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Green Supply Chain Management and Operational Performance: Mediation of Green Product Innovation and Moderation of Top Management Commitment

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ABSTRACT

The study seeks to determine the impact of green supply chain management facets (green purchasing and manufacturing) on operational performance. It also examines the mediation role of green product innovation and the moderating role of top management commitment on various paths. A self-administered structured questionnaires were used to collect time lag data from 279 managers from 31 manufacturing firms in Jordan. We found that both green purchasing and green manufacturing positively impact green product innovation, which mediates the relationship between the two facets and operational performance. Top management commitment moderates the relationship between green manufacturing and operational performance, as well as between green product innovation and operational performance. However, this moderating effect is not significant on the relationship between green purchasing and operational performance. Our findings have valuable practical, societal, policy, and educational implications. A few limitations and directions are provided.

Introduction

Resource depletion and environmental challenges have increasingly pressured firms to address sustainability concerns in recent years (Al-Ghwayeen & Abdallah, 2018; Appiah et al., 2022; Khan et al., 2023; Migdadi & Omari, 2019; Saeed et al., 2022; Seman et al., 2019; Younis et al., 2016). Additionally, firms are often viewed as contributors to environmental risks due to their operations (Afum and Osei-Ahenkan et al., 2020; Çankaya & Sezen, 2019; Kalyar et al., 2019; Seman et al., 2019). Consequently, it has become essential for firms to revise existing production methods and transition from traditional supply chain management (SCM) to green supply chain management (GSCM) to meet the sustainability demands of customers (Afum and Agyabeng-Mensah et al.,

2020; Al-Ghwayeen & Abdallah, 2018; El-Kassar & Singh, 2019; Li et al., 2020; Seman et al., 2019; Stekelorum et al., 2021). Embracing strategies that prioritize environmental protection, ecological responsibility, and transparent procurement (green purchasing)—combined with the production of high-quality, eco-friendly products that significantly reduce environmental impact throughout their lifecycle (green manufacturing)—is vital for driving impactful green innovation.

On the other hand, green innovation represents a proactive approach to environmental management, aiming to mitigate adverse environmental impacts (Khan et al., 2023). Thus, green technology innovation is a dynamic and long-term process. The demand for green products stimulates a favorable environment for organizations to innovate in green technology (Saether et al., 2021; Wei & Wang, 2021; Xie & Jamaani, 2022). In this respect, the Jordanian government has approved numerous environmental laws that support greening in Jordanian firms and oblige manufacturing and service firms to comply with these laws (Al-Ghwayeen & Abdullah, 2018). Due to the adverse effects of traditional SCM on the environment, industry, and global services—especially in developing countries like Jordan. Thus, research on GSCM is both necessary and urgent to address these impending dangers to human prosperity.

Research on the relationship between GSCM facets and operational performance shows mixed results. For example, studies indicated that the impact of GSCM facets on operational performance is positive (Adusei et al., 2023; Fang & Zhang, 2018; Famiyeh et al., 2018; Geng et al., 2017; Maaz et al., 2022; Santoso et al., 2022; Sharma & Modgil, 2020; Stekelorum et al., 2021; Yu et al., 2014). Meanwhile, other studies have reported that certain GSCM facets can have adverse effects on operational performance (Ahmed et al., 2020; Nakano & Matsuyama, 2022; Younis et al., 2016; Zhu et al., 2007). Previous research is fragmented and shows diverse empirical results (Benjamin et al., 2023; Yi & Demirel, 2023). The contradictory results highlight a gap in understanding the effect of GSCM facets on operational performance. Translating green product innovation (GPI) into operational performance is more achievable with a strong top management commitment (TMC). Surprisingly, TMC's role has rarely been studied, making this research both novel and critically important in clarifying the process and boundary conditions.

Therefore, further research is necessary to address these gaps and understand the effects of GSCM facets on operational performance. Specifically, the study examines *how and when green purchasing and manufacturing influence a firm's operational outcomes*. This study aims to investigate the transition of Jordanian manufacturing firms toward GPI through the adoption of green purchasing and manufacturing practices and thus obtaining operational performance under the boundary condition of TMC.

The present study contributes to existing literature and practice. It provides valuable insights into green aspects for manufacturing firms, including green purchasing and manufacturing practices, particularly given the limited research on the sustainability of green practices in developing countries like Jordan. Second, it establishes and advocates the role of TMC in maintaining and affecting the conversion of GSCM factors and GPI towards operational performance. Third, it assesses and outlines the theoretical, practical, societal, and educational implications for policymakers on implementing GSCM in the industry, thereby enhancing GSCM adoption. Finally, decision-makers will benefit from the results of managing and enhancing the firm's performance during manufacturing operations by optimizing resources and capabilities.

Literature review and Hypothesis development

Green Supply Chain Management Facets

Understanding GSCM requires examining its mechanisms, as it encompasses more than just innovation. Unlike traditional SCM, GSCM involves a broad range of activities that include engaging with green suppliers, overseeing manufacturing and operations, fostering innovation, as well as marketing and managing customer relationships (Khan et al., 2023). These activities take into account social and environmental factors, prioritizing them in the process (Zhang & Zhao, 2022). Yang et al. (2023) and Burki et al. (2019) argue that maintaining closed communication with customers and other stakeholders hinders the successful implementation of GSCM strategies within a firm.

Today, GSCM and environmental sustainability are among the most critical considerations in the industry. Researchers suggest that the establishment of GSCM is rooted in integrating ecological thinking into supply chain management (Zhu et al., 2008; Srivastava, 2007; Umar et al., 2022; Yi & Demirel, 2023). Ramli et al. (2022) found that adopting GSCM practices can lead to improved operational performance. Furthermore, GSCM aims to minimize the environmental damage caused by manufacturing, including pollution, overuse of resources, and incorrect disposal of used products. (Micheli et al., 2020; Seman et al., 2019). Therefore, GSCM presents a significant opportunity to enhance firm performance (Novitasari & Agostini, 2022).

Greening involves additional burdens and costs for firms that already have limited resources (Ahmed et al., 2019; Zhang & Zhao, 2022). However, it also offers numerous benefits, such as enhancing a firm's reputation, attracting environmentally conscious customers, and promoting innovative sustainability practices (Banik et al., 2022). Firms that adopt green practices often encounter various technological challenges. Therefore, top management (TM) is responsible for addressing these challenges and finding ways to overcome them (El-Kassar & Singh, 2019). As a result, the successful implementation of green supply chain management (GSCM) relies heavily on the full support of top management, which in turn fosters green innovation.

Researchers explore many facets of GSCM in their studies. This study will focus specifically on two facets: green purchasing and green manufacturing, which are fundamental to manufacturing operations. While GSCM encompasses various aspects, this research will only focus on these two.

Green Purchasing

The first phase of the value chain is purchasing, which involves implementing green practices throughout the purchasing process (Luong et al., 2023). As awareness of environmental issues among purchasers increases, green purchasing has become a primary approach, with firms increasingly committed to making their products more sustainable (Azam et al., 2022; Li et al., 2022). Sustainable purchasing, often referred to as environmental or green purchasing, encompasses these initiatives (Abdul-Rashid et al., 2017). Shekarian et al. (2022) emphasize that sustainable purchasing practices require the purchasing process to be both green and sustainable. Scholars such as Abdallah and Al-Ghwayeen (2019), Arora et al. (2020), and Younis et al. (2016) argue that green purchasing is a procurement strategy aimed at ensuring that all acquired goods and materials align with the environmental goals of the purchasing organization.

Supplier selection is a critical strategic approach for firms aiming to mitigate the environmental impacts of their operations (Shin & Cho, 2022). Additionally, supplier selection plays a vital role in the decision-making processes of SCM and contributes to green purchasing practices (Bravo et

al., 2022). This is particularly important when evaluating suppliers based on their performance in terms of flexibility and responsiveness (Zimmermann et al., 2020). Collaboration between buyers and suppliers is crucial for sustainable purchasing, enabling the production of products developed through eco-friendly processes that do not harm the environment (Galati, 2022; Khan & Qianli, 2017; Nguyen et al., 2022). Despite this, green purchasing remains a relatively minor focus for many firms, with only a few engaging in such practices, even among those certified with ISO 14000 (Azevedo et al., 2011).

Green Manufacturing

Green manufacturing refers to producing high-quality products at the lowest cost by using the best resources, which, in the long run, may lead to a competitive advantage (Kalyar et al., 2019). Further, green manufacturing encompasses all sustainable activities that continuously integrate green manufacturing methods for products (Azam et al., 2022). In the same vein, Rajesh (2022) argued that green manufacturing encompasses the application of sustainability techniques, such as Industry 4.0 (Lundgren et al., 2023), principles, and operations in manufacturing products. In addition, green manufacturing, when utilizing the highest resources over time, can lead to a CA with quality products at the lowest possible cost (Khan & Qianli, 2017). Moreover, green manufacturing aims to reduce the environmental impact of production by converting inputs into preferred outputs using suitable apparatus and technology, minimize health and environmental hazards, lower energy consumption and emissions, enhance material efficiency, and improve overall operational effectiveness (Hariadi et al., 2023; Khan et al., 2020; Mubarik et al., 2021). Additionally, Maaz et al. (2022) argued that green manufacturing aims to reduce waste and carbon emissions without additional cost in the manufacturing process. However, the complete green product is unavailable (Al-Hakimi et al., 2022).

Resource-Based View and Green Supply Chain Management

This study extensively utilized the resource-based view (RBV) to clarify and ground the relationships in the study model, thereby enhancing our understanding of greening. It also focuses attention on the internal resources of the firm to organize operations and gain a sustained competitive advantage (SCA) (Hart, 1995; Li et al., 2020). RBV assumes that firms are bundles of resources and capabilities (Barney et al., 2021). However, not all resources generate a competitive advantage for the firm (Barney, 1991; Ranasinghe et al., 2022). RBV is a firm SCA grounded in its value, rarity, and cost to imitate (Barney, 1991; Barney & Hesterly, 2019). Barney (2021) outlined the conditions under which a firm's resources and capabilities can create a SCA. That is, the intangibility, ambiguous causality, and social complexity inherent in firms' innovation strategies and activities within the SC can serve as sources of SCA (Alkaraan et al., 2025). However, when applying RBV to the GSCM-firm's performance relationship, the GSCM is viewed as a vital resource that meets the criteria of RBV for generating and supporting higher performance and competitive advantage (Al-Hakimi et al., 2022). The RBV theory highlights asset integration as a strategy to leverage resources and boost organizational capabilities. It views the firm as a combination of tangible and intangible assets (Barney, 1991; Manzoor et al., 2022; Stranieri et al., 2022).

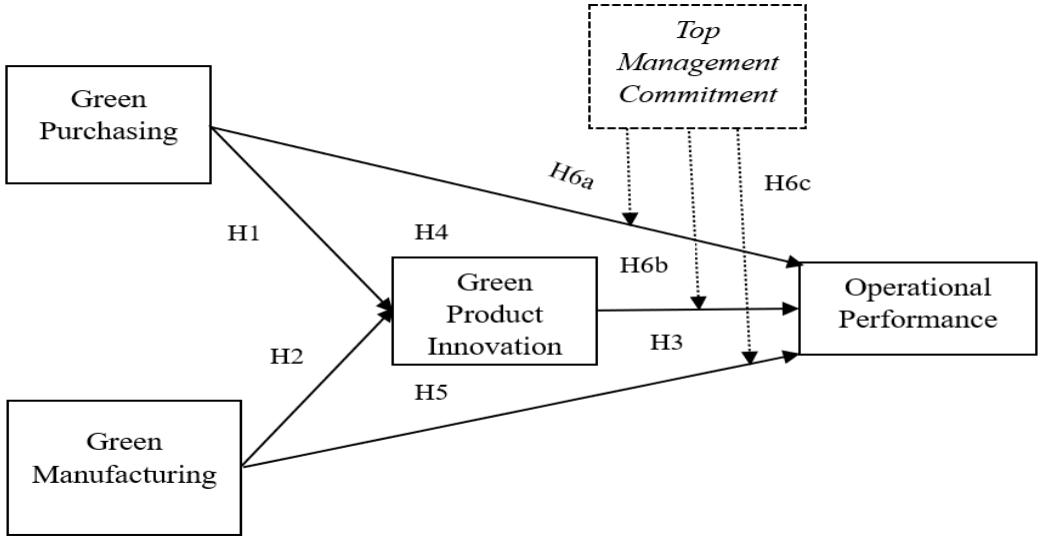
Top Management Commitment

A strong commitment from top management shows that the firm will take key steps to develop and enforce necessary organizational and operational frameworks for adopting sustainable practices. TMC aims to reduce resistance during the implementation of GSCM practices (Rupa & Saif, 2022; Wiredu et al., 2024). TMC is crucial for implementing green practices, without which these efforts

may not be effective (Afum et al., 2021; Wijethilake & Lama, 2019). Besides decisions on resource allocation and organizational changes, it is vital to assess whether firms genuinely care about environmental sustainability—the beliefs and knowledge of top management influence technology implementation. Hence, Khan et al. (2019) noted that ninety percent of GSC projects failed because top managers lacked seriousness. Additionally, Tseng et al. (2013) found that firms are more likely to adopt green innovation strategies when managers prioritize and show concern for the environment. In this context, Hariadi et al. (2023) and Tarigan et al. (2020) stated that TMC enhances competitive advantage. Furthermore, Alexandrou et al. (2022) questioned whether managers see greening as an opportunity and whether they will be supportive and committed to its implementation, and vice versa.

The hypothesized model in Figure 1 represents the relationships between the variables formally grounded in the following paragraphs.

Figure 1: The hypothesized model



GSCM Facets and Green Product Innovation

GPI refers to the growth of new products or services with little to no adverse effect on the environment or less than existing or competing products (Helmi & Widiastuty, 2023; Tang et al., 2018). Furthermore, Xie et al. (2019) stated that using non-toxic materials throughout manufacturing significantly reduces the adverse effect on the environment and maximizes energy efficiency. GPI changes product designs. Therefore, with more environmental concerns, firms can consider GPI an opportunity (Lin et al., 2013). However, GPI is a strategy that allows firms to achieve sustainable development while simultaneously reaching their goals (Hariadi et al., 2023; Qiu et al., 2020). Thus, Jusoh et al. (2021) and Nsiah et al. (2022) consider GPI a capability.

It is worth noting that there is a shortage of evidence regarding the relationship between GSCM and green innovation. Further research could provide valuable insights to help us towards a more sustainable future (Seman et al., 2019). RBV suggests that GSCM facets can lead to SCA (Barney, 1991; Hart, 1995). According to Zulfikarijah et al. (2023) GSCM facets affect green innovation. Further, firms can promote sustainable development by implementing GPI, which requires internal resources and implementation measures (Qiu et al., 2020). Based on the RBV perspective,

collaboration with suppliers helps firms share knowledge. It internalizes knowledge generated by collaborating partners and transforms it into a capability to provide a sustainable product in which the firm outperforms its competitors. Furthermore, green manufacturing is a valuable and rare resource that enables product manufacturing through innovative design, minimizing and preventing waste and removing hazardous substances by combining with GPI to generate a capability that can be considered a distinctive source of CA. Based on RBV and the above literature, the study proposes hypotheses:

H1: Green purchasing positively affects green product innovation.

H2: Green manufacturing positively affects green product innovation.

Green Product Innovation and Operational Performance

Efficient activities can reduce inventory levels, decrease scrap rates, and improve capacity utilization and delivery times, resulting in enhanced operational performance (Stekelorum et al., 2021). Furthermore, operational performance is a strategic dimension by which a firm selects to compete with other firms (Famiyeh et al., 2018) because operational performance is the ability of a firm to deliver products to its customers quickly and efficiently (Stekelorum et al., 2021; Zhu et al., 2008). Additionally, Maaz et al. (2022) stated that the concept of operational performance refers to a firm's ability to produce efficiently and deliver products to customers. Moreover, improving the firm's innovation capability and reducing manufacturing costs are essential for operational performance (Sharma & Modgil, 2020). Optimizing operational performance is crucial to minimizing scrap rates and delivery times, elevating quality, lowering reduction levels, and maximizing capacity utilization (Stekelorum et al., 2021). Novitasari and Agostina (2022) reported that firm performance is a means of achieving multi-dimensional firm goals and describes the firm's success in executing and completing the business with maximum profit.

Green innovation adds intangible value for firms, and such firms gain a SCA (Aftab et al., 2022). Manufacturers must adopt green strategies to meet customer demand for eco-friendly products, improve operational performance, and reflect positively on firm performance (Ahmed et al., 2020; Ojani & Darestani, 2022). Furthermore, firms adopting green strategies that improve environmental performance will impact operational performance by default (Migdadi & Elzzqaibeh, 2018; Safian et al., 2022). Al-Mesaiadeen et al. (2022) argued that operational performance aids firms in addressing problems such as carbon emissions and reducing environmental effects and waste. However, RBV suggests that competitive advantage and performance depend on how firms leverage their strategic resources, which are valuable, scarce, and hard to imitate (Alkaraan et al., 2025; Barney, 1991; Kamra et al., 2024). In the same context, Phan et al. (2019) indicated that operational performance is a critical issue that controls a firm's competitive advantage. The results of Nawaser et al. (2023) suggest that green innovation affects both directly and indirectly a firm's performance. Based on RBV logic, it is believed that implementing GPI can significantly enhance a firm's operational performance as it serves as a valuable organizational resource. Thus, the study postulates the following hypothesis:

H3: Green product innovation positively affects operational performance.

Mediation of Green Product Innovation

The implementation of GPI has a positive relation with both operational and environmental performance (Chen et al., 2006). This relation will finally be affected by GSCM (Chiou et al.,

2011). Furthermore, Geng et al. (2017) stated that operational performance is related to reducing scrap rates, decreasing inventory levels, and improving capacity use and delivery time. In this context, Ahmed et al. (2020) found that GSCM collaboration with suppliers and customers has a strong and positive relationship with operational performance. Moreover, Chen et al. (2006) and Santoso et al. (2022) indicated that the literature supports the positive relation between GSCM and operational performance. Furthermore, Silva et al. (2019) concluded that GPI mediates the sustainable performance relation with GSCM. According to a previous study, there is a need for further investigation into the relationship between GSCM and operational performance (Barney & Clark, 2007). RBV explains that firms that possess resources can help attain their innovative goals (Barney, 1991). Therefore, GPI implementation as an eco-friendly technology to produce enhanced goods will stimulate operational performance and gain a SCA (Barney, 1991). Thus, the study postulates the following hypotheses:

H4: Green product innovation mediates the relationship between green purchasing and operational performance.

H5: Green product innovation mediates the relationship between green manufacturing and operational performance.

Moderation of Top Management Commitment

Alexandrou et al. (2022) questioned whether managers understand greening as an opportunity and whether they will be supportive and committed to implementing it and vice versa. Thus, they are instrumental in leading the firms toward sustainable development (Hariadi et al., 2023). Moreover, Top management needs commitment to organizing and controlling employees within the corporate structure to achieve set goals (Tarigan et al., 2020). Likewise, Khan et al. (2023) stated that TMC is the primary process of transforming external stimuli into managerial actions and integrating them with internal knowledge to establish new or revise existing organizational rules. In this vein, Adusei et al. (2023) and Nugroho et al. (2024) found a positive effect of TMC on operational performance.

The role of the TMC in developing capabilities, allocating resources, and assisting the firm in achieving competitive advantage is crucial for the adoption of various facets of GSCM. This aligns with the aims of the RBV theory (El-Kassar & Singh, 2019; Fatima et al., 2024; Ranasinghe et al., 2022; Wiredu et al., 2024). The RBV posits that a firm's core is its facet, driving its success in gaining an SCA in a specific market. Therefore, top management can be valuable, rare, and costly to imitate, as well as a resource for considering and implementing a plan to gain an SCA (Barney, 2021; Ranasinghe et al., 2022). According to RBV, resources encompass a wide range of assets, including technical know-how, capabilities, information, knowledge, processes, attributes, and management skills (Barney, 1991). The RBV emphasizes the significance of intangible resources and capabilities for the firm to attain a competitive advantage (Barney, 1991). The RBV theory considers top management an intangible resource (Barney, 1991; Khan et al., 2023).

Therefore, the TMC's role as a moderator is to enhance the adoption of GSCM facets and GPI, create synchronization between them, and give support wherever and whenever needed. From another perspective, Khan et al. (2023) argued that the RBV declares that resources are combined to create capabilities. Resources cannot provide any value to firms until they are logically combined; the combination of resources can be a competitive advantage for firms. This effort can be executed only by the top management. Furthermore, a firm can enhance operational performance by fostering strong relationships between internal parties, such as top management,

and external parties like suppliers (Nugroho et al., 2024; Tarigan *et al.,* 2019). Therefore, the study posits the following hypotheses:

H6a: TMC moderates the relationship between green purchasing and operational performance.

H6b: TMC moderates the relationship between green product innovation and operational performance.

H6c: TMC moderates the relationship between green manufacturing and operational performance.

Methodology

Thirty-one manufacturing firms registered with the Jordan Chamber of Industry (JCI, 2022), with than 150 employees, are the target population. Firms from five strata and outside of these strata were selected using proportionate stratified random sampling. The participants included managers from various departments, such as production, supply chain, quality control, and operations, who routinely interact with GSCM processes. At time 1, 411 questionnaires were distributed conveniently among the managers to capture GSCM facets and TMC. Multiple visits were made for data collection. At time 2, a second questionnaire was distributed to those who completed the first questionnaire to assess GPI and operational performance. After two lags, 293 matched questionnaires were received, 14 were discarded for being incomplete, and 279 usable responses were finally obtained, representing a response rate of 67.9%. According to Khine (2013:38), a sample size over 200 is considered good, and our sample size is also adequate because the sample-to-item ratio 279/27 = 10.3 is very good (Sameeni et al., 2024). The common method bias (CMB) estimate was 33.96%, which is below the 50% cutoff (Khine, 2013; Kock et al., 2021). Additionally, all Skewness and Kurtosis values for the variables were less than 2 and 7, respectively (Podsakoff et al., 2003). The study used pre-tested measures from previous relevant studies based on a literature review to assess the variables. All items were measured using a seven-point Likert scale, adapted from existing literature (Table 1).

Table 1: Details of measures

Constructs	***Items***	***Sample Item***	***Source***
Green purchasing	5	Supervising environmental audit of suppliers	Zsidisin and Hendrick (1998)
Green manufacturing	7	Uses life-cycle assessment to evaluate an environmental load of products	Afum & et al. (2020)
Green product innovation	4	The company uses eco-labeling	Chiou et al. (2011)
Top management commitment	5	Top management articulates a vision for green supply chain collaboration	El-Kassar and Singh (2019)
Operational performance	6	Decreasing inventory levels	Zhu et al. (2008)

Data Analysis and Results

Sample Characteristics

The study performed data cleaning and screening, and there were no issues. About 77% were male. Incidentally, the percentage of married respondents was also 77%. The respondents were well educated, with 79.2% holding a bachelor's degree and 16.5% a master's degree. Regarding the age of the respondents, 35.1% were between 26-35 years, 36.6% between 36-45 years, and 20.4% between 46-55 years. The others were below 25 (1.8%) or above 55 (6.1%) years old. About 23%

of the managers had work experience of 1-5 years in the firm, 35.8% had 6-10 years, 31.2% had 11-19 years, and the remaining 9.7% had 20-30 years. Our sample represented 53.8% senior-level managers, 38.7% middle managers, and 7.5% lower managers. Table 2 highlights the results of the respondents' demographics.

Table 2: Demographics of the Respondents (n = 279)

Variable	*Category*	*Freq*	*%*
Gender	Male	215	77.1
	Female	64	22.9
Marital status	Married	215	77.1
	Single	64	22.9
Education	Intermediate	12	4.3
	Bachelor	221	79.2
	Master	46	16.5
Age in years	Below 25	5	1.8
	26-35	98	35.1
	36-45	102	36.6
	46-55	57	20.4
	56-65	17	6.1
Hierarchical level	Lower	21	7.5
	Middle	108	38.7
	Senior	150	53.8

Descriptives, Reliability, Validity, Factor Loadings, and Multicollinearity

Factor loadings for items should be at least 0.50 (Hair et al., 2019). According to Kline (2011), the composite reliability (CR) value should be above 0.70. The results show that the Skewness values of all variables are less than 2, and the Kurtosis values are less than 7 (Khine, 2013). Additionally, convergent validity is evaluated by calculating the Average Variance Extracted (AVE), which should be at least 0.50 (Hair et al., 2019). All four variables had AVE values above 0.5, so the study also met this criterion. Discriminant validity was then assessed using the (Fornell & Larcker, 1981) method. There is no multicollinearity problem, as the variance inflation factor (VIF) is below 10 (Hair et al., 2019; Kline, 2011); see Tables 3 and 4.

Table 3: Factor Loadings, AVE, C R, and D V

Variable	*Items*	*Factor Loading*	*AVE*	*C R*	*DV*	*VIF*	*CS*
Green purchasing	GPUR1	0.650	0.539	0.853	0.734	1.67	.599
	GPUR2	0.722					
	GPUR3	0.774					
	GPUR4	0.755					
	GPUR5	0.763					
Green manufacturing	GMF1	0.760	0.596	0.830	0.772	1.80	.555
	GMF2	0.780					
	GMF3	0.880					
	GMF4	0.750					
	GMF5	0.690					
	GMF6	0.760					

	GMF7	0.770					
Green product Innovation	GPRO1	0.731	0.615	0.864	0.784	1.72	.581
	GPRO2	0.814					
	GPRO3	0.803					
	GPRO4	0.785					
Top management commitment	TMC1	0.786	.634	.897	.796	1.635	.611
	TMC2	0.806					
	TMC3	0.795					
	TMC4	0.829					
	TMC5	0.765					
Operational performance	OPR1	0.753	0.547	0.878	0.739	-	-
	OPR2	0.712					
	OPR3	0.667					
	OPR4	0.754					
	OPR5	0.778					
	OPR6	0.765					

Note: AVE = average variance extracted, CR= composite reliability, DV= discriminant validity, VIF=variance inflation factor, CS= collinearity statistics.

Cronbach's alpha coefficient was utilized to assess construct reliability. All constructs exhibited an acceptable level of reliability with $\alpha > 0.70$, indicating adequate internal consistency (Hair et al., 2019). Table 4 shows the bivariate correlations between green purchasing, manufacturing, and GPI (0.505 and 0.577 at p<0.01). Also, between green purchasing, manufacturing, and operational performance (0.395 and 0.458 at p<.01). Similarly, the correlation between GPI and operational performance is positive with a (0.483) at p<0.01. Moreover, the correlations between TMC, green purchasing, and operational performance are positive, with a p<0.01 (0.196 and 0.195). Finally, the correlation between TMC and GPI is positive, 0.142 at p<0.05.

Table 4: Descriptive Statistics, Reliability, and Correlations

Variable	***Mean***	***SD***	***Skewness***	***Kurtosis***	***1***	***2***	***3***	***4***	***5***
1. Green purchasing	5.22	.79	-.107	.0171	***.78***				
2. Green manufacturing	5.32	.68	-.399	.455	.544**	***.76***			
3. GPI	5.28	.78	.303	-.375	.505**	.577**	***.79***		
4. Operational performance	5.33	.767	.150	-.393	.395**	.458**	.483**	***.83***	
5. TMC	5.47	.75	-.297	1.05	.196**	.105	.142*	.195**	***.86***

Note: n = 279, *p <.05; ** p < .01, SD= standard deviation, GPI = green product innovation, TMC = top management commitment.

Regression Analysis

The result shows (Chi-square=309.242, *df* =195, x^2/df = 1.586, GFI=0.911, TLI=0.937, CFI= 0.947, RMSEA= 0.046) that the model fit is achieved according to the criteria (Hair et al., 2019).

The study conducted model testing in two steps: calculating the direct and indirect impacts using AMOS 23 for H1, H2, and H3. The second step involved testing mediation hypotheses with the PROCESS macro for H4 and H5, developed by Hayes (2022). The direct impact of GSCM facets

H1 and H2 on GPI showed statistically significant effects (H1: β= 0.497, p <.01), indicating that each unit of green purchasing accounts for a 0.497 unit increase in GPI. Similarly, (H2: β= 0.66, p <.01), green manufacturing accounts for a 0.66 unit increase in GPI. These findings align with previous results (Chiou et al., 2011; Li et al., 2022; Seman et al., 2019). Therefore, both *H1 and H2 are supported*.

Similarly, the impact of GPI on operational performance was also statistically significant (H3: β= 0.34, p <.01), indicating that GPI accounts for a 0.434 unit increase in operational performance. Consequently, *H3 is supported*.

Hayes (2022) proposed using 5000 bootstrap samples for testing mediation effects in SEM. Model no. 4 was used for mediation analysis at a 95% confidence level. The GSCM facets, including green purchasing and manufacturing, indirectly influence operational performance through GPI. The results in Table 5 clearly illustrate this. Additionally, results showed a direct positive effect of GSCM facets on operational performance (Nazeri et al., 2024). As a result, both *H4 and H5 are supported*.

Table 5: Regression Results: Direct and Indirect Paths (H1 to H5)

Outcome Variable	***B***	***SE***	***T***	***R^2***
GPI				
Constant	2.687	.269	9.974**	.25
Green Purchasing *(H1)*	.497	.051	9.729**	
Constant	1.75	0.30	5.81**	.33
Green Manufacturing *(H2)*	.66	0.06	11.76**	
Operational Performance				
Constant	2.86	.28	10.36**	
Green Purchasing	.18	.05	3.4**	.26
GPI*(H3)*	.34	.05	6.36**	
	Effect	*SE*	*LL 95% CI*	*UL 95% CI*
The indirect impact of green purchasing on operational performance*(H4)*	0.17	0.03	0.11	.24
Constant	2.58	.29	8.78**	
Green Manufacturing	.27	.06	4.3**	.28
GPI	.29	.05	5.25**	
	Effect	*SE*	*LL 95% CI*	*UL 95% CI*
The indirect impact of green manufacturing on operational performance*(H5)*	.19	.04	.11	.28

Note: n=279, Bootstrap sample size = 5000, ** p <.01, LL=lower limit; CI=confidence interval; UL=upper limit.

The study used the PROCESS macro to test for moderation effects, and a 5000 bootstrap sample was selected for analysis with model no. (1) at a level of confidence of 95% (Hayes, 2022). For the moderation role of TMC, H6a, H6b, and H6c, the results revealed that H6a has an insignificant effect (β= 0.09, t= 1.84 at p<0.1). Meanwhile, H6b and H6c have a significant impact (β= 0.1, t= 0.04 at p<0.01) and (β= 0.12, t= 2.44 at p<0.02) respectively. Table 6 highlights the results.

Table 6: Moderation of TMC (H6a, H6b, and H6c)

Outcome Variable	*B*	*SE*	*T*	R^2
Operational Performance				
Constant	5.52	1.27	4.34	
Green Purchasing	-.22	.25	-.86	.21
TMC	-.24	.25	-.96	
Green Purchasing x TMC (*H6a*)	.09	.05	1.84^	
Change for unconditional interaction				.1^
Constant	5.56	1.31	4.26**	
GPI	-.16	.25	-.66	.27
TMC	-.36	.25	-.85	
GPI x TMC (*H6b*)	.10	.05	.04*	
Change for unconditional interaction				.01*
Constant	6.02	1.37	4.38**	
Green Manufacturing	-.26	.26	-.99	.25
TMC	-.49	.27	-1.78	
Green Manufacturing x TMC (*H6c*)	.12	.05	2.44*	
Change for unconditional interaction				.02*

Note: n=279, Bootstrap sample size = 5000, * p <.05, ** < .01, ^ p < .10

Discussion

The study examined how different facets of GSCM, such as green purchasing and manufacturing, affect operational performance. The study also looked at the involvement of GPI as a mediator and TMC as a moderator. In this study, the strategic role of purchasing and manufacturing leads to a stimulus effect on GPI and TMC to improve operational performance.

The results indicated that GSCM facets have a statistically significant positive effect on GPI ($p<0.01$). The findings align with the previous results (Chiou et al., 2011; Li et al., 2022; Seman *et al.,* 2019). According to statistical analysis, GPI was found to have a significant positive impact on operational performance ($p < 0.01$). Thus, for the direct effect, the findings support the proposed hypotheses. The study formulated two hypotheses to examine the mediation effects, finding that GPI mediates the relationship between GSCM facets and operational performance. These mediation effects are statistically significant ($p<0.01$) for the chosen GSCM facets.

The study formulated three hypotheses to address the moderation effects, and we found that TMC does not moderate the relation between green purchasing and operational performance at a 95% confidence interval. Meanwhile, the TMC has had a significant impact on the green manufacturing-operational performance relationship and the GPI-operational performance relationship. There are reasons why TMC does not moderate the relationship between green purchasing and operational performance. The reasons are: first, it often requires expensive equipment upgrades and significant investments in redesigning products and processes to be more eco-friendly. These initiatives can be costly and reduce the firm's profitability. Second, most Jordanian firms have limited resources, and greening needs high-cost equipment. Moreover, the perfect selection and collaboration with a suitable supplier are critical, which reflects the negative role of top management in Jordanian firms.

As the study relies on the RBV as an overarching theoretical framework, the study clarified the effect of GSCM on firm performance. The new idea underlying RBV is that resources will influence a firm's ability to implement strategy (Barney, 1991). RBV focuses on the firm's internal resources to form operations and gain an SCA. Green purchasing, manufacturing, product innovation, and TMC are internal firm resources that can be prepared to accomplish SCA. Therefore, the use of RBV matches the objective of the study.

Implications

This study has yielded critical findings that hold immense value for specialists and policymakers in emerging countries, theoretically, practically, societally, and educationally. The implications of these findings are highly beneficial and can potentially revolutionize the field (Wickert et al., 2021). Theoretically, it has extended the literature on GSCM facets, GPI, TMC, and firms' performance. The study identified green innovation as an important mediator between GSCM facets and the firm's performance. Practically, it suggests that top managers should focus more on the green issue and support greening in their firms, as greening is a long-term process. Greening the SC process will improve firms' compliance with regulatory necessities. We recommend that managers implement "supplier monitoring" as their primary collaborative approach, enabling them to stay informed about their suppliers' performance. This will enable managers to make informed decisions and take appropriate action in case of any issues. We highly recommend that managers prioritize supplier monitoring to promote transparency, accountability, and overall success (Laari et al., 2016) and work in close and long-term cooperation with suppliers of potentially advanced technologies. Societally, we recommend collaborating with governments and policymakers to improve labor rights. In line with the Sustainable Development Goals (SDGs)-Goal 9, the firms should consider all the possible measures to apply the SDGs by 2030 (UN, 2025). Educationally, we recommend that officers in education and industry leverage new research by academicians on manufacturing industries in developing countries. This could facilitate discussion seminars on greening manufacturing processes and addressing environmental education challenges.

Limitations and Future Research

Some theoretical and methodological limitations will provide opportunities for future research: First, the study used TMC as a moderator. Future studies may investigate green training as a moderator between GSCM facets and the firm's performance. Second, the study population consisted only of manufacturing firms, limiting the generalization of the results to the service sector. Third, the sample consisted of firms from various industries because of the limited number of firms in Jordan that belong to any specific industry. Fourth, the study context was Jordan; future studies can replicate similar investigations in other developing countries or across countries to generalize results. Finally, having cross-sectional data on Jordanian manufacturing firms assisted us in recognizing the effect of GSCM facets and GPI on operational performance. However, longitudinal data can help understand causal relationships and variable patterns over a certain period, ensuring further accuracy. A qualitative study is needed to uncover why TM is unenthusiastic about implementing GSCM facets.

Conclusion

The key takeaway from this study is that TMC must align with GSCM practices. Ultimately, managers implement green purchasing and manufacturing initiatives. Without their dedication and a supportive work environment, the likelihood of achieving positive outcomes diminishes. Therefore, firms should prioritize fostering managers' commitment and ensuring their focus on environmental responsibility.

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Conflicts of Interest

The authors declare no conflict of interest.

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