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Greening the supply chain: unveiling its impact on operational performance in Malaysian SMEs

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Abstract

There is a growing focus on integrating green supply chain management (GSCM) to improve environmental impact and operational performance. This study examines the effect of the adoption of GSCM on the operational performance of SMEs in Malaysia. A survey methodology using a five-point Likert scale questionnaire was employed to collect data from small and medium-sized enterprises (SMEs). In this study, the questionnaire assessed the adoption and perceived effectiveness of GSCM, including green procurement, warehousing and green building, distribution strategies and transportation execution, and internal environmental management, as well as their influence on operational performance. Of the 170 distributed questionnaires, 127 valid responses were collected and analyzed. The research findings offer valuable insights for SMEs aiming to enhance their environmental and operational outcomes through sustainable practices. This study provides originality by focusing on the adoption and impact of GSCM practices among SMEs in Malaysia. This context has been underexplored in existing literature. While much research has concentrated on large corporations, this study uniquely examines SMEs and their operational performance in terms of GSCM adoption in an emerging country context. Thus, this study provides empirical insights into the effectiveness of specific GSCM practices, contributing valuable insights to academia and industry.

Keywords:
SME;
Operational performance;
Green supply chain;
Green purchasing;
Warehousing
Sustainability.

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1. Introduction

The logistics sector is essential for driving global economic growth.(Li & Chen, 2021). However, its rapid expansion has raised significant environmental concerns, including greenhouse gas emissions, excessive energy consumption, and pollution. (Kim et al., 2024). Addressing these challenges requires a sustainable approach and green supply chain management (GSCM) has emerged as a critical strategy. GSCM integrates eco-friendly practices across supply chain activities—green procurement, warehousing and green building, distribution strategies and transportation execution, and internal environmental management—to enhance sustainability while optimizing operational efficiency (Choudhary et al., 2021).

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Despite its benefits, implementing GSCM remains a challenge, particularly for SMEs. Most SMEs face financial constraints, inadequate infrastructure, and insufficient technical skill experts, which hinders them from adopting GSCM (Ibrahim et al., 2024). For example, warehousing, distribution, and internal environmental management face significant challenges owing to the cost balance between sustainability goals and operations (Ahmed et al., 2019). Additionally, while research on GSCM has predominantly focused on large corporations, studies examining SMEs in emerging economies such as Malaysia remain scarce (Micheli et al., 2020). This study focuses on the relationship between GSCM practices and Malaysian SMEs' operational performance, green procurement, warehousing, distribution strategies, transportation execution, and internal environmental management. In short, this study contributes to the academic literature and industry practice by offering empirical insights into the efficiency of sustainable supply chain practices in SMEs. Thus, the findings are an essential asset for SMEs, policymakers, and industry stakeholders, offering practical recommendations for enhancing environmental sustainability and business performance.

Bibliometric analysis examines sustainability and green supply chain issues to gain holistic insight into sustainability. As indicated in Figure 1, the primary keywords in these articles were identified and examined within the context of the prevailing circumstances.

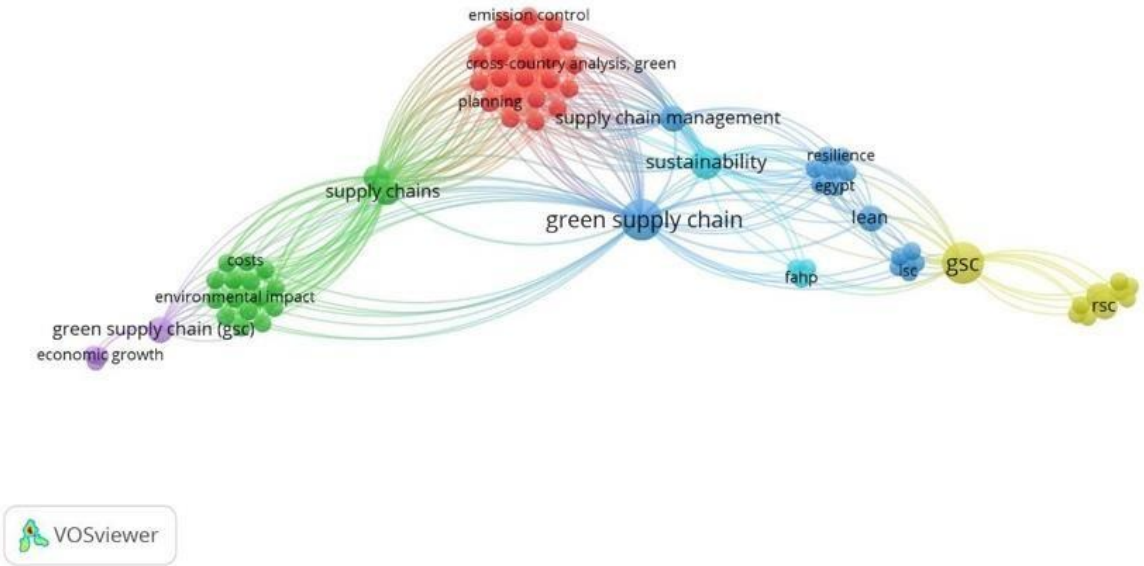

Figure 1: Co-occurrence network of green supply chain

1.1 Problem statement

GSCM practices have arisen as a practical approach to minimize carbon footprints while maintaining high operational performance (Alzoubi et al., 2020), as they have gained global attention on environmental sustainability, which is emphasized in implementing sustainable practices across organizational supply chains (Alzoubi et al., 2020). However, despite the increasing interest in GSCM practices, limited research has explored their implementation and impact in specific areas, namely green procurement, warehousing and green building, distribution strategies and transportation execution, and internal environmental management, which could contribute to enhanced organizational performance.

Green procurement is often linked to getting products and services from suppliers who, in one way or another, can be considered environmentally responsible (Allam et al., 2021). Ahmed et al. (2019) pointed out a gap in the research, mentioning that very few studies have looked at how

purchasing decisions could relate to or influence operational performance, which may or may not be significant. It can be argued that there exists, or maybe even exists, a sort of connection that is somehow related to GSCM, which is still underexplored or at least not thoroughly explored, according to Micheli et al. (2020). Furthermore, it can be said that both warehousing and green buildings are also critical, at least in today's supply chain systems, as they help organize, store, and distribute goods while, or at least attempting to reduce ecological impact, cutting down on energy usage, and maybe even lower the production of wastewater, as stated by Bekrar et al. (2021) and Eti et al. (2023). However, there seems to be a problem, or at least a lack of detailed research, when fully understanding or capturing how these green building techniques and sustainable warehousing methods impact the operational efficiency. The significance of sustainable development goals (SDGs) still does not seem clear or fully realized in past research. Even though the benefits of these practices might be acknowledged or recognized in some circles, it seems that a deeper understanding of how these practices impact, or might impact, operational performance either directly or indirectly is still required and may even be needed, as argued by Wen et al. (2020).

It is important to point out that distribution strategies and transportation execution are vital in sustainability discussions concerning supply chain management, mainly focusing on reducing carbon emissions and cutting down on energy consumption (Sarkar et al., 2019). Previous research has focused on optimizing transportation routes and modes of transportation, looking at ways to decrease empty miles, and considering alternative fuel sources. However, even with all this, a theoretical gap remains concerning the understanding of the challenges and the effectiveness of these strategies. Within the world of logistics, there is a large missing link on how internal environmental management affects daily operations. According to diligent research carried out by Santoso et al. (2024), this management system is not at all a standard bureaucratic obligation. This is an effective mechanism that aims to improve performance according to environmental management. It attempts to reduce energy consumption, improve waste management, and reduce carbon emissions (Shah & Soomro, 2021).

Internal environmental management is important, but its impact on supply chain sustainability has not been uncovered in the literature or in the supply chain context. Nonetheless, despite its significance, there is a considerable gap. In academia, little research has been conducted on the connection between internal environmental Management and Supply Chain Sustainability. This theoretical gap is not simply a gap but an urgent call for action. It points out significant gaps in the ability to measure these practices with appropriate indicators, which are essential for major sustainability goals. This understanding is not only lacking at the academic level but also prevents businesses from using these practices to obtain credible sustainability indicators (Mardani et al., 2020). The ambiguous role of internal environment management significantly undermines resilience and sustainability in the logistics sector. This lack of clarity creates obstacles that hinder effective operations and long-term viability. To promote a truly sustainable business model, it is essential to define and understand these internal processes to foster a more robust logistical framework.

2. Literature review

GSCM is defined as the integration of environmentally sustainable practices into supply chain operations aimed at reducing ecological impacts while sustaining operational efficiency (Saini et al., 2023). This approach differs from traditional supply chain management, which emphasizes economic objectives to optimize costs and improve efficiency in meeting customer demands, often neglecting environmental impacts (Micheli et al., 2020). GSCM practices among Malaysian SMEs have grown more important in business today, as they strive to incorporate sustainability into their operations. However, Malaysian SMEs face challenges in adopting these green practices,

including financial constraints and low awareness and capability (Baskaran et al., 2023). However, there is an increased recognition of the benefits of green supply chains, which include improved operational efficiency, cost savings, and a better reputation (Kumar et al., 2019). Government initiatives, industry collaborations, and capacity-building programs are essential to encourage and facilitate the adoption of GSCM among SMEs (Hong et al., 2019). With government support, industry collaboration, and pressure from rising consumer demand, Malaysian SMEs have accelerated the adoption rate of GSCM. Thus, this initiative would improve market positioning and sustain a competitive edge, while minimizing the environmental footprint (Wong et al., 2020). Despite these insights, gaps exist where past studies focus on large corporations in developed countries, with limited research conducted in emerging economies such as Malaysian SMEs (Micheli et al., 2020). The impact of GSCM practices on SMEs performance is underexplored (Ahmed et al., 2019). For example, although green procurement improves efficiency in large organizations (Bag et al., 2022), its applicability to SMEs with limited supplier options is unclear. This study aims to address these gaps by investigating the impact of GSCM on Malaysian SMEs performance.

2.1 GSCM in SMEs

GSCM applies sustainable practices throughout the manufacturing and distribution processes to reduce environmental impact. According to Ahsan et al. (2022) and Balasubramanian et al. (2020), general supply chain management is important for green responsibility in business activities. Adopting GSCM and eco-friendly supply chains has improved market competitiveness (Saini et al., 2023). According to Adaui et al. (2024), GSCM should be designed for the reuse, recycling, and environmentally friendly management of resources. GSCM has gained increasing attention among sustainability practitioners, academic researchers, and business organizations in response to climate change. Thus, it provides a framework for managing eco-challenges, while maintaining business efficiency. By incorporating GSCM practices, businesses can achieve both economic and environmental objectives (Khan et al., 2022). GSCM reduces the negative sustainability impact on the environment, along with the life cycle of products (Yang et al., 2023).

Various sectors, such as SMEs and logistics, are shifting to green transport, fuel-efficient logistics, and digitalization of supply chains (Akbulut & Burçin Yereli, 2023). However, Mardani et al. (2020) state that SMEs often lack sufficient technical knowledge, financial resources, and regulatory support to undertake large-scale GSCM initiatives. According to previous studies, SMEs' ability to transition to green supply chains depends mainly on government regulations and environmental policy terms (Yang et al., 2023). Yang et al. (2023) further illustrate that the successful adoption of warehousing sustainability, green logistics, and in-house environmental practices hinges on macro-level institutional pressures (for example, environmental policies) and micro-level business strategies (such as lean manufacturing, supplier relationship management, and technology adoption) to improve operational efficiency and enhance sustainability. Understanding these patterns is important to provide SMEs, regulators, and the industry with useful insights into managing the difficulties faced in the competitive performance of green supply chain implementation (Yang et al., 2023).

2.2 Operational performance

Operational performance refers to an organization's capability to deliver products and services efficiently while optimizing resources and meeting customer expectations (Saleheen & Habib, 2023). While legacy manufacturing systems, such as textile industries, prioritize operational scales, the contemporary business environment demands a shift towards sustainable practices, positioning GSCM as a critical balance for balancing performance with environmental responsibility (Nazir et al. 2024). The manufacturing industry remains notably resource-dependent while confronting substantial environmental obstacles that require attention.

Environmentally conscious production methods within this field contribute to operational improvements, efficiency enhancements, and waste minimization – that is to say, these practices lead to better resource utilization and output optimization. In the context of SMEs, operational performance is critical for achieving competitive advantage and sustaining growth in a resource-constrained environment (Ahmad & Karadas, 2021). Research findings by Jain et al. (2024) demonstrate how such sustainable approaches enable manufacturers to address ecological concerns while maintaining business viability, although implementation challenges persist, particularly for smaller enterprises with limited technical capacities.

In addition, the incorporation of sustainable supply chain management practices in garment organizations has positively influenced their economic, environmental, and social performance, highlighting the essential role of sustainability initiatives in this industry (Rubel & Rimi, 2022). The benefits encompassed in this context include enhanced efficiency through reduced inventory and scrap rates, improved product quality, expanded production and capacity efficiency, and enhancement in timely delivery performance to customers (Saleheen & Habib, 2023). The term 'operational performance' corresponds to the ability of companies to provide their customers with products in a timely and efficient manner. It comprises effective measures aimed at inventory level minimization, product quality enhancement, scrap rate and delivery lead time reduction, and capacity utilization.

Recent research by Pintuma et al. (2024) indicated that stakeholder-driven efforts may positively affect sustainable supply chain management through the combined effects of green supply chain approaches and innovation. Operational performance, that is, how well a company operates, is considered a strategic area that businesses choose to focus on when competing. Manufacturers can create a competitive edge if they convert competitive objectives into strategic capabilities. GSCM refers to a strategic ability that allows organizations to maintain competitive advantage. GSCM includes various components such as green procurement, warehousing, distribution strategy, transportation execution, and internal environmental management (Saini et al., 2023). For example, more efficient green procurement and warehousing methods can enhance product quality and lower costs. According to the latest research findings, it helps organizations better position themselves in the market and have amended customers for the long run (Ibrahim et al., 2024; Ren et al., 2021).

2.3 GSCM practices

As global institutional pressure towards green adoption has become evident, supply chain management has evolved to focus on GSCM and sustainability, working within the framework to establish environmental needs (Bari et al., 2022; Saini et al., 2023). GSCM refers to the implementation of environmentally conscious practices in the supply chain. Internal GSCM practices refer to those implemented within the organization, whereas external GSCM practices involve interactions with external partners within the organization's network (Stekelorum et al., 2021).

It encompasses a range of green activities that are not limited to the management of materials, green procurement, green manufacturing, reverse logistics, green design, investment recovery, internal environmental management, green distribution, and marketing. These practices aim to promote environmental sustainability and integrate supply chain management with consumer end-of-life management (Burke et al., 2023). The context of GSCM practices has been extensively discussed in academic discourse. Various practices have been deliberated, and internal environmental management denotes top management support in GSCM efforts and supports the adoption of appropriate environmental management systems. In addition, eco-design and packaging entail the use of recycled materials and environmentally friendly packaging design to reduce waste. Investment recovery involves strategically selling excess inventory and using materials to improve capital returns (Stekelorum et al., 2021). Implementing greener production,

transportation, and packaging practices would improve the environmental, economic, and social aspects of sustainability. In contrast, other practices positively affect only one or two of these dimensions (Tantan & Akdağ, 2023). This necessitates the incorporation of environmentally friendly practices in all supply chain processes, along with the subsequent environmental consequences, operational processes, immediate financial costs, and long-term organizational performance (Ahsan et al., 2022).

GSCM practices encompass fundamental organizational strategies, including internal environmental management, supplier evaluation and selection, green procurement, and investment recovery (Sahoo & Vijayvargy, 2021). GSCM has gained increased attention in recent decades because of the need for organizations to eliminate environmentally damaging practices and improve collaboration between suppliers and customers for eco-friendly products (Khan et al., 2022). The concept of GSCM was first introduced in the early 1990s and gained popularity around 2000, as evidenced by an increase in scholarly publications (Khan et al., 2022; Rajkiran & Almeida, 2024; Tseng et al., 2019). These practices encompass the concept of green supply, which refers to the collaborative efforts between suppliers and third-party logistics providers with assessments of supplier environmental practices. The implementation of external practices in GSCM involves engaging in collaborative endeavors with external stakeholders, including suppliers and customers (Bag et al., 2022; Stekelorum et al., 2021). Furthermore, customer collaboration entails engaging with customers to co-create environmentally sustainable services and solutions that align with their specific requirements (Stekelorum et al., 2021). Thus, GSCM practices have evolved from regulatory necessity to a strategic tool for improving environmental sustainability and operational performance. Figure 2 shows the research model that examines the relationship between GSCM practices and operational performance.

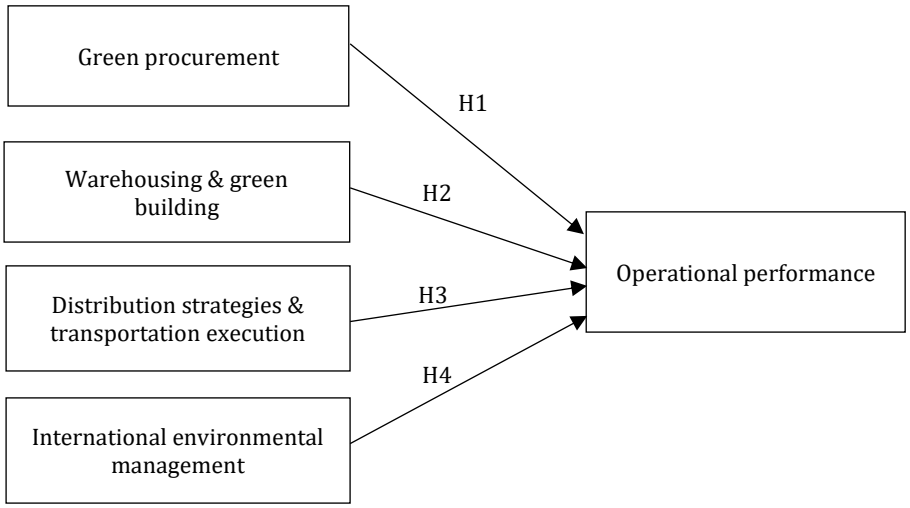

Figure 2: The research model of the study

2.4 Green procurement

Green procurement is a smart purchasing approach towards energy-efficient products and services for carbon emission reduction and improvement of suppliers' relationships for sustainable development and performance improvement. (Khan et al., 2022). Prior research has indicated a link between green procurement and improved operational performance. Organizations that apply green procurement mitigate their footprint by establishing

environmental collaborative networks with their suppliers and complying with material standards according to Yang et al. (2023). Moreover, adhering to green procurement standards facilitates the consistency of goods, elongation of product lifespan, and enhancement of production efficiency through the effectiveness of resources and reduction of waste, which contributes to the circular economy (Bag et al., 2022). Moreover, Arora et al. (2020) revealed that green procurement can help enhance supply chain reliability in an organization and add it as a GSCM practice in an organization. Thus, the chain reliability is improved. This results in a reduced delivery time and improved delivery efficiency. When the supplier network is streamlined, forecast accuracy is improved, helping a company respond quickly to market demands. This mitigates stock-outs and improves customer retention. Bag et al. (2022) study the impact of green procurement practices on internal environmental management systems. The study showed that companies that included green criteria when procuring demonstrated better internal ecological management, worked better with suppliers, and improved overall sustainability performance. In other words, enhanced supplier collaboration can result in more reliable delivery schedules and better stock level management. This enhancement helps make the entire supply chain more efficient and improves the performance of operations.

Similarly, green procurement improves inventory optimization and capacity utilization. Bag et al. (2022) further demonstrated that adopting recyclable materials and modular parts according to green procurement standards would significantly reduce excessive inventories and improve production flexibility. More efficient usage of resources and enhanced supplier consistency would allow businesses to scale their operations efficiently, thus reducing holding costs and improving overall production throughput. Green procurement is often viewed through the lens of environmental benefits. Therefore, it would directly contribute to the operational performance. Strengthening supplier relationships would improve product quality, enhance supply chain resilience, and help companies meet customer demands effectively.
H1: There is a positive relationship between green procurement and operational performance.

2.5 Warehousing and green building

Warehousing and green buildings focus on implementing eco-friendly material handling, a design that promotes energy efficiency, and technology-based solutions for warehouse operations. This approach aims to reduce the environmental impact of warehousing activities, while improving operational efficiency (Oloruntobi et al., 2023). Implementing green building practices and warehousing operations is paramount for advancing sustainability within the green supply chain framework. A study conducted by Ibrahim et al. (2024) indicated that companies that integrate environmentally conscious material handling machinery and procedures experience a decrease in carbon emissions, an increase in operational effectiveness, and an overall improvement in sustainability outcomes. In addition, studies conducted by Gilani et al. (2023) and Herbes et al. (2020) substantiate that implementing green practices, such as sustainability initiatives, within warehousing operations can yield a prompt return on investment while simultaneously satisfying stakeholder expectations and contributing to long-term environmental improvement. These green warehousing practices can enhance operational performance by improving internal resource utilization and waste reduction (Ibrahim et al., 2024). Moreover, the adoption of cost-effective, energy-saving lighting and material-handling systems can reduce operational costs and improve throughput by reducing machine and equipment downtime and failure rates (Oloruntobi et al., 2023). Streamlining inventory control through sustainable practices minimizes holding costs and reduces lead-time, thereby improving overall supply chain responsiveness (Bag et al., 2022; Stekelorum et al., 2021). In short, integration from these improvements would allow the organization to respond swiftly to customer orders, leading to enhanced customer loyalty and sustaining competitive advantage (Ahmad & Karadas, 2021; Yang et al., 2023). The message of sustainability is becoming clear in the ever-changing world of global trade. According to Chueamuangphan et al. (2020), the harmful practices commonly used in warehouses aggravate

climate change phenomenon (Yang et al., 2023). Against this backdrop, green supply chain management could provide a suitable alternative. When firms incorporate green aspects into their logistics, they reduce harmful effects and enhance their cultural environment (Kumar & Alok, 2020). With the advent of COVID-19, the relationship between social living and the economy has undergone massive change.
H2: There is a positive relationship between warehousing, and green building & operational performance.

2.6 Distribution strategies and transportation execution

Distribution strategies and transportation execution are practical applications of sustainable distribution strategies, proficient route planning, and technology-based solutions aimed at enhancing transportation operations, mitigating environmental impacts, and augmenting the supply chain's overall sustainability (Arunmozhi et al., 2022). Recent research has emphasized the importance of distribution strategies and transportation execution in achieving sustainable supply chain operations within business entities. A study by Apte and Viswanathan (2000) investigated how using sustainable ways of distribution, which are cross-docking and last-mile consolidation, could reduce emissions while improving supply chain performance. When these techniques are used, changes in transport spending, pollution caused by the environment, and road congestion are seen to be affected in a way that makes them less problematic. Warehousing operations see a decrease in costs by cross-docking, and order fulfilment experiences improvement because storage space is wasted less, so in general, supply chains can react more quickly (Yang et al., 2023). In addition, last-mile consolidation in the delivery process makes things work more efficiently and increases the delivery reliability (Bag et al., 2022). When these aspects are combined, a company can spend less money on operations and the supply chain can become more flexible, which is necessary for staying ahead in market competition (Ahmad & Karadas, 2021).

A survey conducted by Fan et al. (2023) explored the significance of transportation execution practices, such as vehicle load planning and routing optimization, in reducing environmental impacts. Fan et al. (2023) conducted a survey on how transportation execution techniques could affect the environment, including how vehicle load planning and routing optimization play roles in reducing damage. If vehicle loading is planned effectively, transport costs can decrease because it uses full truck capacity and avoids having empty runs, leading to less fuel (Fan et al., 2023). Routing optimization can enhance delivery speed and accuracy by minimizing traveling distances and reducing traffic delays (Bag et al., 2022).
H3: There is a positive relationship between distribution strategies and transportation execution and operational performance.

2.7 Internal environmental management

Internal environmental management refers to the implementation of ecological activities within an organization's structure, so there is no involvement of external parties and partners. In other words, this improves efficiency within the organization through employee initiatives, not through external areas, which helps reduce their footprint. The latest studies have drawn attention to using internal environmental management systems and techniques. A study by Zimon et al. (2021) assesses how internal environmental management systems, specifically the adoption of ISO 14001 certification, affect an organization's environmental performance. Organizations that possess ISO 14001 certification yield better waste management, energy efficiency, and sustainability outcomes. Smart waste management will help save costs and improve efficiency. Furthermore, as energy efficiency increases, less money will be spent on utility bills and the equipment will run on less downtime, which will help create a higher output at a lower cost (Zimon et al., 2021).

Recent studies show that internal environmental management strategies are key drivers of corporate innovation and ecological design. Wungkana et al. (2023) analyzed the link between internal environmental management and ecological design activities. According to their findings, firms with strong internal environmental management systems tend to spend their resources on ecological design practices. Such practices have led to the development of green products and reduced usage of materials, along with product durability. As indicated by Wungkana et al. (2023), these outcomes can enhance operational performance through improved production synchronization, lower material costs, and greater customer satisfaction.
H4: There is a positive relationship between internal environmental management and operational performance.

3. Methods

This study uses a quantitative survey research design to examine the relationship between GSCM practices and operational performance in SMEs. The unit of analysis is SME, defined as organizations with annual revenue below RM50 million and number of employees less than 250, consistent with the Malaysian SME classification based on SME Corp. (2024). SMEs were selected because of their critical role in the supply chain, where logistical operations are essential for enhancing efficiency, ensuring timely delivery, and optimizing costs to meet customer demand (Tarigan et al., 2021). By focusing on SMEs, this study explores whether GSCM practices can be effectively implemented in resource-constrained environments to improve operational performance.

3.1 Population and sample

The primary objective of this study is to examine the overall impact of GSCM on operational performance within the target group of SMEs in the Malaysian industry. Therefore, the target population of this research will be Penang, Selangor, Melaka, Johor, and Sarawak. These states were selected because they are major industrial hubs collectively hosting a significant proportion of Malaysian manufacturing SMEs, which are critical to supply chain activities relevant to GSCM, based on SME Corp. (2024). By focusing on these regions, the study ensures a representative sample that captures diverse GSCM practices and their effects, aligning with the goal of generating insights applicable to the broader Malaysian SME sector Targeted respondents focused on the middle management positions, which are executive top management, manager, and supervisor within SMEs, the study potentially overlooks diverse perspectives from other organizational levels.

To enhance the rationale for determining the required sample size, the study employed the sample size determination method proposed by Faul et al. (2009), which involved utilizing the G*Power software. According to Cohen's (2013) recommendation, the desired effect size for the population is set at 0.15. A significance level of 0.05 and a statistical power of 0.8 were specified as inputs in the G*Power software to determine the necessary sample size. Four predictors were selected for the study. The G*Power software output indicated that a minimum sample size of 85 was appropriate. However, low response rates may indicate potential biases in survey research, including non-response bias (Pielsticker & Hiebl, 2020). As a result, the number of questionnaires issued doubles to approximately 170 responders. This study adopted simple random sampling as its sampling methodology.

Based on SME Corp. (2024), the population used in this study consisted of 71,612 SME manufacturing companies across Malaysia. The SMEs were grouped according to their parent names. A random sampling technique was adopted to determine the selection of senior

executives directly involved in new product development per company. Random sampling was performed by selecting every fifth element after the first element was chosen from the list of SMEs. In addition, random sampling is the most relevant technique in which senior executives and management with at least three years of experience involved in GSCM activities have equivalent chances to be selected and signify SMEs in Malaysia (Sileyew, 2020). This technique enables researchers to acquire a representative sample, thereby mitigating bias and transforming the generalizability of the results into an enormous population. Table 1 summarizes the study's sample.

Table 1: Demographic profile of the respondents

Demographic attributes		%
Gender	Male	70.1%
	Female	29.9%
Education	Associate Degree/ Diploma	10.2%
	Bachelor's Degree	81.1%
	Master's Degree	8.7%
Type of industry involve	Food and Beverage	36.2%
	Electrical and Electronics (E&E)	19.7%
	Chemical and Pharmaceutical	1.6%
	Automotive	16.5%
	Transportation	23.6%
	E-Commerce	2.4%
Experience in the industry	3 to 5 years	10.2%
	5 to 10 years	47.2%
	10 years and above	42.5%
Duration of working experience in the company	1 to 2 years	13.4%
	3 to 5 years	36.2%
	5 years and above	50.4%

3.2 Research instrument

The survey questionnaire utilizes a 5-point Likert scale for respondents to assess the respondents' attitudes and opinions on the questionnaire (Santino et al., 2022), denoting the numbers from 1 to 5, signifying strongly disagree through strongly agree, will be used to assess the questionnaire. Green procurement (GP) was measured using five items adapted from Bag et al. (2022) and Yang et al. (2023), focusing on environmentally responsible purchasing practices and supplier collaboration. These items assess the extent to which SMEs incorporate environmental criteria in their procurement decisions. To evaluate the use of eco-friendly materials, energy-efficient systems, and sustainable warehousing practices, warehousing and green building (WGB) was measured using five items drawn from Ibrahim et al. (2024) and Oloruntobi et al. (2023). Distribution strategies and transportation (DSTE) was assessed using five items adapted from Fan et al. (2023) and Yang et al. (2023), focusing on sustainable distribution practices, such as route optimization and alternative fuel use. Internal environment management (IEM) was measured using five items sourced from Zimon et al. (2021) and Wungkana et al. (2023) to assess internal sustainability practices, such as environmental certifications and waste management. Operational performance (OP) was measured using five items adapted from Ahmad and Karadas (2021) and Saleheen and Habib (2023) to evaluate metrics such as cost reduction, productivity, and responsiveness to market demands. All the survey items are provided in the Appendix.

According to Soni and Kodali (2012), content validity is crucial for validating the constructed items of the measurement model. Content validity is crucial because it provides confidence in measured instruments. This study achieved face and content validity by utilizing metrics derived

from reliable sources from previous research. Four senior academic experts and practitioners pre-tested the items to validate the content of the questionnaires. Materials encompassing the definition of constructs, items, ratings, participants' designations, and acknowledgement were provided to four experts (Soni & Kodali, 2012). Subsequently, the four experts are required to respond to the significance associated with the construct using a four-point ordinal scale that ranges from "1," which signifies "not relevant," "2," which signifies "somewhat relevant," "3" signifies "quite relevant," and "4" signifies "highly relevant." This study adopted a four-point ordinal scale to reduce ambiguities in ratings (Ibiyemi et al., 2019). In Table 2, all content validity indices obtained are significant above the value of 0.70, indicating a high acceptance level of content validity indices for GSCM and operational performance measurement.

Table 2: Content validity indices

	Expert			
Variables	1	2	3	4
GSCM Practices				
Items that are "not/somewhat relevant"	2	1	1	1
Items that are "quite/highly relevant"	18	19	19	19
Content Validity Indices	0.89	0.94	0.94	0.94
Operational performance				
Items that are "not/somewhat relevant"	1	0	1	0
Items that are "quite/highly relevant"	4	5	4	5
Content Validity Indices	0.94	1.00	0.94	1.00

Note(s): 1-non-relevant, 2- relevant, 3- quite relevant, 4- highly relevant

4. Results

A reliability analysis was conducted to determine the consistency and dependability of the measured items in each variable between GSCM and operational performance. Coefficients above 0.7 are considered acceptable (Ibiyemi et al., 2019). Table 3 shows the results of Cronbach's alpha. As illustrated in Table 2, all variables in this study had coefficient values that exceeded 0.70, indicating sufficient reliability for all utilized items. The reliability tests ascertained the items' validity and reliability, laying a solid basis for evaluating the subsequent hypothesis.

Table 3: Reliability analysis

Variables	Number of Items Utilized	Cronbach's Alpha
GP	5	0.734
WGB	5	0.824
DSTE	5	0.707
IEM	5	0.718
OP	5	0.776

Note: GP = Green procurement, WGB = Warehousing & Green Building, DSTE = Distribution Strategies & Transportation Execution, IEM = Internal Environmental Management, OP = Operational Performance

4.1 Pearson correlation analysis

Pearson's correlation analysis determined the association between GSCM practices and operational performance. In general, a correlation is considered high when the absolute value of r is more than 0.60 (Saccenti et al., 2020). Table 4 illustrates the association between GSCM practices and operational performance. The warehousing and green building variables had the

most substantial relationship with operational performance (r=0.898), followed by internal environmental management (r=0.763) and distribution strategies and transportation execution (r=0.733). However, green procurement has a low correlation with operational performance (r=0.722). All the independent variables have a strong correlation with operational performance.

Table 4: Pearson correlation analysis

	OP
GP	0.722**
WGB	0.898**
DSTE	0.733**
IEM	0.763**

Note: p**<0.01 (one-tailed)

4.2 Multiple regression analysis

The R^2 value of 0.262 suggests that approximately 26.2% of the variation in operational performance can be explained by GSCM practices, indicating a certain level of influence. The F-value of 10.812, with a p-value of less than 0.001, is quite significant. This means that the model is statistically significant and that the relationship between GSCM practices and operational performance is unlikely to be due to chance. Table 5 shows that one of the four GSCM practice variables is positively related to operational performance. The hypothesis is not supported if the p-value exceeds 0.05 (Rovetta & Mansournia, 2024). Therefore, the accepted variables are warehousing and green buildings (β=0.405, t-value=4.058, p-value=0.003), showing a strong positive relationship with the operational performance of SMEs in Malaysia. Hence, H2 is supported. Meanwhile, there is no significant relationships between operational performance and green procurement (β=0.004, t-value=0.043, p-value=0.483) with distribution strategies and transportation execution (β=0.076, t-value=0.735, p-value=0.232), and internal environmental management (β=0.097, t-value=0.961, p-value=0.170). Consequently, H1, H3, and H4 are rejected.

Table 5: Multiple regression analysis

Hypothesis	Standardized beta	t-value	p-value	Decision
H1: GP → OP	0.004	0.043	0.483	Not Supported
H2: WGB → OP	0.405	4.058	0.003	Supported
H3: DSTE → OP	0.076	0.735	0.232	Not Supported
H4: IEM → OP	0.097	0.961	0.170	Not Supported

Note: GP = Green procurement, WGB = Warehousing & Green Building, DSTE = Distribution Strategies & Transportation Execution, IEM = Internal Environmental Management, OP = Operational Performance

To understand the extent of GSCM adoption, descriptive statistics (mean scores on a 5-point Likert scale, 1 = strongly disagree, 5 = strongly agree) were calculated for each GSCM variable based on the survey responses (N=127). Table 6 presents the results of the study.

Table 6: Descriptive analysis

Variables	Mean	Standard Deviation
GP	3.12	0.85
WGB	3.65	0.72
DSTE	3.08	0.90
IEM	3.15	0.88

5. Discussion

Based on hypothesis testing, the findings of this study rejected H1. This shows that green procurement has no positive or significant relationship with operational performance. While these practices are essential for sustainable growth and may offer competitive advantages such as cost savings and enhanced customer satisfaction, their direct relationship with operational performance is not always straightforward. One of the reasons that green procurement has a limited impact on operational performance is that financial constraints significantly hinder the sustainable development practices. When SMEs view green products or services as expensive, they are likely to prioritize cost savings over environmental considerations (Lin et al., 2020). Additionally, the lack of regulatory incentives or clear policies from the government to promote sustainable procurement may contribute to the reluctance and lack of motivation among SMEs in Malaysia to adopt green practices (Bakar et al., 2020).

A study conducted by Ahmed et al. (2019) further highlighted the supply chain challenges of SMEs in Malaysia concerning the implementation of green procurement. If options are limited or suppliers are not adequately ready to provide green materials consistently, the effectiveness of green procurement initiatives cannot be guaranteed. Finally, Yee et al. (2021) pinpoint cost as an important barrier towards the adoption of sustainable practices by Malaysian SMEs. Many such firms often lack the necessary resources, particularly in emerging economies, such as Malaysia. Green products and technologies can be expensive initially, and the direct operational benefits are often not great for SMEs considering going green.

The correlation between warehousing & buildings and operational performance is worth probing in contemporary business practice. The hypothesis test for H2 is supported, which illustrates a significant and positive relationship. Ibrahim et al. (2024), Perotti and Colicchia (2023), Ren et al. (2021), and Yin et al. (2024) have come up with studies that support these findings and provide enormous evidence to support their assertions regarding sustainable logistics warehousing. As companies increasingly adopt green building initiatives, they not only enhance environmental management, but also boost operational efficiency. As companies increasingly adopt green buildings, they enhance their environmental management and operational efficiency (Perotti & Colicchia, 2023). Based on Ren et al. (2021), the future efficiency, integration, and sustainability of modern warehouses will pave the way for new development that is both sustainable and profitable.

Sustainable building techniques, such as installing solar panels, harvesting rainwater, and implementing energy-efficient lighting systems, would yield better energy efficiency and water utilization, and reduce greenhouse gas emissions (Manzoor et al., 2021). Moreover, previous research by Ibrahim et al. (2024) highlighted the importance of implementing environmentally friendly practices in warehouse material management and processes. Organizations that implement environmentally sustainable material-handling equipment and processes can reduce carbon emissions, enhance operational efficiency, and improve sustainability.

Next, H3 is not supported because there is no significant relationship between distribution strategies and transportation execution, and operational performance. This might be due to inadequate logistics management skills and expertise in the workforce, which poses a significant challenge for SMEs (Hulla et al., 2021). This skill gap can impede the effective implementation and execution of distribution and transportation strategies, thereby affecting their impact on operational performance (Argiyantari et al., 2022). Therefore, the workforce's logistics management capability plays a critical role in determining the success of distribution strategies and transportation execution, which impacts operational performance.

Hypothesis H4 is not supported by the hypothesis testing results. The Malaysian government has implemented several initiatives, such as the Green Technology Tax Incentive, to promote sustainable practices among SMEs (Isa et al., 2021). Additionally, the 2025 National Budget aims

to improve SMEs' competitiveness through targeted sustainability measures. However, these efforts have not been sufficient to drive widespread adoption of internal environmental practices. Thus, governmental bodies must create awareness programs among SME leaders to encourage their active involvement in these programs. (Thanki & Thakkar, 2019).

6. Limitations and future research

Although this research provides valuable insights and expertise on SMEs in Malaysia, it is crucial to recognize that limitations may affect the relevance and practical consequences of this study. The first limitation of this study is sample selection and geographical restrictions. The study's results are generally from Malaysian free trade industrial states, such as Penang, Selangor, Melaka, Johor, and Sarawak, which may restrict the generalizability of the findings. The regional characteristics of the chosen state, including its economic, cultural, and industrial dynamics, may differ significantly from those of other regions. Thus, the results may not represent SMEs in other parts of Malaysia or different economic environments. In addition, the concept of GSCM practices and operational performance is still in its infancy in emerging countries, such as Malaysia. The lack of extensive studies in this research area poses challenges in establishing a robust theoretical framework and drawing a comprehensive comparison. This emerging nature of the field is an obstacle in establishing metrics and benchmarks to evaluate GSCM practices among Malaysian SMEs.

Future research could further emphasize the expansion of broader geographical coverage, recognizing that participants from different regions may provide more distinctive points of view. Investigating the impact of GSCM practices on the operational performance of Malaysian enterprises on a large scale is crucial. Future research should focus on a broader scope, such as green eco-packaging, green supplier collaboration, green transportation, and energy efficiency initiatives, which would allow researchers to better understand GSCM practices and their impact on operational performance. Future research could look into similar topics to improve their findings by combining quantitative surveys and in-depth interviews or focus group discussions with the decision-makers in SMEs, as these would be valuable inputs to business owners in choosing the strategies of SMEs to implement GSCM practices. Combining these approaches allows researchers to understand the topic in detail, going beyond simply looking at numbers.

7. Conclusion

The research has revealed significant implications for research communities on the impact of GSCM practices, including green procurement, purchasing, warehousing and green building, distribution strategies and transportation execution, and internal environmental management towards operational performance. However, the relationship between green procurement and operational performance has been inconsistent. This is mainly due to financial constraints, and SMEs may prioritize cost savings over environmental considerations as sustainable practices are perceived as costly. As mentioned above, SMEs mostly move towards their primary objectives of profit maximization in the short term rather than the long term. This is also due to limited options for green suppliers or insufficient preparation to provide consistent green materials.

The findings reveal a consistent relationship between warehousing and green buildings, and operational performance. Support for this hypothesis indicates that investments in warehousing & green building practices have a tangible positive effect on operational performance. This finding reinforces the growing body of literature that supports the efficacy of sustainable infrastructure in enhancing operational efficiency, reducing energy costs, and improving environmental outcomes. Moreover, the findings revealed no consistent relationship between the

distribution strategies, & transportation execution, and operational performance. This is due to the lack of logistics management skills among SMEs in the workforce. This non-significant result may indicate that in the context of SMEs in Malaysia, merely adopting green practices in distribution and transportation does not necessarily guarantee operational performance improvements. This may be due to the complexities of implementing such strategies cost-effectively, especially for SMEs with limited resources. The study also demonstrated an inconsistent relationship between internal environmental management and operational performance, as internal environmental management practices alone may not be sufficient to drive operational performance improvements among SMEs in Malaysia. This could be attributed to a lack of employee engagement, insufficient resources for effective implementation, or a mismatch between internal practices and broader organizational goals.

From a practical perspective, the findings of this study provide important insights for SMEs along with policymakers and industry stakeholders in Malaysia. Practitioners must recognize the value of GSCM and actively integrate these practices into their management strategies. Green procurement, warehousing, and green buildings are essential elements of the green supply chain that companies can implement to enhance operational performance. The analytical outcomes within each category serve as instructive benchmarks for prospective implementation of GSCM. Furthermore, the findings empower practitioners to comprehensively evaluate their existing supply chain landscape concerning green procurement, warehousing & green building, distribution strategies & transportation execution, and internal environmental management by applying the prescribed model. This study emphasized the need for industrial practitioners to integrate GSCM practices with technological innovation, asserting that such advancements would elevate the proficient application of sustainable practices while increasing overall supply chain productivity. The findings reveal that integrating state-of-the-art technologies within the GSCM framework alleviates environmental concerns and empowers organizations to attain competitive edges, operational effectiveness, and long-term sustainability in a commercial landscape that is increasingly influenced by ecological considerations and technological evolution. In short, the findings have substantial practical implications for policymakers as they demonstrate a positive relationship between diverse GSCM practices and operational efficiency within SMEs. This knowledge would provide policymakers with a thorough understanding of the benefits linked to the adoption of GSCM practices. Given the escalating significance of environmental issues in Malaysia, policymakers must proactively formulate pertinent legislation and guidelines for these practices. Embracing this proactive approach is vital for fostering sustainable business GSCM practices among Malaysian firms, aligned with the nation's broader environmental challenges.

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Appendix

Survey items for green procurement

GP1 Environmental criteria for bought products in design specifications are provided to vendors.
GP2 Our organization collaborates with suppliers to achieve environmental goals.
GP3 An internal environmental audit for suppliers' management is performed
GP4 Environmental parameters are used to choose suppliers.
GP5 Our products are eco-labelled.

Survey items for warehousing & green building

WGB1 Our company pays attention to green building materials (e.g. use of recycled concrete, steel, asphalt, and other green materials).
WGB2 Our company has day lighting (installing skylights and clerestory windows in distribution facilities allows companies to use natural light as a source of interior illumination).
WGB3 Our company emphasize energy-efficient lighting systems.
WGB4 Our company emphasize energy-efficient material-handling equipment.
WGB5 Our company has been using alternative energy sources (e.g. solar or photovoltaic panels).

Survey items for distribution strategies and transportation execution

DSTE1 We have an environmentally friendly facility location. DSTE2 Our company has been using alternative fuels.
DSTE3 Within the firm, we have mode selection based on "eco-friendly" parameters.
DSTE4 We have an effective shipment consolidation and full vehicle loading.
DSTE5 We can route systems to minimize travel distances.

Survey items for internal environmental management

IEM1 Within the company, there are practices of adopting environmental certification.
IEM2 Within the company, there are systematic environmental performance assessment practices.
IEM3 Within the company, there are practices to systematically monitor environmental aspects and impacts.
IEM4 Within the company, there are practices of using alternative energy sources. IEM5 Within the company, there are practices of using 3R systems.

Survey items for operational performance

OP1 The number of complaints from customers is steadily decreasing. OP2 The ISO14001 certification of suppliers is performed.
OP3 Productivity has been steadily rising.
OP4 Manufacturing unit costs are steadily falling.
OP5 We respond quickly to changes in market demand.