Testing and Results

Table 8: Hypothesis Testing

Tests	Values	P Value	Sum square	Mean square	F	Test Stats	Avg.Predicted Values
Environmental performance							
Intercept		0.157					
Regression			67.10	6.71	24.64		
Durbin-Watson test	1.813						
Breusch-Pagan Test						73.07	
EP with instruments							1.665
GI-Green Process Innovation							
Intercept		0.054					
Regression			44.93	14.97	50.55		
Durbin-Watson test	1.790						

Breusch-Pagan Test						122.3	
GPI with instruments							1.755
GI-Green Managerial Innovation							
Intercept		0.029					
Regression		63.66		21.22	79.8		
Durbin-Watson test							
Breusch-Pagan Test						32.01	
GMI with instruments							1.785
GSCMP-Green Design							
Intercept		0.135					
Regression			47.23	6.747	21.12		
Durbin-Watson test	2.187						
Breusch-Pagan Test						24.46	
GD with instruments							1.585
GSCMP-Green Logistics							
Intercept		0.024					
Regression			42.63	10.65	49.66		
Durbin-Watson test	1.692						
Breusch-Pagan Test						9.726	
GL with instruments							1.74
GSCMP-Green Operation							
Intercept		0					
Regression			51.71	17.23	53.83		
Durbin-Watson test	1.988						
Breusch-Pagan Test						72.64	
GO with instruments							1.74
GSCMP-Green Purchasing							
Intercept		0.007					
Regression			54.90	18.3	52.40		
Durbin-Watson test	1.783						
Breusch-Pagan Test						26.78	
PR with instruments							1.865
GSCMP-Reverse logistics							
Intercept		0.004					
Regression			53.99	26.99	69.67		
Durbin-Watson test	2.028						
Breusch-Pagan Test						7.979	
RL with instruments							1.78
Segregation Practice							
Intercept		0.018					
Regression			35.38	11.79	34.41		
Durbin-Watson test	1.873						
Breusch-Pagan Test						66.82	
SP with instruments							1.665
Waste Management							
Intercept		0.017					
Regression			49.46	16.48	67.47		
Durbin-Watson test	1.871						
Breusch-Pagan Test						23.17	
WM with instruments							1.615
Waste Management policy and strategy							
Intercept		0.41					
Regression			47.93	2.663	10.51		
Durbin-Watson test	2.045						
Breusch-Pagan Test						91.64	
WMP with instruments							1.605
Waste Storage							
Intercept		0.361					
Regression			0.635	0.317	0.49		
Durbin-Watson test	1.586						
Breusch-Pagan Test						4.9467	
WS with instruments							1.67

Waste treatment								
Intercept		0.002						
Regression			19.99	6.664		13.96		
Durbin-Watson test	2.038							
Breusch-Pagan Test							15.29	
WT with instruments								1.82

Source*: SPSS output*

As you can see in table 8 the results of Hypotheses 1 and 2 confirmed a strong direct relationship between Green Supply Chain Management (GSCM) and both green innovation and environmental performance. The findings are as follows:

H1a (GSCM – Green Design): $\beta = 0.104$; $p < 0.05$

H1b (GSCM – Green Operations): $\beta = 0.196$; $p < 0.05$

H1c (GSCM – Reverse & Inbound Logistics): $\beta = 0.245$; $p < 0.05$

H1d (GSCM – Green Purchasing): $\beta = 0.202$; $p < 0.05$

H1e (GSCM – Level of Implementation of Green Logistics): $\beta = 0.166$; $p < 0.05$

H1 (GSCM – Environmental Performance): $\beta = 0.079$; $p < 0.05$

These results indicate a statistically significant relationship between GSCM and environmental performance, strongly supporting H1, H1a, H1b, H1c, H1d, H1e, and H2. The average predicted values (APV) of GSCM range between 1.585 and 1.865, highlighting a significant impact of collinear behavior, which further validates the hypotheses.

Hypothesis 3: Relationship between Green Innovation and Environmental Performance

Hypothesis 3 established a direct relationship between green innovation and environmental performance, with the following results:

H3a (Green Process Innovation): $\beta = 0.184$; $p < 0.05$

H3b (Green Managerial Innovation): $\beta = 0.211$; $p < 0.05$

The findings confirm a statistically significant relationship, supporting H3, H3a, and H3b. The APV of Green Process Innovation (GPI) is 1.755, while Green Managerial Innovation (GMI) is 1.785, demonstrating a strong impact on environmental performance.

Hypothesis 4: Relationship between GSCM and Waste Management Policy & Strategy

Hypothesis 4 suggests a positive relationship between GSCM and waste management policy & strategy (WMP). The results indicate:

H4 (GSCM – Waste Management Policy & Strategy): $\beta = 0.042$; $p < 0.05$

Although this relationship is nearly significant, it still supports H4, with an APV of WMP at 1.605, indicating a moderate but notable effect.

Hypothesis 5: Relationship between Waste Management Policy & Strategy and Environmental Performance

Hypothesis 5 explores the direct relationship between waste management policy & strategy

(WMP) and environmental performance, with the following specific results:

H5a (WMP – Waste Storage): $\beta = 0.019$; $p < 0.05$

H5b (WMP – Waste Treatment): $\beta = 0.114$; $p < 0.05$

H5c (WMP – Segregation Practices): $\beta = 0.169$; $p < 0.05$

H5d (WMP – Waste Management): $\beta = 0.217$; $p < 0.05$

While H5 is supported, it appears to have a weaker impact compared to other hypotheses. Specifically, H5a and H5b exhibit relatively lower significance, indicating that further research is needed to better understand their influence on environmental performance.

4.11 Overall Analysis

The results confirm that all variables fit well within the model and are significantly related to environmental performance (EP). The findings strongly support H1, H2, H3, and H4, while H5 particularly H5a and H5b shows limited support and requires further exploration.

5. Summary, Discussion, and Conclusion

This chapter presents a summary of the conclusions and recommendations derived from the study. Additionally, it outlines limitations, offers suggestions for future research, and provides practical recommendations.

5.1 Discussion & Conclusion

This study examined the impact of Green Supply Chain Management (GSCM) practices, green innovation, and waste management on an organization's environmental performance. The primary objective was to determine the relationships between these factors and their collective influence on environmental performance. The findings validated the proposed model, demonstrating that implementing green innovation practices, waste management policies, and GSCM significantly enhances an organization’s environmental performance. The study concluded that implementing Green Supply Chain Management (GSCM) enhances the value of green innovation, leading to significant improvements in an organization’s environmental performance. When green innovation practices, waste management policies, and GSCM are effectively integrated, businesses can achieve greater sustainability outcomes. To remain competitive in highly dynamic markets, organizations must adopt innovative green practices, continuously drive innovation, and ensure proper waste management and disposal, reinforcing their commitment to environmental responsibility and long-term success. The study also confirmed a strong link between GSCM and environmental performance, reinforcing prior research while extending existing knowledge on the subject. The results suggested a positive relationship between GSCM and environmental performance, highlighting its importance in the healthcare industry. The study emphasized that GSCM plays a crucial role in enhancing environmental performance and maintaining competitiveness within the sector.

Furthermore, the study demonstrated that GSCM has a direct, strong, and positive effect on green innovation. These findings align with previous research (Chiou et al., 2011; Rashid et al., 2025a, b; Rusli et al., 2012; Van den Berg et al., 2013; Sharma et al., 2017), which similarly emphasized the significance of GSCM in fostering green innovation. Additionally, the research established that green innovation has a direct, positive, and significant impact on an organization’s environmental performance. By implementing green innovation practices, organizations can effectively address environmental challenges, improve sustainability, and maintain regulatory compliance (Rashid et al., 2025c).

Moreover, the study highlighted the mediating role of green innovation in the relationship between GSCM and environmental performance. The findings demonstrated that GSCM indirectly enhances environmental performance by fostering green innovation. These results align with previous studies that explored direct relationships between GSCM, green innovation, and environmental performance (Chiou et al., 2011; Rashid et al., 2025d; Van den Berg et al., 2013). The statistical analysis confirmed that both direct and indirect relationships between GSCM and environmental performance were significant. This indicates that increasing GSCM adoption not only enhances green innovation but also leads to higher environmental performance levels. As environmental challenges continue to evolve, businesses must consistently enhance their green capabilities throughout their supply chains and adopt innovative sustainability practices to improve environmental performance. This study offers several theoretical and managerial contributions. First, it presents a validated model that establishes the relationship between GSCM, green innovation, waste management, and environmental performance. This model provides a valuable foundation for future sustainability management research, particularly in the healthcare sector, where GSCM and green innovation play a crucial role.

Additionally, the study provides empirical evidence supporting the positive effects of green innovation practices and GSCM on organizational environmental performance. These insights offer practical implications for managers seeking to develop sustainable supply chain strategies and integrate environmental considerations into their business models. By adopting GSCM practices, organizations can drive innovation, enhance environmental sustainability, and maintain a competitive edge in the evolving global market. Second, this study expands the knowledge base on Green Supply Chain Management (GSCM) and green innovation in Pakistan, providing insights applicable to other developing nations. Given the limited research on GSCM and green innovation in developing economies, this study aimed to evaluate the implementation of GSCM in Pakistan while also exploring the multidimensional aspects of green innovation and its mediating effects. Existing studies primarily focus on product, process, and managerial aspects of green innovation. To address this gap, this research introduced an additional dimension, marketing innovation to provide a more comprehensive perspective. The proposed model was developed based on an empirical analysis of Pakistan's existing green innovation practices. Furthermore, the validity of GSCM and green innovation concepts in Pakistan was confirmed through Partial Least Squares Structural Equation Modeling (PLS-SEM) results. This pioneering research extends previous investigations of green innovation and GSCM conducted in Malaysia and other developing nations.

Third, this study identified key GSCM and green innovation practices that have the potential to enhance environmental performance, warranting further exploration. Additionally, it developed a validated conceptual model to facilitate the adoption of GSCM and green innovation practices by local manufacturers and suppliers. The model provides a framework for identifying gaps between current and ideal practices, enabling manufacturers to formulate effective strategies to close these gaps and remain competitive. The study also highlighted the practices that have the most significant impact on the successful implementation of GSCM and green innovation, as well as areas requiring further improvement. These findings can help manufacturers strategically enhance key indicators and improve the effectiveness of GSCM and green innovation initiatives. The study's findings further reinforce the positive impact of hospitals adopting sustainable practices such as using biodegradable materials, investing in hazardous waste disposal equipment, utilizing recycled materials, and purchasing eco-designed products with lower material and energy consumption. This aligns with prior research, which indicates that GSCM practices are linked either positively or negatively to environmental and economic performance. In this study, the Supply Chain Performance (SCP) parameters showed a significant positive correlation with GSCM practices. Implementing GSCM practices enhances an organization's ability to manage supply chain disruptions, demonstrating the crucial role of sustainable practices in supply chain resilience.

However, this study also revealed significant gaps in waste management policies within the hospitals analyzed. There is no clear policy or strategic plan for acquiring necessary equipment and providing facilities for proper waste management. At the provincial level, there is a lack of regulations, and neither provincial authorities nor hospital budgets allocate sufficient resources for hospital waste disposal. Moreover, this study found that no standardized procedures exist for waste collection and disposal in specific hospital departments, including operating rooms, chemotherapy units, laboratories, pathology sections, and hemodialysis units. Hospitals do not regularly prepare reports on waste management practices, nor do they conduct systematic studies to improve waste disposal. In contrast, developed nations have well-defined national, regional, and hospital-level policies and regulations governing hospital waste management (Askarian et al., 2004).

5.2 Practical Implications

The findings of this study provide valuable insights for managers on improving environmental performance by integrating supply chain management, environmental initiatives, and waste management practices. Organizations can enhance sustainability by implementing green purchasing, green design, green operations, reverse logistics, and green logistics. Managers should recognize the synergistic effects between environmental initiatives and quality management efforts, as these can drive the adoption of eco-friendly practices. Furthermore, the study highlights the importance of achieving both GSCM practices and environmental sustainability. Organizations should establish clear quality requirements for suppliers and actively engage them in sustainability efforts. Providing resources to support suppliers in enhancing product and process quality can further strengthen the effectiveness of GSCM initiatives.

5.3 Limitations and Future Research Directions

This study has three main limitations. First, to enhance the generalizability of the findings, future research should replicate this study in other countries with different business, institutional, and cultural environments. Comparative studies across various regions could provide a broader understanding of the factors influencing Green Supply Chain Management Practices (GSCMP) and environmental performance. Second, this study relied on perceptual measures to assess green innovation, waste management, GSCM, and environmental performance. Future research could employ objective metrics to empirically examine the relationships between quality management, green management, and environmental performance, offering more robust and data-driven insights. Third, this study primarily focused on the direct effects of GSCMP on environmental performance. Future research could explore the moderating effects of internal and external contextual factors, such as business and institutional environments, strategic orientation, and regulatory frameworks. Investigating these factors could provide a more nuanced understanding of how different conditions influence the effectiveness of GSCM practices.

5.4 Recommendations

The findings of this study highlight a critical gap in the regulations governing medical waste management, which poses significant risks to public health. The lack of proper segregation between hazardous and non-hazardous waste in hospitals indicates an urgent need for stricter compliance with recommended waste management standards. Implementing standardized waste management guidelines can significantly reduce the improper disposal of medical waste and mitigate associated health risks. To address this issue, it is imperative for the healthcare sector to conduct comprehensive nationwide studies, develop necessary regulations, and establish standardized protocols for medical waste management. Additionally, hospitals should implement regular and effective training programs for healthcare personnel, covering key aspects such as waste collection, segregation, storage, preventive measures, and accident/injury control. Raising awareness about the importance of protective measures and ensuring adherence to safety protocols can further enhance waste management practices. Organizations should actively engage customers in quality management initiatives and maintain close communication to address challenges collaboratively. Strong supplier relationships are essential for achieving optimal environmental performance through Green Supply Chain Management Practices (GSCMP). Hospitals can enhance sustainability efforts by integrating green purchasing practices and fostering customer collaboration. To maximize the benefits of GSCMP on environmental performance, hospitals should provide suppliers with detailed design specifications incorporating sustainability requirements, collaborate with them to set and achieve environmental objectives, and integrate environmental criteria into supplier selection and auditing processes. Additionally, implementing eco-design principles, cleaner production techniques, and eco-friendly packaging solutions, along with establishing product recall mechanisms and responsible waste disposal systems in collaboration with customers, can further enhance sustainability. By adopting these strategies, hospitals can significantly improve their environmental sustainability while ensuring compliance with waste management regulations.

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