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Impact of green supply chain integration management on business performance: a mediating role of supply chain resilience and innovation the case of Saudi Arabian manufacturing sector

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Impact of green supply chain integration management on business performance: a mediating role of supply chain resilience and innovation the case of Saudi Arabian manufacturing sector

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ABSTRACT

This study examines the impact of green supply chain integration on business performance in the Saudi Arabian manufacturing sector, focusing on the mediating role of supply chain resilience and innovation. Inferential statistical techniques, including correlation and regression analyses, were applied to data collected from 450 respondents. The study found a strong positive correlation between green supply chain integration and company performance, supporting the hypothesis that better company performance is associated with green supply chain integration. Additionally, this study investigates the mediating effects of supply chain resilience and innovation. The results indicate that supply chain resilience negatively affects green supply chain integration, whereas innovation positively mediates the relationship between green supply chain integration and company performance. Furthermore, environmental supplier selection and eco-friendly production methods were found to be positively correlated but not statistically significant, suggesting the need for further investigation in this area. The findings underscore the importance of fostering a culture of innovation and environmental responsibility in Saudi Arabian manufacturing enterprises. The study concludes with implications for future practices, suggesting the need for strategic investments in innovation-driven strategies and collaborative partnerships to promote sustainable development within the supply chain.

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Business, Management and Accounting; Environmental Economics; Sustainable Development; Technology; Innovation Management

1. Introduction

Increasing industrial and technical challenges have led companies to greener their organizations. (Zhu & Sarkis, 2007; Lai et al., 2010). Effective management is crucial for maintaining a balance between organizational economic performance and activities aimed at promoting environmental sustainability (Boiral, 2007; Zhao & Yang 2017). Additionally, single companies merged into larger company networks, moving separate operations to a single supply chain approach (Vachon & Mao 2008; Zhao & Yang 2017). Furthermore, because of organizational ties, supply chain integration and cooperation have steadily increased (Frohlich & Westbrook, 2018; Gunasekaran et al., 2018). Green supply chain management (GSCM) chain is becoming more difficult because of supply chains and environmental problems. Manufacturing firms used GSCM and their supply chains used order to boost productivity.

The integration of ecologically friendly ideas and practices, which can be challenging in a supply chain, is recognized as '*green supply chain management*.' Businesses find it difficult and unpredictable to use GSCM. The concerns of environmental, production, technical, marketing, and logistical professionals should be integrated across organizational and functional boundaries to effectively handle variety and unpredictability (Sarkis, 2006). Manufacturing companies can profit from GSCM practice adoption by

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coordinating and integrating internal factors, such as management support, and external factors, such as supplier and customer cooperation. GSCM improves financial and nonfinancial enterprise performance (Geffen & Rothenberg 2016; Mueller et al., 2019; Sarkis, 2013; Vachon, 2007). It is difficult to realize and evaluate many performance parameters, making the adoption of GSCM difficult.

As more individuals become aware of how traditional supply networks affect the environment, green supply chain integration management has grown in importance as a component of contemporary company strategies (Yu et al., 2014). As companies in the Saudi Arabian manufacturing sector navigate a dynamic global marketplace, green supply chain integration management adoption has become pivotal in sustaining long-term competitiveness and ensuring responsible corporate citizenship (Junaid et al., 2022). The potential impact of enhancing business performance through the integration and management of a sustainable supply chain is multifaceted (Han & Huo 2020). Companies that embrace sustainability practices are likely to enhance brand reputation and increase market competitiveness. Previous research (Setyadi, 2019; Greenfield et al., 2021) suggests that companies with robust green supply chain integration have increased customer loyalty and trust, which translates into improved market share and revenue growth.

However, despite its positive momentum, the manufacturing sector in Saudi Arabia faces specific obstacles in the implementation of environmentally friendly activities (Durugbo et al., 2021). One more challenge is the historical dependence on traditional energy sources, particularly fossil fuels, to power industrial processes. The transition to renewable and more sustainable energy alternatives poses both technological and financial challenges for manufacturers. The initial investment required for the adoption of green technologies (Alharthi et al., 2020) such as solar or wind energy is a barrier for some companies, especially for smaller enterprises with limited resources. Many businesses do not fully understand the potential advantages of incorporating sustainable measures into their supply chains and manufacturing processes (Cerchione et al., 2018). Efforts to disseminate knowledge and provide incentives for the adoption of green technologies and processes are crucial to overcoming this challenge.

This research is of paramount significance to the Saudi Arabian manufacturing sector as it endeavors to shed light on the intricate connections between the integration of environmentally friendly supply chains, supply chain resilience, innovative supply chain practices, and company success. A comprehensive analysis by Greenbaum et al. (2023) on enhancing business performance through green practices. By systematically exploring these aspects, this study aims to provide a robust foundation for strategic decision making within the sector. The exploration of innovative practices and their mediating roles, positions this research at the forefront of advancing sustainable business practices, thereby substantially contributing to the ongoing dialogue on responsible and forward-looking business operations.

Many Saudi industrial companies use green supply chain management (GSCM) to improve corporate sustainability (Hejazi, et al., 2023). These practices include waste reduction, energy efficiency, and green production. Adopting GSCM has improved economic, social, and environmental performance (Khan et al., 2023a, 2023b). Energy transition efforts in Saudi Arabia include developing a green hydrogen supply chain (Mint, 2023). This initiative supports sustainable energy worldwide and helps both countries meet their emission reduction goals. Advanced supply management operations (ASMO) is a joint venture between Aramco and DHL supply chain to promote sustainable supply chains (Hejazi et al., 2023). This initiative creates efficient and sustainable logistics and procurement services for energy, chemical, and industrial sectors. Aramco has been rethinking business processes to incorporate circular economy principles (Moore, 2021). Additionally, King Fahd University of Petroleum and Minerals found that integrating circular economy practices with Industry 4.0 and lean manufacturing improved Saudi Arabian manufacturing firms' sustainability (Ghaithan et al., 2023). These integrated strategies have improved organizations' environmental, economic, and social impacts.

The Saudi government has been actively promoting renewable energy projects, presenting opportunities for manufacturers to collaborate on sustainable initiatives (Islam et al., 2017). Embracing green practices can result in the production of environmentally sustainable goods and the execution of circular economic principles, further enhancing the competitiveness of Saudi Arabian products in the international market (Pinto, 2020). The research focus of any study provides a clear indication of the specific area or topic that the researchers aim to investigate, analyze, and contribute knowledge. This serves as

the guiding principle that directs the scope, methodology, and objectives of the research endeavor. Based on the literature gaps and problem statement, the study offers the research questions:

1. What impact does the implementation of green supply chain integration techniques have on the manufacturing operational performance of Saudi Arabian companies?
2. What is the mediating influence of supply chain resilience in the relationship between Saudi Arabian manufacturing business performance and the integration of a green supply chain?
3. What role does innovation play as a mediator between green supply chain integration and corporate performance in Saudi Arabian manufacturing?
4. What are the major aspects and methods that Saudi manufacturing firms utilize to run their green supply chains?
5. What is the relationship between the usage of green supply chain integration strategies and the status of company performance in Saudi Arabia's industrial sector?

2. Literature review

2.1. Green supply chain management (GSCM)

Green Supply Chain Management (GSCM) has emerged as a pivotal approach in contemporary business operations, reflecting increasing awareness and commitment towards sustainability and environmental responsibility. A fundamental aspect of GSCM involves the adoption of renewable energy sources and the promotion of energy efficiency measures within manufacturing and transportation processes. According to Sarkis and Zhu (2018), integrating renewable energy technologies, such as solar, wind, and hydroelectric power, into production facilities not only reduces greenhouse gas emissions but also enhances energy security and resilience. Additionally, implementing energy-saving practices, such as optimizing transportation routes and employing fuel-efficient vehicles, can significantly minimize carbon emissions and operational costs (Sarkis & Zhu, 2018). By prioritizing renewable energy adoption and energy efficiency improvements, companies can simultaneously achieve environmental sustainability objectives and gain a competitive edge in the market.

GSCM emphasizes the importance of sustainable sourcing practices and integration of eco-friendly materials into product design and packaging. By collaborating with suppliers who adhere to responsible environmental practices and ethical labor standards, companies can ensure the integrity and sustainability of their supply chains (Sarkis & Zhu, 2018; Sumarlah & Al-Hakeem, 2023). Additionally, incorporating eco-friendly materials, such as biodegradable polymers and recycled content, into product design reduces reliance on finite resources and minimizes the environmental impact throughout the product lifecycle (Sarkis & Zhu, 2018). Through sustainable sourcing and material selection, businesses can not only enhance their environmental credentials, but also mitigate supply chain risks associated with resource scarcity and regulatory compliance.

Scholarly research emphasizes the strategic importance of Green Supply Chain Management (GSCM) in a variety of industries, highlighting its role in improving environmental sustainability, operational efficiency, and cost reduction (Khan et al., 2023a, 2023b). While studies such as Walker et al. (2019) and Carter and Rogers (2008) demonstrate the benefits of incorporating environmental factors into supply chain activities, research on the Saudi manufacturing sector still needs to be completed. GSCM has been shown to improve environmental and economic performance, as suggested by Elenkov et al. (2005) and supported by research from Sarkis and Cordeiro (2018) and Wagner et al. (2017), though the degree of impact varies. Zhu et al. (2005) acknowledge the importance of GSCM in improving performance, emphasizing the need for additional research into the challenges and disparities in its implementation. The literature also delves into GSCM's conceptual frameworks, discussing its comprehensive integration into supply chain processes and the development of performance metrics to assess its impact on organizational outcomes, as seen in studies by Govindan et al. (2015) and Kumar et al. (2015).

Moreover, GSCM encompasses the adoption of green logistics practices aimed at optimizing transportation and distribution processes, while minimizing emissions and resource consumption. Utilizing advanced technologies, such as route optimization software and telematics systems, enables companies to optimize

vehicle routes, reduce fuel consumption, and reduce carbon emissions (Sarkis & Zhu, 2018). Implementing multimodal transportation solutions, such as rail and waterways, can further reduce the environmental impact of freight transportation by leveraging more energy-efficient modes of transport (Sarkis & Zhu, 2018). By embracing green logistics practices, businesses can enhance their operational efficiency, reduce costs, and contribute to a more sustainable transportation infrastructure (Muthuswamy, 2023).

2.2. Impact of GSCM on business performance

The adoption of GSCM practices can have significant positive effects on various aspects of business performance, ranging from cost reduction and operational efficiency to brand reputation and market competitiveness. By implementing strategies such as lean manufacturing, just-in-time inventory management, and waste minimization, companies can streamline production processes, optimize resource utilization, and reduce operational costs (Sarkis & Zhu, 2018). Moreover, the integration of energy-saving measures and renewable energy technologies within manufacturing facilities can lead to substantial savings in energy expenses in the long term (Sarkis & Zhu, 2018). These cost savings directly contribute to improved financial performance and profitability for businesses adopting GSCM.

Furthermore, GSCM can enhance operational efficiency and supply chain resilience by promoting collaboration and transparency between supply chain partners. Through sustainable sourcing practices and closer relationships with suppliers, companies can mitigate supply chain risks associated with resource scarcity, regulatory compliance, and geopolitical instability (Sarkis & Zhu, 2018). As consumers become more environmentally conscious and socially responsible, they increasingly favor brands that demonstrate commitment to sustainability and ethical business practices (Sarkis & Zhu, 2018). By publicly communicating their GSCM initiatives and environmental achievements, companies can enhance their brand credibility, attract environmentally conscious consumers, and differentiate themselves in the marketplace. Moreover, by offering eco-friendly products and packaging, businesses can tap into the growing consumer demand for sustainable alternatives and capitalize on emerging market trends (Muthuswamy, 2023; Sarkis & Zhu, 2018). This enhanced brand reputation and market positioning not only drive customer loyalty and retention but also create opportunities for premium pricing and market expansion.

2.3. Saudi Arabian manufacturing sector

The manufacturing industry in Saudi Arabia benefits from its strategic geographic location and abundant natural resources, particularly its oil and gas reserves. These resources provide a solid foundation for downstream industries such as petrochemicals and plastics, which have experienced substantial growth in the country (World Bank, 2020). Moreover, significant investments in infrastructure, including transportation networks, industrial parks, and logistics facilities, have been instrumental in supporting the expansion of the manufacturing sector and facilitating domestic and international trade (Al-Shuaibi et al., 2016). Government-led initiatives, including tax incentives, subsidies, and streamlined regulatory processes, have played a crucial role in attracting foreign investment and promoting industrial diversification in Saudi Arabia (World Bank, 2020). The establishment of economic cities and special economic zones has created designated areas conducive to industrial development, providing investors with access to advanced infrastructure and favorable business environments.

Technological advancements and innovation have propelled the Saudi manufacturing sector. Investments in research and development, coupled with collaborations with international firms, have facilitated the adoption of advanced manufacturing technologies, such as automation, robotics, and digitalization (Al-Shuaibi et al., 2016). These innovations have increased productivity, efficiency, and product quality, positioning Saudi Arabia as a competitive player in the global manufacturing landscape.

2.4. Business performance

Kaplan and Norton (1992) developed the Balanced Scorecard framework, which focuses on a holistic approach to evaluating business performance. Employing the Balanced Scorecard as a strategy has been extensive across many industries worldwide, indicating that assessing corporate success based only on

financial perspectives is insufficient. The concepts of market share and competitiveness have been thoroughly examined in the realm of strategic management. Porter's (1985) research on competitive advantage has established itself as a fundamental pillar for understanding how companies attain and maintain competitive positions in their respective industries.

Carter and Rogers (2008) emphasize the significance of operational efficiency in driving business performance, highlighting the importance of optimizing processes, allocating resources effectively, and minimizing waste to enhance competitiveness and profitability. Similarly, Sarkis and Zhu (2018) underscored the critical roles of financial performance, operational efficiency, and innovation in achieving sustainable growth and competitive advantage in dynamic market environments. Moreover, Seuring and Müller (2008) explore the relationship between corporate social responsibility (CSR) initiatives and business performance, suggesting that engagement in ethical, social, and environmental practices can enhance reputation, stakeholder relationships, and long-term profitability. Through an examination of these seminal works and their insights, a comprehensive understanding of the multifaceted nature of business performance emerges, underscoring the importance of considering various dimensions and perspectives when assessing organizational success.

Govindan et al. (2015) provided valuable insights into the role of sustainability practices.

Seuring and Müller (2008) delved into the concept of CSR and its impact on business performance. Their research suggests that engagement in CSR initiatives such as philanthropy, environmental stewardship, and ethical labor practices can enhance reputation, stakeholder relationships, and long-term profitability. By aligning business objectives with societal values and demonstrating a commitment to responsible business practices, organizations can create shared values and contribute to sustainable development (Muthuswamy, 2023; Seuring & Müller, 2008).

2.5. Supply chain resilience

Christopher and Lee (2004) and Pettit et al. (2010) investigated the concept of supply chain resilience in response to challenges. A supply chain's resilience indicates its ability to anticipate and address operational and environmental difficulties. Pettit et al. (2010) expanded the discourse on supply chain agility and robustness as a means of establishing supply chain resilience. Robustness involves the ability to absorb shocks and maintain functionality, whereas agility pertains to the speed and flexibility that enable a supply chain to react to disturbances. Together, these dimensions contribute to an overarching understanding of resilience that aligns with the dynamic and interconnected nature of modern supply chains.

Pettit et al. (2010) emphasized the importance of risk management and vulnerability assessment in identifying potential points of failure and implementing proactive measures to mitigate risks. By conducting risk assessments and scenario analyses, organizations can better understand their exposure to various disruptions and develop strategies to enhance resilience (Pettit et al., 2010). Supply chain flexibility and agility play crucial roles in building resilience against disruptions. Christopher and Peck (2004) highlighted the importance of flexibility in supply chain design, operations, and sourcing strategies. Flexible supply chains can quickly adapt to changing market conditions, customer demands, and disruptions, enabling organizations to maintain continuity and responsiveness in the face of uncertainty (Christopher & Peck 2004).

In addition to flexibility, collaboration and knowledge sharing among supply chain partners are essential for building resilience. Chopra and Sodhi (2004) stress the importance of collaboration, coordination, and trust among supply chain actors in managing disruptions effectively. By establishing strong relationships, sharing information, and developing contingency plans, organizations can enhance their ability to collaboratively respond to disruptions and expedite recovery efforts (Chopra & Sodhi, 2004). Technology and innovation play significant roles in enhancing supply chain resilience. Ivanov (2020) explored the potential of digital technologies, such as blockchain, Internet of Things (IoT), and AI, in improving supply chain visibility, traceability, and real-time decision-making. By leveraging advanced technologies, organizations can enhance supply chain visibility, monitor disruptions in real time, and deploy agile response strategies to mitigate risks and minimize impacts (Ivanov, 2020).

2.5.1. Innovation

Innovation is a critical aspect in gaining both competitive advantage and long-term sustainability (Govindan et al., 2015; Prajogo et al., 2012). Zhu et al. (2013) find on the topic reveal that GSCM practices frequently

encourage innovation by cultivating a culture of continuous improvement and environmental responsibility. However, additional research is required to investigate the specific mechanisms that mediate the association between GSCM and financial success of enterprises engaged in the manufacturing sector in Saudi Arabia.

2.6. Identifying gaps in current research

Although there is an abundance of studies on supply chain resilience, innovation, company performance, and GSCM, there is a visible gap in the context of the Saudi Arabian manufacturing industry. Few studies have examined the intricate relationships between these elements in the unique socioeconomic and environmental context of Saudi Arabia. Innovation is widely recognized as a crucial driver of competitive advantage and long-term sustainability within organizations (Govindan et al., 2015; Prajogo et al., 2012). As highlighted by Zhu et al. (2013), research suggests that GSCM practices play a significant role in fostering innovation by nurturing a culture of continuous improvement and environmental responsibility. By integrating environmental considerations into supply chain operations, GSCM encourages organizations to explore novel solutions, technologies, and processes that reduce environmental impacts while enhancing efficiency and performance.

GSCM practices, such as eco-design, waste reduction, and sustainable sourcing, stimulate creativity and innovation throughout the supply chain. By incentivizing suppliers, employees, and other stakeholders to develop and adopt environmentally friendly practices, GSCM creates opportunities for process optimization, product differentiation, and market innovation. Companies that embrace the principles of GSCM are more likely to develop innovative products, services, and business models that resonate with environmentally conscious consumers and differentiate themselves in the marketplace.

2.7. Relevant theories and models

2.7.1. Resource-Based view

Barney (1991) further refined the RBV, which was first presented by Wernerfelt (1984). This finding highlights the significance of a company's unique resources in achieving a competitive edge. Within the parameters of the resource-based study, it is possible to provide insights into how GSCM techniques, as unique assets, enhance the performance and competitiveness of Saudi Arabian manufacturing firms.

2.7.2. Dynamic capabilities Theory

Teece et al. (1997) proposed dynamic capabilities theory examines how organizations adjust to external changes. This theory can help analyze how organizations use dynamic capacity to incorporate environmentally friendly practices, increase supply chain resilience, and foster innovation in GSCM and business performance.

2.7.3. Institutional Theory

The use of Institutional Theory, specifically the research conducted by DiMaggio and Powell (1983) and Scott (2017), illuminates how institutional forces affect Saudi Arabian GSCM implementation in the manufacturing sector. In addition, understanding the institutional variables that favor or hinder environmental actions requires institutional analysis.

2.7.4. Triple bottom line (TBL)

Elkington 1997 presented the TBL framework in 1997, which deals with the social, environmental, and economic drivers of company success. The effects of GSCM on social, environmental, and economic sustainability are quantified.

2.8. Conceptual framework

The conceptual framework clarifies the intricate relationships between four essential components in the Saudi Arabian manufacturing sector: innovation, green supply chain integration management, business

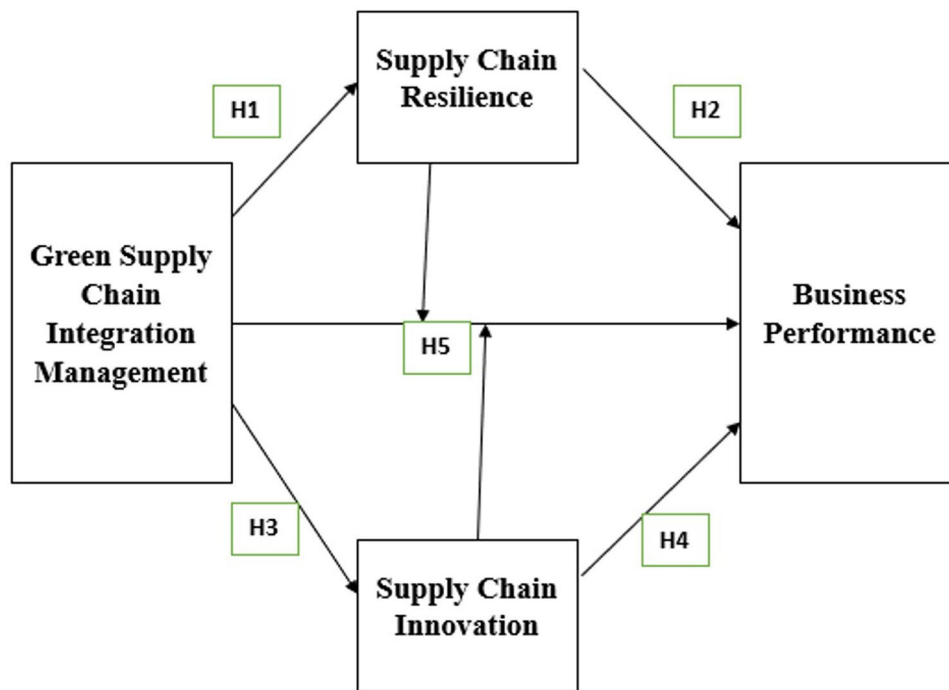


Figure 1. Theoretical framework.

performance, and supply chain resilience (see [Figure 1](#)). In the first strand of the framework, a direct relationship was established between GSCIM and SCR. This indicates that the adoption of environmentally conscious practices encompassed by GSCIM directly influences development with more durability and an adaptable supply chain. The integration of green principles serves as a catalyst for building a supply chain capable of withstanding and effectively responding to various disruptions, both environmental and operational.

Moving forward, the mediating role of supply chain resilience has been emphasized. The dashed arrow indicates that SCR plays a pivotal mediating role between GSCIM and Business Performance. This suggests that the favorable influence of environmentally friendly initiatives on corporate performance is facilitated by the enhancement of supply chain resilience. A resilient supply chain acts as a buffer to mitigate risks and ensure operational continuity, thereby contributing to overall business success.

Additionally, the conceptual framework incorporates another mediating dimension, represented by the dashed arrow between GSCIM and Business Performance, which is mediated by innovation. This signifies that the positive impact of green applications on business performance is, in part, facilitated by fostering innovative processes and products. Innovation has become a crucial intermediary factor, transforming sustainability efforts into tangible business advantages, enhancing competitiveness, and positively affecting overall performance. Therefore, the study develops the research hypotheses:

- H1: Better company performance in the Saudi Arabian industrial sector is favorably correlated with green supply chain integration.
- H2: The business performance of Saudi Arabian manufacturing firms and the integration of a green supply chain are positively correlated, with supply chain resilience acting as the major mediating factor.
- H3: In Saudi Arabian manufacturing enterprises, innovation plays a mediating role in the favorable correlation between green supply chain integration and company performance.
- H4: Environmental supplier selection and eco-friendly production methods are necessary for successful integration of ecological supply chains into Saudi Arabia's industrial sector.
- H₅: There is a positive correlation between the extent of green supply chain integration and current business performance levels in the Saudi Arabian manufacturing sector.
- H₆: Saudi manufacturing enterprises benefit from strategic proposals that promote green supply chain prac-

tices, particularly those that boost resilience and innovation.

In essence, this conceptual framework offers a comprehensive viewpoint on the links between GSCIM, SCR, Innovation, and business performance (Figure 1). It not only shows how green practices impact supply chain resilience but also identifies how resilience and innovation work together to shape the final business results for Saudi Arabian industrial companies.

3. Methodology

3.1. Research design

In this study, quantitative research design with deductive approach were employed to investigate the impact of green supply chain integration on the commercial performance of the industrial sector in Saudi Arabia. A quantitative research design with a deductive approach can objectively measure and analyze data to determine how green supply chain integration affects commercial performance (Creswell, 2017). When testing theories or hypotheses with empirical data, use deductive reasoning (Bryman, 2016). This method is useful for industrial sectors with measurable performance indicators (Saunders et al., 2019). Quantitative methods also enable sector-wide generalization (Zikmund et al., 2013). Quantitative research involves the collection and analysis of numerical data to test hypotheses and identify patterns and relationships (Hair et al., 2019). Using a quantitative approach, this study aimed to systematically examine the relationship between green supply chain practices and commercial performance metrics.

The primary objective of this study is to assess how the integration of green supply chain practices influences the commercial performance of companies within the Saudi Arabian industrial sector. To achieve this goal, standardized questionnaires were used to collect data from manufacturing companies operating in Saudi Arabia. The questionnaire was designed to capture information on various aspects of green supply chain integration such as environmental sourcing, green manufacturing processes, eco-friendly logistics, and reverse logistics. Importantly, an approval for the study was under supervision of the Deanship of Scientific Research (DSR) at University of Business and Technology.

3.2. Sampling

Stratified sampling was used to ensure representation of various subgroups across the Saudi manufacturing sector. Companies were categorized according to their size, type, and level of green supply chain integration practices. The sample was gathered from the stratum to ensure balanced and diverse representation.

3.3. Participants

For this study, the target participants included key decision makers, supply chain managers, and individuals responsible for sustainability initiatives within manufacturing companies in Saudi Arabia. These individuals possess crucial insights into the operational dynamics, strategic decision-making processes, and sustainability practices within their respective organizations.

3.4. Inclusion criteria

- Individuals holding key decision-making roles within the organization.
- The supply chain manager supervises the planning and implementation of the chain's operations.
- Individuals responsible for overseeing and implementing sustainability initiatives within the company.
- Written informed consent for participation in the study has been obtained.

3.5. Voluntary participation

Engaging in the research was elective. Individuals who met the inclusion criteria and were eligible to participate received invitations to participate. The research team prioritized the voluntary aspect of

participation, guaranteeing that individuals were free to choose whether to take part without facing any negative consequences.

3.6. Sample size determination

A sample size of 450 respondents was chosen to ensure the statistical power and reliability of this study. The sample size was determined by conducting a statistical power analysis, taking into account variables such as the required level of confidence, anticipated impact size, and potential attrition. This rigorous methodology seeks to improve the accuracy and applicability of results.

3.7. Recruitment strategy

The participants were selected using a stratified sampling technique to ensure a diverse representation of organizational size, industry type, and degree of green supply chain integration practices. The first communication occurred via formal means, and prospective volunteers received comprehensive information regarding the study's goals, methodology, and voluntary aspect of their participation.

3.8. Ethical considerations

Ethical standards were upheld in the recruitment process, and the consent of every participant was obtained. The research team strictly followed ethical guidelines and protected the privacy of the participants. By targeting these specific roles within manufacturing companies and emphasizing voluntary participation, this study aims to gather valuable insights from individuals directly involved in decision-making processes and sustainability initiatives, thus contributing to the robustness of the research findings.

3.9. Data collection

Structured questionnaires were developed based on the established scales and validated measures. The questionnaire covered key variables such as the extent of green supply chain integration practices, levels of supply chain resilience, innovation initiatives, and various business performance indicators. The survey was administered electronically to enhance efficiency and to facilitate data collection from a geographically dispersed sample.

3.10. Data analysis

A quantitative data analysis was performed in this study. Descriptive statistics offer a comprehensive summary, while inferential statistical techniques analyze the relationships among the variables. This study aimed to determine statistically significant correlations. The SPSS statistical software was used to compute the results. The hypotheses of this study investigate the mediating relationships among the variables.

Quantitative data analysis methods were employed to examine the relationships proposed by the hypotheses. Descriptive statistics were used to provide a comprehensive summary of the data, including measures such as means, standard deviations, and frequency distributions. These descriptive statistics offer insights into the central tendencies and variability of the study variables.

Inferential statistical techniques were then applied to analyze the relationships among the variables and test the hypotheses. Specifically, correlation analysis was used to examine the strength and direction of the associations between variables, such as the correlation between green supply chain integration and company performance. Regression analysis may also be employed to explore the predictive power of independent variables (e.g. green supply chain integration) on dependent variables (e.g. company performance).

Statistical software, such as SPSS (Statistical Package for the Social Sciences), was used to compute the results and test the hypotheses. SPSS provides a user-friendly interface for conducting various

statistical analyses including correlation, regression, and mediation analyses. By employing these quantitative data analysis techniques, this study aims to provide valuable insights into the relationships between green supply chain integration, business performance, and mediating factors within the Saudi Arabian manufacturing sector.

The study tested hypotheses using SPSS's robust statistical capabilities for demographic and regression analyses (Pallant, 2020). Social science researchers use SPSS to analyze data, including regression, which is essential for studying variable relationships (Field, 2018). The software's user-friendly interface and extensive output options help interpret and report statistical results, improving research reliability and validity (Bryman & Cramer, 2011). Demographic analysis in SPSS helps understand sample characteristics, contextualizing the results within the study's framework (Brace et al., 2016).

4. Results

4.1. Validity and reliability

Several measures were implemented to ensure the validity and reliability of the data. First, a preliminary test was conducted on a small sample size to identify any uncertainties or comprehensibility-related issues using the questionnaire (see demographics, Table 1). This pilot test allowed for refinement of the questionnaire items and ensured that the survey instrument was clear, relevant, and easily understandable to the target respondents. By addressing potential ambiguities or confusion early in the research process, the validity of the data-collection instrument was enhanced. Reliability was ensured with established scales and careful questionnaire design. The established scales with demonstrated reliability and validity in previous research were selected whenever possible to measure constructs such as green supply chain integration, company performance, innovation, and supply chain resilience. By utilizing established scales, this study benefitted from the psychometric properties of these instruments, including internal consistency and construct validity.

Additionally, careful attention was paid to the design and formatting of the questionnaire to minimize response bias and maximize data quality. Clear instructions were provided to the respondents and response options were structured in a logical and consistent manner. Moreover, efforts were made to minimize the use of leading or biased language in the questionnaire items to ensure the neutrality and objectivity of the responses.

Reliability was assessed using Cronbach's alpha coefficients for each scale utilized in the study. Cronbach's alpha values between 0.8 and 0.9 were considered indicative of high internal consistency and reliability (Cronbach, 1951). Any scale with Cronbach's alpha values below this threshold was subjected to further examination and potential refinement to improve reliability.

The demographic analysis revealed that out of the total sample of 450 respondents, 54.0% were male and 46.0% were female (Table 1). This balanced distribution of gender representation within the sample ensures a comprehensive perspective across diverse demographic groups, thus enhancing the robustness and generalizability of the study findings.

The demographic analysis of the age distribution among the respondents indicated that the majority fell within the age brackets of 30-40 (28.0%) and 40-60 (34.0%). Additionally, 24.0% of respondents were above the age of 60, 12.0% were between 25 and 30, and 2.0% were under the age of 25. This diverse age representation within the sample ensured a comprehensive understanding of perspectives across different age groups, contributing to the richness and depth of the study findings.

The educational background of the respondents revealed a diverse distribution, with the highest percentage holding postdoctoral degrees (44.0%), followed by PhD holders (26.0%). Additionally, 18.0% of the respondents had master's degrees, while 10.0% held MPhil degrees. A small proportion (2.0%) possessed bachelor's degrees with honors (BS [Hons.]). This varied educational profile within the sample ensured a broad range of expertise and perspectives, enriching the depth and comprehensiveness of the study's insights.

The company's age shows a variety of Saudi Arabian industrial tenures. Most companies, 33.3%, have been around for 6-10 years, indicating a young but established industry. A large portion, 22.2%, has been operating for 1-5 years, suggesting strong new company entry. The sample includes 13.3% of older

Table 1. Demographic analysis.

Demographics	Categories	N	%
Gender	Male	243	54.0
	Female	207	46.0
Age	Less than 25	9	2.0
	25 – 30	54	12.0
	30 – 40	126	28.0
	40 – 60	153	34.0
	Above 60	108	24.0
Education level	BS (Hons.)	9	2.0
	Masters	81	18.0
	MPhil	45	10.0
	PhD	117	26.0
	Post Doc	198	44.0
Company's age (years)	1–5 years	100	22.2
	6–10 years	150	33.3
	11–15 years	80	17.8
	16–20 years	60	13.3
	>20 years	60	13.3
Company's size (number of employees)	1–50 employees	120	26.7
	51–100 employees	150	33.3
	101–200 employees	100	22.2
	201–500 employees	50	11.1
	>500 employees	30	6.7
Role in the company	Staff	180	40.0
	Middle Manager	150	33.3
	Top Manager/CEO	120	26.7
Length of Work (years)	1–5 years	200	44.4
	6–10 years	150	33.3
	11–15 years	50	11.1
	16–20 years	30	6.7
	>20 years	20	4.4

companies, including legacy and emerging firms. Newer and older companies may have different approaches and resources for adopting sustainable supply chain practices.

The industrial sector is mostly SMEs, with 33.3% employing 51-100 people and 26.7% employing 1-50. This matters because SMEs face different challenges and opportunities in the green supply chain than larger companies. Smaller firms can adopt new practices faster despite fewer resources. Although smaller (6.7% have more than 500 employees), larger firms may have more resources and supply chain networks for green initiatives. This distribution suggests that green supply chain strategies must appeal to large and small businesses.

The roles and tenures of company employees reveal internal dynamics affecting green supply chain implementation. The majority of respondents (44.4%) have been in their roles for 1-5 years and 33.3% for 6-10 years, indicating a balanced workforce with experience and fresh perspectives. 40% were staff, 33.3% were middle managers, and 26.7% were top managers or CEOs, representing diverse organizational levels. Effective green supply chain implementation often requires company-wide buy-in and collaboration, so broad representation is essential for comprehensive insights. The findings suggest that inclusive strategies must address the needs and capacities of diverse company sizes and ages and foster engagement at all organizational levels to improve green supply chain practices.

4.2. Hypothesis testing

H1: Better company performance in the Saudi Arabian industrial sector is favorably correlated with green supply chain integration.

The hypothesis proposes a positive correlation between better company performance in the Saudi Arabian industrial sector and the implementation of a green supply chain (Table 2). The descriptive

Table 2. Descriptive statistics and correlation.

	Mean	Std. deviation	N
GS	37.8600	13.20257	450
CP	19.1000	3.27320	450
Correlations			
		GS	CP
GS	Pearson correlation	1	.5733**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	78264.180	3350.700
	Covariance	174.308	7.463
	N	450	450
CP	Pearson Correlation	.5733**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	3350.700	4810.500
	Covariance	7.463**	10.714
	N	450	450

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

Table 3. ANOVA and model summary.

					Change Statistics							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change			
1	.486 ^a	.236	.235	11.55018	.236	138.659	1	448	.000			
Model	Sum of squares		Df	Mean square	F	Sig						
1	Regression	18498.025	1	18498.025	138.659	.000 ^b						
	Residual	59766.155	448	133.407								
	Total	78264.180	449									

^aPredictors: (Constant), CSR.

^bDependent Variable: GS.

Table 4. Regression analysis.

Unstandardized Coefficients		
Model		B
1	(Constant)	67.625
	CSR	−1.305

^aDependent Variable: GS.

Table 5. Regression analysis.

Table 37. Regression analysis.						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	56770.805	2	28385.402	35679.761	.000 ^b
	Residual	355.615	447	.796		
	Total	57126.420	449			
				Standardized		
		Unstandardized coefficients		coefficients		
	Model	B	Std. Error	Beta	t	Sig.
1	(Constant)	−.797	.317		−2.512	.012
	CSR	−.009	.010	−.004	−.921	.358
	GS	.850	.004	.995	232.989	.000

^aDependent Variable: I.

^bPredictors: (Constant), GS, CSR.

statistics reveal that the mean score for green supply chain (GS) integration is notably higher than that for company performance (CP), indicating a relatively higher level of implementation of green supply chain practices. The correlation analysis shows a strong positive correlation coefficient of 0.5733 between GS and CP, which is statistically significant at the 0.01 level (2-tailed). This suggests that there is strong evidence to support the hypothesis that better company performance is indeed associated with the integration of a green supply chain in the Saudi Arabian industrial sector.

H2: The business performance of Saudi Arabian manufacturing firms and the integration of a green supply chain are positively correlated, with supply chain resilience acting as a major mediating factor.

Table 6. Descriptive statistics and correlation.

	Mean	Std. Deviation	N
EFPM	11.7600	2.53707	450
ESS	30.9200	5.83346	450
EFPM	Pearson Correlation		EFPM
	Sig. (2-tailed)		ESS
	Sum of Squares and Cross-products		
	Covariance		
	N		
ESS	Pearson Correlation		EFPM
	Sig. (2-tailed)		ESS
	Sum of Squares and Cross-products		
	Covariance		
	N		

Table 7. Regression analysis.

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	49.475	3.240		15.270	.000
	CP	4.618	.373	1.145	12.366	.000
	CSR	.589	.177	.219	3.332	.001
	ESS	-3.663	.275	-1.618	-13.304	.000

^aDependent Variable: GS.

The hypothesis posits a positive correlation between the business performance of Saudi Arabian manufacturing firms and the integration of green supply chains, with supply chain resilience serving as a significant mediating factor (Tables 4, 5). The regression analysis revealed that the model accounted for 23.6% of the variance in the integration of green supply chain practices, indicating a moderate level of explanatory power. The ANOVA results demonstrate that the regression model is statistically significant suggesting that the inclusion of supply chain resilience as a predictor significantly improves the model's ability to explain the variance in green supply chain integration. The standardized coefficient for supply chain resilience (CSR) is -0.486, indicating a negative relationship with green supply chain integration and implying that higher levels of supply chain resilience are associated with lower levels of green supply chain integration (see Table 3). However, this negative relationship may be due to the specific operational dynamics within the Saudi Arabian manufacturing context.

H3: In Saudi Arabian manufacturing enterprises, innovation plays a mediating role in the favorable correlation between green supply chain integration and company performance.

The hypothesis proposes that, in Saudi Arabian manufacturing enterprises, innovation acts as a mediating factor in the positive correlation between green supply chain integration and company performance (Table 7). The ANOVA results indicate that the regression model is highly significant and explains a substantial portion of the variance in innovation. Specifically, the integration of a green supply chain (GS) has a strong positive relationship with innovation, as evidenced by the significant standardized coefficient of 0.995. However, the coefficient of supply chain resilience (CSR) is not statistically significant, suggesting that its impact on innovation is negligible.

H4: Environmental supplier selection and eco-friendly production methods are necessary for the successful integration of ecological supply chains into Saudi Arabia's industrial sector.

This hypothesis asserts the importance of environmental supplier selection and the adoption of eco-friendly production methods for the successful integration of ecological supply chains into Saudi Arabia's industrial sector (Table 6). However, the correlation analysis suggests that while there is a positive correlation between environmental supplier selection (ESS) and eco-friendly production methods (EFPM), the relationship is not statistically significant at the 0.05 level (2-tailed). Despite the lack of statistical significance, the positive correlation coefficient of 0.649 indicates a tendency for companies to prioritize environmental supplier selection to adopt eco-friendly production.

H₅: A positive correlation exists between the extent of green supply chain integration and the current business performance levels in the Saudi Arabian manufacturing sector.

H₆: Saudi manufacturing enterprises was benefit from strategic proposals promoting green supply chain practices, particularly those that boost resilience and innovation.

The regression analysis presents coefficients indicating the relationships among company performance (CP), supply chain resilience (CSR), environmental supplier selection (ESS), and the integration of a green supply chain (GS). The results reveal that all three predictors—CP, CSR, and ESS—have statistically significant effects on green supply chain integration (Table 7). Specifically, a one-unit increase in company performance (CP) was associated with a 4.618-unit increase in green supply chain integration, demonstrating a positive impact. Similarly, higher levels of supply chain resilience (CSR) and environmental supplier selection (ESS) are also positively linked to greater green supply chain integration, with coefficients of 0.589 and -3.663, respectively. These findings suggest that focusing on improving company performance, enhancing supply chain resilience, and prioritizing environmental supplier selection are crucial factors for promoting the integration of sustainable practices within supply chains in Saudi Arabian industries.

5. Discussion

The hypothesis proposes that innovation mediates the correlation between green supply chain integration and company performance in Saudi Arabian manufacturing enterprises. This assertion aligns with previous research, indicating that innovation plays a crucial role in driving organizational success, particularly in the context of sustainability and supply chain management (Sarkis et al., 2010; Zhu et al., 2018). Studies have suggested that integrating green practices into supply chains can stimulate innovation by encouraging firms to develop new technologies, processes, and products that reduce environmental impacts while enhancing operational efficiency and competitiveness (Sarkis et al., 2010; Seuring & Müller, 2008; Zhu et al., 2018). Additionally, research has emphasized the importance of innovation as a key determinant of company performance, highlighting its positive influence on profitability, market share, and overall organizational effectiveness (Mudgal et al., 2010; Rothaermel & Hess, 2007). Therefore, by proposing that innovation mediates the relationship between green supply chain integration and company performance, this hypothesis builds upon existing literature and contributes to a deeper understanding of the mechanisms through which sustainability initiatives drive organizational success in the Saudi Arabian manufacturing sector.

Moreover, the proposed mediating role of innovation in the relationship between green supply chain integration and company performance is consistent with the ecological modernization perspective, which posits that firms can achieve environmental sustainability while simultaneously enhancing economic performance through innovative practices (Seuring & Müller, 2008; Zhu et al., 2018). By integrating green principles into their supply chains, companies are incentivized to explore novel solutions, develop new technologies, and forge strategic partnerships that contribute to both environmental stewardship and financial prosperity (Mudgal et al., 2010; Sarkis et al., 2010). This aligns with the broader trend of sustainability-driven innovation, where organizations recognize the business imperative of adopting environmentally responsible practices to remain competitive in a rapidly evolving global marketplace (Rothaermel & Hess, 2007).

5.1. Theoretical contributions

This study advances green supply chain management and manufacturing performance theory. First, it fills a gap in regional practices and outcomes literature by explaining how green supply chain integration (GSCI) techniques affect Saudi Arabian manufacturing companies' operational performance (Zhu et al., 2013). Second, the study shows how supply chain resilience can mitigate and enhance GSCI's positive effects on business performance (Ponomarov & Holcomb, 2009). Third, the study examines how innovation mediates GSCI and corporate performance, helping to enhance sustainable supply chain strategies (Rao & Holt, 2005). The study also examines how Saudi manufacturing firms implement and

manage green supply chains, providing practical frameworks and strategies for similar firms (Srivastava, 2007). Finally, by examining GSCI strategies and Saudi Arabia's industrial sector's performance, the study shows that sustainability practices are strategically important for business performance (Tseng, 2010).

5.2. Practical implications

This study's findings have many implications for Saudi Arabia's industrial sector. First, the strong positive correlation between green supply chain integration (GSCI) and company performance emphasizes the need for sustainable practices. Saudi companies investing in GSCI can expect improved operational and commercial performance, aligning with global sustainability trends. The findings also emphasize supply chain resilience as a mediator. The study's negative correlation may seem counterintuitive. However, Saudi companies should balance resilience and sustainability efforts and possibly revise their operational strategies to mitigate negative effects.

Innovation as a mediator between GSCI and company performance suggests that supply chain innovation is essential for maximizing the benefits of green practices. This supports research that shows that innovative capabilities improve sustainability initiatives. Even without statistical significance, the study emphasizes environmental supplier selection and eco-friendly production methods. These elements are crucial to green supply chain sustainability and efficiency. Finally, the positive correlation between GSCI strategies and business performance shows Saudi Arabian firms' competitive advantage in sustainability, encouraging sector-wide adoption.

5.3. Conclusion

In conclusion, a rich body of empirical evidence and theoretical frameworks supports the hypothesis highlighting the mediating role of innovation in linking green supply chain integration with company performance in Saudi Arabian manufacturing enterprises. By acknowledging the interplay between environmental sustainability, innovation, and organizational success, this hypothesis contributes to a holistic understanding of the mechanisms that drive sustainable development within supply chains. Further empirical research is needed to validate these relationships and explore the specific strategies and mechanisms through which innovation enhances the performance impact of green supply chain initiatives in the context of Saudi Arabia's industrial sector.

5.4. Limitations and future implication

This study has several limitations. First, cross-sectional data collection makes causality between green supply chain integration and company performance difficult. These relationships change over time, so longitudinal studies are better (Prajogo & Olhager, 2012). Second, the sample is limited to the Saudi Arabian industrial sector, which may limit its applicability to other regions or industries with different economic, regulatory, and cultural contexts (Darnall et al., 2008). Because company representatives self-report their green practices, they may overstate them due to social desirability (Podsakoff et al., 2003). Finally, the study does not consider government regulations, market conditions, or technological advances that may affect green supply chain practices (Zhu et al., 2013). To overcome these limitations, future research should include more diverse samples, longitudinal data, and external moderating variables.

The study also offers the future recommendations. First, recognizing the mediating role of innovation in the relationship between green supply chain integration and company performance underscores the importance of fostering a culture of creativity and continuous improvement within organizations. To leverage the potential benefits of green supply chain initiatives, companies should invest in innovation-driven strategies that prioritize the development of sustainable products, processes, and technologies. Additionally, the positive correlation between environmental supplier selection and eco-friendly production methods highlights the need for strategic investment in supplier partnerships and green manufacturing practices. Policymakers, industry stakeholders, and business leaders should collaborate to develop supportive frameworks, incentives, and initiatives that encourage the adoption of environmentally responsible practices throughout the supply chain. By embracing innovation, environmental

stewardship, and collaborative partnerships, manufacturing enterprises in Saudi Arabia can position themselves for long-term success in a rapidly evolving global marketplace while contributing to the sustainable development goals of the region.

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Ethical approval

Prior to collecting data, the authors obtained ethics approval from Deanship of Research at the University of Business and Technology. The research was exempted because it does not involve collection of individual-level information/data relating to human subjects (including deceased human subjects), the collection of data does not involve any risks to the researchers' safety, or to the safety of any other person involved in the research. In addition, the research is not affecting humans physically nor mentally. The number is: SR.02.01.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Author contributions

Conduct of the research, data collection, qualitative analysis, and data processing were carried out by the author Mohammed Taj Hejazi. Drafting of the manuscript was manually done by the author Mosaab Abdulkader Habani. All transcripts are available, too. Mohammed Taj Hejazi is responsible for sharing dataset.

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Data availability statement

Data are available upon request. However, some questioners were conducted in Arabic, and some participants may not have agreed to disclose the questioner. All transcripts are available, too.

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