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Smart green supply chain management: A configurational approach to enhance firm financial performance

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This study uses the Resource-Based View (RBV) and technology, organization, and environment (TOE) theories to examine how smart supply chain (SSC) practices affect financial performance (FP) in enterprises of various sizes. Our results show that SSC benefits larger enterprises more financially than smaller firms. SSC has a statistically significant effect on green supply chain management (GSCM) and sustainable supply chain performance (SSCP), and the strength of the relationship declines with a decline in firm size. Smaller enterprises are more receptive to competitive pressure and implement GSCM alongside SSC. Our findings show that SSCP improves financial performance, while GSCM does not, even in large enterprises. Further, mediation effects show that GSCM mediates the relationship between SSC and SSCP, whereas it does not mediate between SSC and FP across all sizes. The impact of SSC on FP is sequentially mediated via GSCM and SSCP. Using a non-linear approach (ANN), we also rank independent variables for small, medium, and large firms. Our research provides important implications.

1. Introduction

Manufacturing and service operations depend on supply chain management (SCM). SCM, a systematic strategy for managing asset flows from sourcing raw materials, product manufacturing, and delivery to end customers, greatly impacts supply network participants' business goals. COVID-19 chaos showed the significance of supply chain flexibility and resilience (Carissimi et al., 2023). Thus, manufacturers and other stakeholders must build resilient and smart supply chains, which may not be easy. New ICT technologies like big data analysis, IoT, blockchain, etc., enable smart supply chains (SSC). Technology (push) and market change (pull) drive SSC, which brings manufacturers closer to customers and provides a new platform for smart production (Carissimi et al., 2023). SSC can incorporate customer needs into manufacturing stages with a cyber-physical system (Saucedo-Martínez et al., 2018). This value-generation network usually matches supply chains. Thus, supply chain management affects smart manufacturing performance in Industry 4.0. Smart manufacturing requires smart or smarter supply chains because they affect input availability, production function interaction, finished goods delivery efficiency, and network responsiveness. The smart supply chain (SSC) uses modern technologies, especially emerging ICT, to integrate processes across SC partners to establish an intelligent connected system (Wu, 2016). There are studies on the effects of new technologies on supply chains under Industry 4.0, such as IoT on SCM (Ben-Daya et al., 2019), IoT-embedded sustainable SC (Saucedo-Martínez et al., 2018), and big data analytics in SCM. However, their focus is maximizing operational efficiency, leaving sustainability a second choice. This research integrated the resource-based view (RBV) and Technology, Organization, and Environment (TOE) theories to improve understanding of how smart supply chains affect financial performance across organization sizes (Nandi et al., 2020). The TOE framework promotes technological progress for sustainable performance, while the RBV emphasizes firm-specific resources and capabilities for competitive advantage. All these ideas provide a comprehensive view of supply chain complexity (Nylund, Brem, & Agarwal, 2021). Resources availability and effectiveness vary widely between small, medium, and large firms (Aharoni, 2024). This study explores how larger organizations use

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resources to promote smart supply chains, but smaller firms have distinctive hurdles that may limit their financial benefits (Nandi et al., 2020). GSCM and sustainable supply chain performance can generate long-term financial benefits (D'Amato & Falivena, 2020), but these benefits may not be immediately obvious. This complex consideration emphasizes the need to merge RBV and TOE theories, especially for larger organizations that can better handle these complications (Ben-Daya et al., 2019). Research has generally disregarded smart supply chains, GSCM methods, and financial success across firm sizes (Shibin et al., 2020). This gap provides new insight into the supply chain literature, notably in the GCC, a vibrant and growing business. The GCC is well-positioned as companies grasp the strategic benefits of sustainability and innovation in their supply chains.

Our study examines large, medium, and small MNEs to address these inadequacies. We aim to determine how firm size influences sustainable supply chain strategies and MNE sustainability. This comparative lens aims to provide practical insights that can help organizations of all sizes on their sustainability, illustrating that size is not only a background factor in supply chain sustainability. This study gap highlights the need to explore how size impacts SSCM absorption and efficacy. We divide MNEs into large, medium, and small to assess resource constraints and capabilities. Using this method, we can construct a focused framework to increase sustainable performance across company sizes, enhancing our supply chain dynamics and sustainability knowledge. The research makes several important contributions. First, it integrates RBV and TOE theory to explore the complex relationship between SSC and MNEs' financial performance. This provides novel insight into existing theoretical frameworks of supply chain management. Second, it uses data on MNEs in an emerging GCC context, which helps us explain the dynamic of relationships in emerging contexts. The relationship is tested in firms that use smart technology in their manufacturing and supply chain operations. Third, our comparative study demonstrates that the size effect determines the relationship or strength of the relationship among study contexts. Fourth, we show the effect of mediation and sequential mediation on promoting sustainable and financial performance via SSC in the GCC context. The approach may help stakeholders to align or realign their strategies for sustainability. Lastly, we ranked the importance of each selected variable in financial performance across small, medium, and large-sized firms. A non-linear approach also creates novelty in the supply chain management context, where sustainability and financial performance are firms' priorities.

The rest of the paper follows. First, we provide a theoretical framework, followed by hypotheses development and the development of the questionnaire and data collection procedure. Next, we show initial tests for construct validity, factor loading, and other relevant measures. Then, we provided results, a conclusion, theoretical contributions, and research implications.

2. Theoretical Background

The resource-based view (RBV) and technology, organization, and environment (TOE) theory are used for the research framework (Abdurrahman et al., 2024). The proposed research framework evaluates SSC, GSCM, SSCP, and FP interactions. Our study on how smart supply chain (SSC) tactics affect financial performance across firms of different sizes relies on RBV. A firm's distinctive resources and competencies determine its competitive edge and performance. GSCM practices emphasize resource sustainability to improve environmental and economic performance (Shibin et al., 2020), which matches the RBV paradigm. GSCM helps companies cut waste, costs, and reputational risk (Nandi et al., 2021). Greater resources allow larger companies to engage in sustainability programs that meet legal standards and enhance innovation and customer loyalty. According to the RBV, SSC and GSCM implementation and their impact on sustainable performance depend on a firm's unique resources, highlighting the importance of firm size. To improve supply chain management and strategic resource allocation literature, we emphasize firm size and how resource capacities affect financial performance (Nandi et al., 2021). This perspective illuminates SSC and GSCM's strategic importance and provides actionable insights for competitive resource optimization. Further, we integrate RBV and TOE theory to explore the impact of SSC on sustainable firms across different firm sizes (Abdurrahman et al., 2024; Tian et al., 2021). The TOE provides a thorough view of technology adoption and integrates firm resources. Implementing the TOE framework depends on technology, environment, and organization-related aspects because technological adoption and its utility heavily rely on resource heterogeneity (Tian et al., 2021). Technological factors include competitive advantage, intricacy, appropriateness, volatility and fragility, facilitating conditions, and performance expectancy (Abdurrahman et al., 2024). Finally, environmental influences include competition, stakeholder support, and government regulation. The TOE focuses on smart business strategies that meet stakeholder expectations without harming the local community or damaging resources. Thus, RBV and TOE are interconnected concepts that underline the need for resources to advance technological developments. Therefore, we compared firms across sizes to test the integrative view of TOE in an emerging context of GCC.

3. Hypotheses Development

3.1 Direct Effect

3.1.1 Smart Supply Chain and Financial Performance

Smart supply chains (SSCs) optimize operations with IoT, data analytics, and AI to boost firm financial performance. These technologies enable real-time visibility and decision-making, reducing costs, increasing efficiency, and speeding up responsiveness (Ahn et al., 2016). SSCs can reduce operational costs by improving inventory management, process efficiency,

and waste reduction. Data analysis also helps organizations predict client wants and adjust rapidly to market changes, increasing revenue (AlMulhim, 2021). SSC practices give organizations a sustained competitive advantage and better financial results (Bag et al., 2024). Small, medium, and large MNEs have different resource availability and operational capacity. Therefore, SSCs affect financial performance differently. Large companies have the resources to use SSC technology fully for efficiency and cost reductions (Younis et al., 2016; Khor et al., 2016; Tan et al., 2016). When investing in SSC capabilities, medium-sized organizations may see moderate returns, while medium and smaller firms may struggle to adopt and integrate these technologies due to resource constraints. The efficiency of SSCs in generating financial performance depends on business size, affecting how each category optimizes supply chain tactics. Thus, we proposed the following hypothesis:

H_1: *In an emerging context of GCC, the SSC and FP relationship is linked with firm size, but larger MNEs acquire more financial benefits from SSC than small and medium-sized MNEs.*

3.1.2 Smart Supply Chain and Green Supply Chain Management

The literature shows a positive correlation between SSCs and green supply chain management (GSCM), suggesting that smart technologies can boost sustainability efforts. We believe this relationship works better in large organizations with the capital and capacity to implement SSC initiatives fully (Nandi et al., 2021). Advanced technologies like data analytics and automation can boost large companies' operational efficiency and environmental sustainability, significantly boosting GSCM performance (Gunduz et al., 2021). Medium-sized enterprises may improve GSCM through SSC adoption, benefiting from some resource availability, but they generally encounter constraints that limit their capabilities compared to bigger firms (Lee et al., 2023; Laura et al., 2023). In contrast, small enterprises sometimes lack the capital to invest in SSC technologies (Younis et al., 2016). Consequently, SSC has little potential to improve GSCM practices. This difference shows that while the association exists across all firm sizes, its strength declines with firm size. Therefore, we hypothesized as follows: -

H_2: *In an emerging context of GCC, the significant association between SSC and GSCM exists across all firm sizes; its strength declines with a decline in firm size.*

3.1.3 Smart Supply Chain and Sustainable Supply Chain Performance

Although smart supply chain (SSC) methods and sustainable supply chain performance (SSCP) have received much attention, empirical but outcomes are mixed. SSC uses innovative technologies to improve operations, efficiency, and cost (Lee et al., 2023; Laura et al., 2023). However, this pursuit of operational excellence poses the question: Are these developments sustainable or only for profit? This duality shows that SSC's impact on SSCP is multifaceted and varies by firm size. Larger companies have better-developed sustainability networks and practices (Micheli et al., 2020). These organizations have adopted sustainable practices that support their operational strategies. Thus, they may profit and promote sustainability (Inman & Green, 2022). However, empirical investigations have not consistently supported this idea, suggesting a gap in understanding how SSC contributes to SSCP across company sizes.

Due to specific difficulties and opportunities, firms handle sustainability and smart technologies differently in emerging countries. Larger GCC enterprises may have the means and knowledge to employ SSC initiatives that improve operational efficiency and sustainability (Zaridis, Vlachos, & Bourlakis, 2021). Medium and smaller organizations may struggle to adopt these techniques due to limited resources, resulting in a transactional approach focused on cost reduction rather than sustainable performance (Tan et al., 2016). This perspective contributes to supply chain management discourse and emphasizes the need for regionally adapted strategies that consider business characteristics and capabilities. More research is needed to grasp these complications and the SSC-SSCP interaction.

H_3: *In an emerging context of GCC, the significant association between SSC and SSCP exists across all firm sizes; its strength improves with larger firm sizes.*

3.1.4 Green Supply Chain Management and SSCP

GSCM is essential to sustainable supply chain performance (SSCP) and provides many benefits through external and internal management. GSCM promotes sustainable supply chain operations by minimizing environmental impacts and maximizing resource efficiency (Afum et al., 2023). External GSCM promotes eco-friendly materials sourcing and waste reduction through collaboration with suppliers, customers, and other stakeholders. Firms can improve sustainability performance by sharing knowledge and best practices across their supply chains (Gelagay & Werke, 2024; Ghaderi et al., 2024). Internally, GSCM is comprised of optimizing logistics to reduce carbon footprints, improving energy efficiency, and adopting green technologies (Ghaderi et al., 2024). Small, medium, and large enterprises have different GSCM-SSCP relationships. Larger companies have more resources to invest in cutting-edge technology and sustainability. Since they can impact their entire supply chain network, their existing infrastructures and strategic focus on sustainability can improve SSCP more.

Conversely, SMEs may have limited financial resources, experience, and supplier negotiation strength. They can embrace GSCM practices, although their influence may be less than that of larger enterprises. SMEs may also favor short-term profits over sustainability, which could undermine GSCM projects (Younis et al., 2016; Zhu & Sarkis, 2004). Thus, while GSCM may improve sustainable performance across all company sizes, its success depends on the organization's size and resources (Micheli et al., 2020). Understanding these dynamics allows organizations of different sizes to customize GSCM strategies to their capabilities and difficulties, creating a more sustainable supply chain. Thus, we proposed as under:

H_4: *In an emerging context of GCC, the significant association between GSCM and SSCP exists across all firm sizes; its strength declines with a decline in firm size.*

3.1.5 Green Supply Chain Management and FP

Green Supply Chain Management (GSCM) and financial performance are challenging. Critics say GSCM procedures may increase upfront expenditures, hurting short-term profitability (Gelagay & Werke, 2024; Ghaderi et al., 2024; Kamra et al., 2024; Kara & Edinsel, 2023). This dynamic varies greatly by business size. Larger enterprises with more resources and market presence can better use GSCM for economic benefit. Since they can absorb initial investments and negotiate sustainable supplier practices, they can save money and enhance financial performance over time. Medium-sized enterprises may have a more ambiguous GSCM connection (Kamra et al., 2024; Kara & Edinsel, 2023). They can improve operational efficiency and brand reputation, but they may lack the resources of larger organizations to benefit from these methods. This uncertainty can hinder rapid financial rewards (Zhu et al., 2008a; Lee, 2008; Khor et al., 2016). Thus, while GSCM can drive economic outcomes for all enterprises, larger organizations seem to have a stronger and clearer relationship. In contrast, medium-sized firms may have varied results depending on their conditions and capacities. Our hypothesis is as follows:

H_5: *In an emerging context of GCC, the significant association between GSCM and FP exists across all firm sizes; its strength improves with an increase in firm size.*

3.1.6 SSCP and FP

SSCP affects firm financial performance across all sizes, but the extent and nature vary. SSCP improves operating efficiency, waste reduction, and resource use, saving money (Nayeri et al., 2023; Nguyen & Zuidwijk, 2024). Due to their higher resources and flexibility to invest in advanced technologies and sustainable practices at scale, larger enterprises may gain more. Scale economies allow such enterprises to profit from environmental initiatives (Nayeri et al., 2023; Vergara et al., 2023). SSCM also benefits medium-sized enterprises, but more subtly. Consumers prefer sustainable brands to gain efficiency and client loyalty (Zhu et al., 2008a; Lee, 2008; Khor et al., 2016; Tan et al., 2016). Their smaller resources may prevent them from properly capitalizing on these benefits compared to larger enterprises. While the financial benefit may be less immediate for small businesses, sustainable practices can boost resilience and competitiveness. Small enterprises can grow financially by differentiating themselves and appealing to environmentally sensitive clients. Thus, we hypothesize as follows:

H_6: *In an emerging GCC context, the significant association between SSCP and FP exists across all firm sizes; its strength improves with a decrease in firm size.*

3.2 Moderation Effect

Competitive pressure moderates the impact of smart supply chain (SSC) techniques on green supply chain management (GSCM) (Liu et al., 2022). SSC methods improve operational efficiency and sustainability in today's dynamic corporate environment. However, depending on the competition, these approaches may not lead to effective GSCM (Liu et al., 2022). Due to their brand visibility, resource advantages, and economies of scale, larger enterprises operate in less competitive markets. They may have less urgency to implement GSCM strategies because their market position allows them to maintain profitability without immediate requirements to innovate sustainably (Chatterjee et al., 2023). This low, competitive pressure may reduce SSC's moderating influence on GSCM in large enterprises. Smaller enterprises must differentiate themselves due to increased competition. More direct competition can force these enterprises to adopt SSC practices that support GSCM. Responding to competitive challenges encourages innovative and sustainable practices, enhancing its moderating effect.

While better positioned than smaller enterprises, medium-sized firms suffer more competitive pressure than bigger firms. This can motivate them to incorporate SSC techniques into their GSCM strategy, keeping them agile and competitive. Thus, knowing competitive pressure is essential to evaluate how SSC affects GSCM across company sizes. Thus, the thesis proposes:

H_7: *In an emerging GCC context, competitive pressures moderate the impact of SSCP on GSCM; its strength improves with a decrease in firm size.*

3.3 Mediation Effect

Lastly, the research study constructs the hypotheses for the mediation effect. Each mediation effect is literarily supported as follows:

3.3.1 GSCM as a Mediator between SSC and SSCP

We argue that GSCM practices may mediate the relationship between the SSC and SSCP. Through GSCM, organizations can improve their internal and external sustainability initiatives, improving supply chain sustainability (Feng et al., 2018; Feng et al., 2024). SSC methods use technology and data analytics to improve efficiency, while GSCM emphasizes sustainability and stakeholder participation (Afum et al., 2023). GSCM mediates the SSC-SSCP interaction differently across firm sizes. Larger organizations may apply GSCM methods efficiently because of their systems and resources, strengthening mediation (Agyapong et al., 2023). They can boost performance by investing in cutting-edge innovation and green practices. Due to resource restrictions and sustainability commitment, medium-sized enterprises may have a moderate mediation effect (Choi et al., 2017). Small enterprises facing the most competitive pressure to adopt sustainable practices may struggle implementing

GSCM due to limited resources and knowledge. Thus, GSCM's mediation success depends on the organization's size and capabilities, emphasizing the necessity for supply chain sustainability strategies tailored to the firm. The hypotheses are as follows:

H_8: *In an emerging GCC context, the strength of the mediation effect of GSCM on the association between SSC and SSCP relies on firm size.*

3.3.2 GSCM as a Mediator between SSC and FP

Green Supply Chain Management (GSCM) potentially mediates the relationship between SSC practices and financial success. Due to the high initial costs of GSCM implementation, mediation may be limited. In smaller organizations, these investments might strain resources and detract focus from other strategic efforts, making it less probable for GSCM to moderate the SSC-FP link properly (Feng et al., 2018; Feng et al., 2024). Due to their financial resources, GSCM techniques are more feasible for larger organizations (Nureen et al., 2023). They can integrate sustainable practices using their existing infrastructure without jeopardizing other strategic choices. This optimizes GSCM as a strategic choice, improving financial results (Kara & Edinsel, 2023). Larger organizations can withstand GSCM's initial costs, resulting in long-term financial gains (Choi et al., 2017). GSCM adoption is harder for smaller organizations due to resource and budgetary restrictions. Heavy investments can impede their ability to apply sustainable practices, resulting in insufficient SSC-FP mediation. GSCM can mediate the interaction between SSC and FP, but business size and resource availability greatly impact its effectiveness, especially for smaller firms.

H_{9a}: *In an emerging GCC context, the GSCM mediation effect between SSC and FP relies on firm size, implying that larger firms have the capabilities to use GSCM to acquire financial benefits from SCC.*

3.3.3 SSCP as a Mediator between SSC and FP

We also hypothesize that sustainable supply chain performance (SSCP) mediates the association between smart SSC and financial performance. First, sustainable methods promote efficiency, waste reduction, and brand reputation, which boosts profits (Fantazy & Tipu, 2024). The alignment strengthens the link between SSC initiatives and financial results. Smart technologies and sustainable practices can optimize operations, save money, and increase income (Tipu & Fantazy, 2023; Karmaker et al., 2023). We expect a considerable mediation effect, especially in larger enterprises with more resources and capacities to align SSC with financial goals. Larger companies with powerful analytics and robust infrastructures can employ SSC to turn sustainability initiatives into financial gains (Lee et al., 2012). Thus, organizations seeking to improve financial performance through sustainable and smart supply chain strategies must understand how SSCP mediates this link. Sustainability and SSC are integrated to generate profitability and long-term success. Thus, we proposed the following hypothesis:

H_{9b}: *In an emerging GCC context, the SSCP mediation effect between SSC and FP is statistically significant for small, medium, and large-sized firms.*

3.3.4 Sequential Mediation Effect

The study uses sequential mediation to study SSC's financial impact. Sequential mediation helps sustainable supply chain experts grasp complex variable relationships (Ibrahim et al., 2021). In a developing setting, the sequential mediation effect of GSCM practices on sustainable supply chain performance examines how a smart supply chain affects financial performance (Liu et al., 2022; Bharadwaj et al., 2022). This strategy suggests that smart technologies and green practices can boost operational efficiency and lower costs. Green supply chain management (GSCM) techniques are an initial mediator because sustainable enterprises can better leverage smart supply chain technology advancements (Bharadwaj et al., 2022; Raza et al., 2020). GSCM helps firms optimize processes, reduce waste, and maximize resource use, improving sustainable supply chain performance. As a mediator, SSCP boosts smart supply chain financial performance. This sequential mediation shows that sustainable practices boost the benefits of a smart supply chain beyond technological adoption. Importantly, this association is expected to remain across business sizes, suggesting that both large and small enterprises can use these practices' interconnectedness to improve their financial results (Khor et al., 2016). In an evolving context of resource restrictions and environmental difficulties, this integrated approach is even more important for enterprises to achieve sustainable growth and market competitiveness. Considering the sequential mediation effect, the study presents the sequential mediation hypothesis:

H_{10}: *The relationship between SCC and FP is sequentially mediated via MNES' GSCM practices and SSCP in the GCC context, and the relationship varies across small, medium, and large-sized firms.*

3.4 Research Framework

Fig. 1 below presents the research framework. The study framework shows six direct hypotheses. The dotted line indicates the moderation effect of competitive pressures. We have shown size as a categorical variable that provides the basis for small, medium, and large firms. Control factors include respondent gender, experience, firm age, and sector.

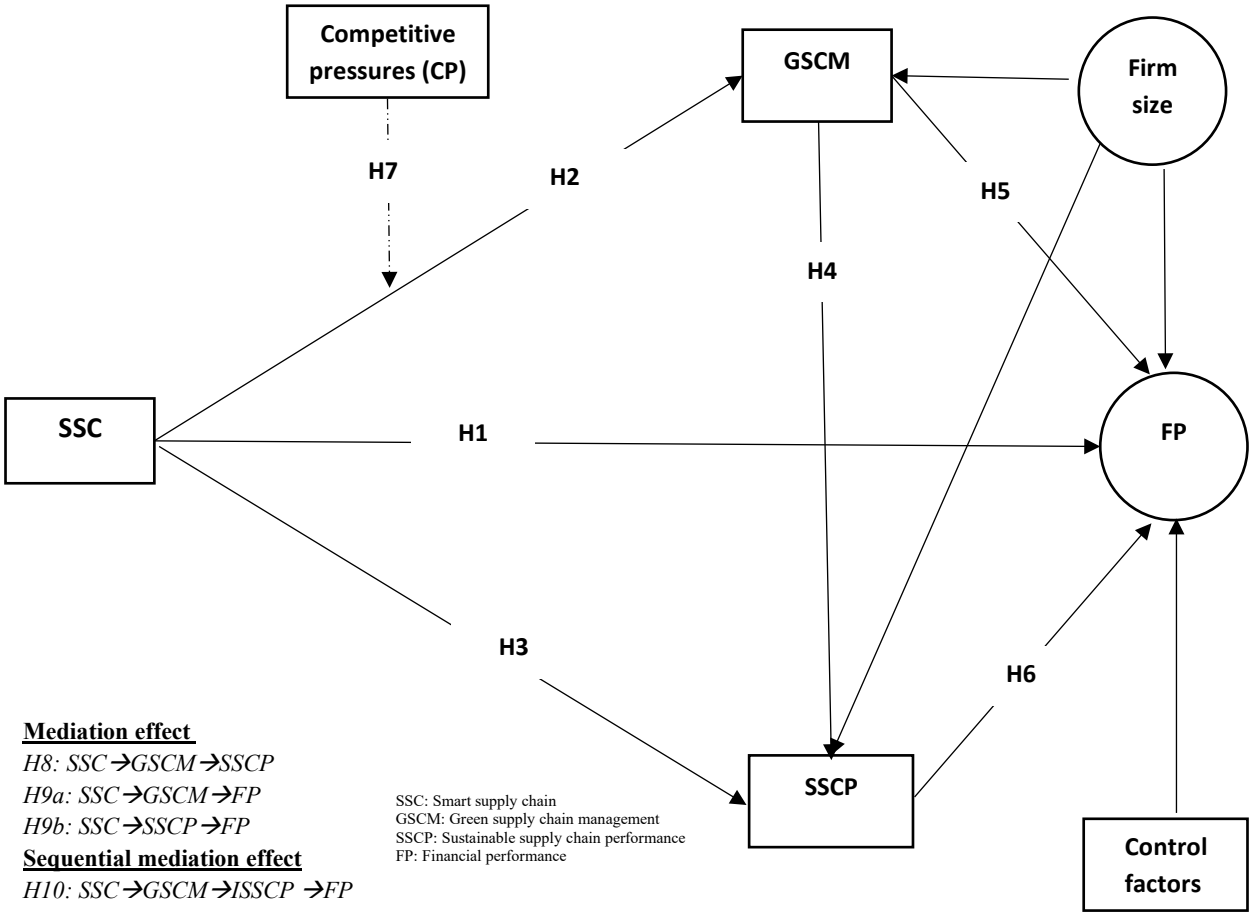

Fig. 1. Proposed Research Framework

3.5 Classification of MENs (Size)

We follow EU recommendation 2003/361 to classify our firms on a size basis. The classification applies to MNEs all over the globe (Younis et al., 2016; Khor et al., 2016; Tan et al., 2016). This classification categorizes firms into four groups, including (1) micro-sized firms (number of employees <10), (2) small-sized firms (10=< number of employees>50), (3) medium-sized firms (50=< number of employees>250) and (4) large-sized firms (number of employees>250). As the operations are restricted in micro-level firms that do not fulfill the research criteria, we exclude them from our sample. So, we are left with three categories: small, medium, and large-sized firms for our comparative analysis.

3.6 Questionnaire Development and Data Collection

A detailed questionnaire examined supply chain management concepts, including digital transformation and green practices. Initially, we adopted each section constructs from different studies. SSC encompasses Digital Transformation Strategy (5 items), Digital Technologies BASE (5 items), and Front-End Technologies (4 items) (Shen et al., 2022). After the SSC, we examine E-GSCM, which comprises Green Supplier and Green Customer Relationships. Four factors assess the Green Supplier Relationship's collaboration and sustainability efforts between firms and suppliers (Saeed et al., 2022). Five Green Customer Relationship construct components examine how firms engage customers on sustainability issues (Saeed et al., 2022). We then investigate I-GSCM, encompassing Green Packaging, Manufacturing, and Purchasing (Wandosell et al., 2021). The Green Packaging concept has four eco-friendly packaging items. With five items, Green Manufacturing evaluates sustainable production techniques. Four criteria assess the Green Purchasing architecture, showcasing sustainable purchase practices (Wandosell et al., 2021). The questionnaire also assesses competitive pressures. SSCP is assessed using eight elements to assess supply chain sustainability initiatives (Bag et al., 2020). Lastly, we used constructs for financial performance following earlier research (Saeed et al., 2022). Once the questionnaire was adopted, we used a sequential process for its adaptation. A comparison study of small, medium, and large firms requires complex questionnaire development to ensure that each category's features are considered. Considering this intricacy, we rigorously established the face validity of the selected measures. This involves working with 21 experts from various domains to modify and clarify each questionnaire item, reducing respondent uncertainty. We had two supply chain management academics, one English language specialist, and a fair mix of industry practitioners, comprising two IT managers, two operational managers, and two financial managers from each firm type. This varied group of 18 experts assessed the questionnaire's relevance across small, medium, and large organizations. The panel met several times to discuss the questionnaire's applicability to the three enterprise groups. After finalizing it, we pilot-tested it. We distributed 36 surveys and requested each group provide 12 responses for this pilot structured method focus area: IT managers promoting smart supply chains. Operational management reviewed GSCM and

sustainable supply chain practices. This concentrated strategy showed how managerial viewpoints affect new supply chain processes, making the questionnaire more useful. The respondents had to answer using a 7-point Likert scale for each measure. After pilot testing, we had another expert group meeting to analyze the data. This debate explored pilot respondents' feedback trends, challenges, and opportunities. The experts assessed questionnaire item clarity, relevance, and value. Their thorough study increased the instrument's depth and usability. The questionnaire evolved to better capture the complexities of supply chain management for IT, operations, and financial managers of varied organizations. Following expert comments and data analysis, we made necessary changes to guarantee that the questionnaire reflected the different viewpoints of stakeholders in small, medium, and large organizations. The MNEs were selected based on their application of smart supply chain technology. This general approach enhances our research and enriches supply chain management discourse by showing how organizations of different sizes address contemporary issues and possibilities. Once the questionnaire was completed, each MNE's management was briefed on research ethics. We underlined confidentiality and guaranteed that their identities and responses would stay anonymous throughout the study. We distributed our electronic questionnaire to a selected sample of 625 MNEs in the GCC region, encompassing a mix of large (30%), medium (32%), and small enterprises 38%). We consistently followed up following questionnaire delivery to maximize response rates.

Table 1
Data Collection

Methods	IT professional		Logistics and supply chain managers		Finance managers		Total	
	N	%age	N	%age	N	%age	N	%age
Emailed	625		625		625		1875	
First Response	127	20.32%	138	22.08%	126	20.16%	391	20.85%
First follow-up	104	16.64%	108	17.28%	113	18.08%	325	17.33%
Second follow-up	99	15.84%	88	14.08%	82	13.12%	269	14.35%
Personally collected	43	6.88%	43	6.88%	43	6.88%	129	6.88%
Total	373	59.68%	377	60.32%	364	58.24%	1114	59.41%
Incomplete	39	6.24%	43	6.88%	30	4.80%	112	5.97%
Complete	334	53.44%	334	53.44%	334	53.44%	1002	53.44%
Number of firms (1002/3)							334	
Firm-wise distribution of response			**Small firms**		**Medium size**		**Large firms**	
Emailed			204		211		210	
First Response			39	19.12%	48	22.75%	30	14.29%
First follow-up			46	22.55%	41	19.43%	37	17.62%
Second follow-up			42	20.59%	33	15.64%	33	15.71%
Sub-total			127	62.25%	122	57.82%	100	47.62%
Incomplete			17	8.33%	25	11.85%	21	10.00%
Complete			110	53.92%	97	45.97%	79	37.62%
Personally collected			11	5.39%	16	7.58%	21	10.00%
Total			121	59.31%	113	53.55%	100	47.62%

Source: Authors' compilation

3.7 Common Method Variance (CMV) and Multicollinearity

We addressed Common method variance (CMV) and multicollinearity. First, we did not show our model to respondents to avoid response biases. Second, early responses (received without reminder) were compared to personally collected responses and treated as non-respondents (Armstrong & Overton, 1977). The covariates and early and late respondent differences were examined using a multivariate t-test. No significant difference was seen between early and late respondents ($p=0.246$). Third, we sent an abridged questionnaire to 20 random non-respondents to test for non-response bias. All 20 selected non-respondents completed and returned the shorter questionnaire after phone calls and personal contacts (Lohr, 1999; Wagner & Kemmerling, 2010). Another multivariate t-test compared these replies to those acquired during data collection. There was no significant difference in item-level or construct-level values between respondents and non-respondents ($p=0.325$). Fourth, we also tested the t-test, treating late response as nonresponse, and found similar results. Fifth, Harmon's single-factor test finds factors in all data (Kitsis & Chen, 2021). Overall, 79.11% of the variance was explained by all the factors, and the first factor accounted for 15.07% of the variation, confirming the absence of any single factor in our model and reducing the risk of unexplanatory biases. Sixth, we assessed VIF to check for any possibility of multi-collinearity among variables, which was observed below 5, confirming the absence of multicollinearity. Lastly, the full collinearity test shows the value of VIF below 3.3, implying that our data is free from the common method bias in the study. Another reason for the absence of CMB may be that we collected data from IT and operational managers, allowing them to answer their relevant questions.

4. Results

Smart PLS was utilized to create the structural equation model in this study. This method predicts models. This method analyzes variable relationships. In finding mediation effects, the PLS-SEM methodology is less paradoxical than regression analysis and better for estimating study results. This method is important, according to Hair et al. (2020). The PLS-SEM literature recommended a two-step analysis. PLS-SEM begins with testing the measurement model's inter-item, internal consistency, and convergence validity. The second step tests hypotheses and structural model predictiveness (Henseler et al., 2009).

4.1 Measurement Model

The first stage of model measurement used a threshold level of 0.70% and factor loading to assess interitem reliability (Hair et al., 2016). Second, this study evaluates convergent validity using the average variance extracted (AVE) at 0.50 (Hair et al., 2016). This study evaluated internal consistency reliability by assessing score composite reliability (CR) over 0.70 in the third phase (Hair et al., 2016). Table 2 shows various CR values. CR is more than 0.70, according to this finding. This value shows dependability and consistency. In this table, convergent validity average variance accounted for values above the benchmark described in earlier studies. This value suggests convergent validity.

Table 2

Questionnaire's Validity

Constructs	F/L	CR	AVE
You are requested to specify by tick (√) the level of importance the following smart supply chain configuration (SSC) best reflects in your firm. (Seven-point scale: 1= Not at all important,2= Slightly important,3= Moderately important,4= Important, 5= Very important, extremely important and 7= Absolutely essential)			
Digital Transformation Strategy			
We aim to digitalize everything possible in the supply chain.	0.876	0.88	0.83
We aim to collect large amounts of data from different sources in the supply chain.	0.912		
We aim to create a more robust communication network between different supply chain sectors with digital technologies.	0.868		
We aim to exchange information in the supply chain with digitalization.	0.764		
We aim to improve the interface with customers with digitization efficiently.	0.834		
Digital Technologies BASE			
We use the Internet of Things in our supply chain processes.	0.932	0.89	0.74
We use cloud computing in our supply chain processes.	0.874		
We use Big Data Analytics in our company processes and the supply chain.	0.679		
We use artificial intelligence in supply chain processes.	0.838		
Digital Technologies BASE			
We use collaborative robotics in our company processes and the supply chain.	0.848	0.91	0.72
We use computer simulation in supply chain processes.	0.000		
We use augmented reality in supply chain processes.	0.702		
We use 3D printing in supply chain processes.	0.758		
You are requested to specify by a tick (√) the extent of your company's relationship with the Supplier and customers. (Seven-point scale: 1=Not at all,3=Slightly, 3= Somewhat,4=Moderately,5= Very, 6= Extremely and 7= Absolutely)			
Green Supplier Relationship			
Our company cooperates with suppliers to consider environmental issues in product design.	0.829	0.89	0.68
Our company develops input logistics with suppliers to be more environmentally friendly.	0.868		
Our company prefers suppliers that have an environmental management system.	0.819		
Green Customer Relationship			
Our company works with customers to consider environmental issues in product design.	0.887	0.94	0.78
Our customers have asked us for information on our environmental compliance.	0.858		
Our customers have demanded that our company ensure the sustainable practices of our suppliers.	0.807		
Green Packaging			
Our company packaging is reusable.	0.741	0.81	0.67
Our company's packaging uses as few materials as possible.	0.799		
Our company encourages the use of reusable packaging.	0.791		
Our company promotes packaging recycling and reuse programs.	0.838		
Green Manufacturing			
Our company assesses the environmental impact of developing/improving products.	0.817	0.87	0.76
Our company develops products with recyclable raw materials.	0.774		
Our company develops products with the lowest consumption of resources.	0.858		
Our company develops products with low impact on the environment.	0.855		
Our company develops products with a high lifespan.	0.891		
Green Purchasing			
Our company purchases are based on environmental specifications established by product design.	0.747	0.83	0.61
Our purchasing process is carried out with ISO 14001-certified partners.	0.815		
Our purchasing process follows procedures that minimize environmental impact.	0.890		
Our purchasing process follows product labeling standards to minimize environmental impact.	0.911		
You are requested to specify by a tick (√) the extent to which you agree with the following statements relating to the Competitive pressure firms face in the industry. (Seven-point scale: 1 =Not at all,2=Very minimally,3=Minimally, 4=Moderately,5= Significantly, 6=Very much and 7=To a great extent)			
Our competitors employ data analytics to acquire, manage, and analyze data for insights.	0.828	0.88	0.65
Our suppliers employ data analytics to acquire, manage, and analyze data for insights.	0.838		
Our customers utilize data analytics to collect, manage, and analyze data for insights.	0.764		
By a tick (√), you are requested to specify the degree to which your organization has achieved the following sustainable supply chain performance objectives. (Seven-point scale: 1=Very Low, 2= Low, 3=Somewhat Low, 4= Moderate, 5=Somewhat High, 6= High and 7= Very High)			
Our organization has visibility of supply chain dynamics in the network.	0.847	0.90	0.82
Our organization manages risks in the supply network proactively.	0.798		
Our organization has proper control over supply chain costs.	0.784		
Wastages in our supply chain network have been reduced significantly.	0.732		
Our organization's supply chain can supply final customers with timely, complete orders.	0.790		
Our organization can adhere to environmental standards as per customer requirements.	0.781		
Our organization has minimized buffer stocks at all levels throughout the supply chain.	0.828		
Our organization's supply chain can respond faster than competitors in a volatile business environment.	0.882		
You are requested to specify, by a tick (√), the degree to which your organization has achieved the following financial performance objectives. (Seven-point scale: 1=Very Low, 2= Low, 3=Somewhat Low, 4= Moderate, 5=Somewhat High, 6= High and 7= Very High)			
Financial performance	0.819	0.92	0.84
The profit margin has increased.	0.776		
The return on investment has increased.	0.820		
Sales volume has increased.	0.715		
Cash flow has increased.	0.724		

CA=Cronbach's alpha, AVE=Average variance extracted, CR= Composite reliability. Diagonal values represent the square root of the AVE of each latent construct.

To address potential response biases, we designed the questionnaire to segment questions based on managerial roles, specifically targeting IT, operational, and finance managers. Each firm received a tailored portion of the questionnaire, ensuring each respondent answered questions relevant to their expertise. This strategy allowed us to aggregate responses from 1,875 managers across the various functional areas. We received 20.85% responses over one month, providing a foundation for our analysis. Recognizing the importance of maximizing our response rate, we implemented a structured follow-up approach. The first follow-up yielded an additional 17.33% response, demonstrating a positive trend in engagement. Encouraged by this increase, we conducted a second follow-up, resulting in 14.35% more responses (see Table 1). This iterative follow-up process was crucial in maintaining momentum and reinforcing the importance of participation among the respondents.

Our comparative research prioritized a balanced representation of enterprises of different sizes. However, large enterprises had a far lower response rate than small and medium-sized firms (Table 1). We contacted managers in larger firms to address this difference more personally. We advocated for the study's relevance and insights via phone calls and meetings—these encounters-built trust and involvement, improving our dataset. By carefully monitoring our data collection processes and using targeted techniques, we achieved an excellent survey response rate of over 53%. Our final sample was well-balanced, with a significant number of small enterprises, enabling rigorous comparison analyses in the following rounds of the research. This thorough and controlled process achieved high response rates and reliable and valid insights from varied managerial viewpoints.

4.2 Discriminant Validity

The study used HTMT (Heterotrait–Monotrait ratio of the correction) and the Fornell–Larcker criterion to determine the discriminant validity. This process is used because of criticism of the criterion of discriminant validity measurement by Ab Hamid et al. (2019). It is recommended that if the HTMT ratio of the correction value increases more than 0.85 or 0.90, then the problem of discriminant validity will exist. Table 3 shows that all the values of HTMT met at 0.85, which is the suggested criteria by Ab Hamid et al. (2019).

Table 3
Construct Validity and Discriminant Validity

	SSC	GSCM	SSCP	CP	FP
	Fornell–Larcker criterion				
SCC	***0.791***				
GSCM	0.476	***0.775***			
SSCP	0.615	0.625	***0.758***		
CP	0.629	0.655	0.570	***0.782***	
FP	0.651	0.517	0.534	0.560	***0.713***
HTMT	SSC	GSCM	SSCP	CP	FP
	Heterotrait-Monotrait Ratio of Correlation				
SCC	—				
GSCM	0.616				
SSCP	0.691	0.722			
CP	0.681	0.702	0.751		
FP	0.720	0.691	0.791	0.791	0.767

Note: n=334, SSC- Smart Supply Chain, GSCM= Green Supply Chain Management, CP= Competitive Pressures, SSCP= Sustainable Supply Chain performance, FP= Financial Performance

Source: Authors' compilation

4.3 Demographics

The demographic profile of this study's respondents helps interpret the conclusions. Men comprise 79.94% of the sample. Males dominate managerial roles, reflecting a regional trend. Most respondents have advanced degrees. Master's degrees are held by 61.48%, bachelor's degrees by 21.16%, and Ph.D. degrees by 17.37%. This educational background reflects a well-informed respondent pool with theoretical and practical insights. A steady and established market presence is shown by 53.49% of enterprises operating for eight to 15 years, followed by 34.03% of firms above 15. This consistency can reveal how these companies handle conventional and modern supply chain management difficulties. Industry representation is also significant in the sample. Transport equipment accounts for 11.08%, followed by Machinery and equipment at 10.78%. This diversity broadens the data beyond a specific industry, improving generalizability. Demographic features of respondents are balanced enough to support this study's empirical conclusions (see Table 4).

Table 4
Respondent and Firm Profile

Items	Sub-items	Number	Percentage
Gender	Male	801	79.94%
	female	201	20.06%
Qualification	PhD	174	17.37%
	Masters	616	61.48%
	Bachelors	212	21.16%
Experience	5 years to 10 years	365	36.43%
	10 years to 15 years	377	37.62%
	above 15	260	25.95%
Firm age	less than eight years	125	12.48%
	eight to 15 years	536	53.49%
	above 15 years	341	34.03%
Sector (HS 2-Digit Classification)	Chemical (28, 29)	44	13.17%
	Raw hides, skin, and leather products (41,42)	34	10.18%
	Oil and Gas	33	9.88%
	Footwear (64)	29	8.68%
	Textiles (50–63)	23	6.89%
	Base metals (72–83)	26	7.78%
	Machinery and equipment (84)	36	10.78%
	Electrical equipment (85)	31	9.28%
	Transport equipment (87)	37	11.08%
	Agriculture	13	3.89%
	Others	28	8.38%

Source: Authors' compilation

4.4 Statistical Measures for the Constructs

We used the item content validity index (ICVI) and the scale content validity index (SCVI). ICVI and SCVI are used to reveal the error-free items in the scale. Our results revealed 0.944 values for ICVI, whereas the SCVI was "1.00," endorsing the content validity of our study. For the construct reliability and validity, we used numerous rounds of analysis, which include Exploratory Factor Analysis (EFA) and Conformity Factor Analysis (CFA). While conducting EFA, we did not consider an item with a loaded value of less than 0.30 (Azmi, Abdullah, Musa, & Wan Mahmood, 2020). Our data was normal and free from a higher level of Skewness. Our results show a satisfactory level of the goodness of fit indices (Azmi et al., 2020). ($\frac{\lambda^2}{df} = 1.844, CFI = 0.907, NFI = 0.645, TLI = 0{:}924; RMSEA = 0{:}068$). As shown in Table 3, the factor loading value is above 0.60. Hence, we retained our variables.

4.5 Direct Effect and Moderation Effects

Once the preliminary tests were performed, we proceeded to hypothesis testing. Firms are divided into four panels: the overall sample and the small, medium, and large firms sample. The overall sample results are used as a benchmark for comparison and are reported in Table 5. First, SSC positively predicted FP in Panel D (β=0.188, p<0.05; see Panel D) in line with earlier studies (Lee et al., 2023). The relationship was identical in Panel B and A; we observed no significant difference compared to Panel D. SSC is associated with financial performance for medium and small firms at an acceptable significance level (p<.05), implying that they may struggle to fully realize the financial benefits due to resource constraints and restricted access to innovative technologies (Lee et al., 2023). However, compared to Panel D and the other three panels (A and B), we find a higher coefficient estimate and significant level in Panel C (β=0.277, p<0.01; see Panel C), demonstrating that larger MNEs better align the SSC and FP relationship (Younis et al., 2016). This shows that larger MNEs with more resources and competencies can better use SSC initiatives (Khor et al., 2016; Tan et al., 2016). These organizations may apply SSC methods that streamline operations and improve financial performance because of their advanced technical infrastructures and procedures, supporting H1, which demonstrates that in an emerging context of GCC, the SSC and FP relationship is linked with firm size but larger MNEs acquire more financial benefits from SSC than small and medium-sized MNEs.

In H2, we proposed that the significant association between SSC and GSCM exists across all firm sizes; its strength declines with a decline in firm size. The results show a positive and statistically significant impact of SSC on GSCM. The strength of the relationship is at the maximum level overall (β=0.299, p<0.001; see Panel D) and in Panel C (β=0.336, p<0.001; see Panel C) and its strength declines in Panel B (β=0.222, p<0.01; see Panel B) and A (β=0.198, p<0.05; see Panel A), supporting H2. These results reveal that the impact of SSC on GSCM is statistically significant across our four panels. However, the improved coefficient estimate, and significance level are observed in Panel C, demonstrating that larger firms better align the SSC-GSCM relationship. Due to their higher resources, larger organizations tend to have better GSCM practices. Financial capital, advanced technology, and a pool of talented workers help them invest in sustainable practices (Khor et al., 2016; Tan et al., 2016). Better supply chain technology, like smart logistics and data analytics, can help larger companies monitor and reduce environmental concerns. In contrast, medium and smaller organizations often lack the resources to execute full GSCM

practices. Specifically, smaller firms may struggle to fund sustainability technologies or staff, and they prioritize operational demands above long-term sustainability goals, which might reduce GSCM efficiency.

In H3, we predicted that the significant association between SSC and SSCP exists across all firm sizes; its strength improves with larger firm sizes. Contrary to our prediction, we found an insignificant impact of SSC on SSC across panels D, B, and C. In contrast, the impact of SSC on SSCP is statistically significant in Panel C (β=0.189, $p<0.05$; see Panel). Small and medium-sized firms are unable to utilize SSC to advance their SSCP. Large firms have established mechanisms that lead them to use SSC technology for sustainable supply chain management (Tan et al., 2016). The findings reject H3.

Further, H4 predicts that in an emerging GCC context, the significant association between GSCM and SSCP exists across all firm sizes, its strength declines with a decline in firm size. Results show strong support in all panels, supporting H4. Incorporating green practices throughout the supply chain, GSCM improves sustainability (Khor et al., 2016; Tan et al., 2016). GSCM reduces waste, carbon emissions, and resource use by prioritizing sustainability of sourcing, production, and distribution (Kumar et al., 2019). This method promotes innovation and efficiency by collaborating with suppliers and stakeholders to meet environmental criteria. GSCM boosts a company's reputation, customer loyalty, and market competitiveness (Borsatto & Amui, 2019). GSCM supports ecological goals and the supply chain's economic viability and resilience (Khor et al., 2016; Tan et al., 2016; Wang & Ozturk, 2023; Wiredu et al., 2024). These results are consistent for all panels. The results show that the strength of relationships holds its significance level, rejecting H4. The size effect does not show any significant variation in the effect of GSCM and SSCP. Once a firm adopts GSCM practices, it shows established mechanisms that enhance SSCP.

In H5, we predict that in an emerging GCC context, the significant association between GSCM and FP exists across all firm sizes; its strength improves with firm size. The results show an insignificant impact of GSCM on FP, rejecting H5. The results for all samples in our analyses demonstrate that GSCM practices do not lead to operational efficiency. Initially, GSCM practices may be costly, showing their insignificant association with FP (Kumar et al., 2019). This also aligns with the view that GSCM practices yield profit in the long run, and the firms should not expect immediate financial return. The insignificant GSCM-FP relationship led us to test the mediation effect of SSCP.

In H6, we found strong support for the positive impact of SSCP on FP. This aligns with the view that sustainability enhances firms' operational efficiency, which results in higher profitability (Kumar et al., 2019). The variations in coefficient estimates were observed, but the significance level continues ($p<.001$) to hold for all these panels, showing that firms of all sizes may benefit from sustainability. A small variance in coefficient estimates is minimal, demonstrating that the link is stable and consistent regardless of firm size (Khor et al., 2016; Tan et al., 2016; Kumar et al., 2019). This shows the need for sustainable supply chain methods for environmental, social, and economic goals. Businesses should consider sustainability as a strategic goal to improve performance (Borsatto & Amui, 2019). Resultantly, H6 is rejected.

H7 predicts that in an emerging GCC context, competitive pressures moderate the impact of SSCP on GSCM; its strength improves with a decrease in firm size. For the moderation effect, we introduced interaction terms between SSC and CP to test their direct impact on GSCM. Compared to the direct impact of SSC on GSCM, the results of interaction terms are identical in panels D and C, showing consistency in the impact of SSC on GSCM in a competitive environment (Borsatto & Amui, 2019). However, the competitive pressures enhance coefficient estimates and level of significance in Penal A (β=0.268, $p<0.001$; see Panel A) and B (β=0.283, $p<0.01$; see Panel B) compared to the direct impact of SSC on GSCM. These results indicate that competitive pressures continue to affect MNEs' GSCM practices, and small and medium-sized firms take measures to absorb pressure. Though the direct impact is statistically significant in all panels, the results provide a specific insight regarding small and medium-sized firms, thus supporting H7.

4.6 Mediation Effect

We used IBM AMOS V 23 to test the mediation effect of GSCM (E-GSCM and I-GSCM). As Byrne (2009) suggested, the bootstrapping method is conducted to test the indirect effect. This method involves using 2,000 resamples with a 95% confidence interval in IBM AMOS V.23 to conduct the indirect effect of SSC on FP via GSCM and SSCP (Byrne, 2009), ensuring the robustness and validity of our findings.

H8 predicts that in an emerging GCC context, the strength of GSCM's mediation effect on the association between SSC and SSCP relies on firm size. First, the impact of SSC on SSCP was statistically insignificant, as reported in the first half of Table 5, except in Panel C; the introduction of GSCM as a mediator significantly enhanced the coefficient estimates and significance level in all Panels (Agarwal et al., 2018; Movahed et al., 2024). In Panel C, we also observed a significant increase in coefficient estimates and level of significance (β=0.268, $p<0.001$; see Panel C), showing a partial mediation effect. GSCM, as a mediator, enhances the association between SSC and SSCP in all penal, showing no significant differences in its mediation role, thus rejecting H8.

H9a demonstrates that in an emerging GCC context, the GSCM mediation effect between SSC and FP relies on firm size, implying that larger firms can use GSCM to acquire financial benefits from SCC. Regardless of business size, SSC does not improve performance through GSCM. The results imply that firm size is unaffected by the expected mediation effect of green practices (Kumar et al., 2019). Therefore, firms may need to reassess their smart and sustainable supply chain projects because

the promised benefits may not materialize across different sizes of enterprises (Kumar et al., 2019). This highlights how complex technological integration and sustainability strategies drive corporate performance. Thus, H9a is rejected.

H9b predicts that in an emerging GCC context, the SSCP mediation effect between SSC and FP is statistically significant for small, medium, and large-sized firms. The results show that the GSCM mediation effect varies across Panels. In Panels A, B, and C, the significance levels are 5%, 1%, and p<.01, respectively, showing an increasing trend. Though the GSCM mediates the relationship, its mediation effect increases across sizes, rejecting H9b. In H9b, the size effect is more pronounced, indicating that large-sized firms are the most beneficial of the mediation effect, followed by medium-sized firms.

Lastly, we used a sequential mediation approach to determine the complex association between SSC and FP. The results show a strong sequential mediation effect, as we found a significant sequential mediation effect of GSCM and SSCP. The sequential mediation effect is moderately accepted by small firms (p<.05), followed by medium-sized firms (p<.01), showing that small firms are the least beneficiaries of the sequential mediation effect. Thus, H10 is accepted, which states that the relationship between SCC and FP is sequentially mediated via MNES' GSCM practices and SSCP in the GCC context, and the relationship varies across small, medium, and large-sized firms. Firm size has an important role to play in the sequential mediation effect.

The results of control factors show that firms' age is a significant predictor of FP. The sector effect is also found across panels. For brevity, the results of control factors are presented in regression using the mediation effect.

Table 5
Hypotheses Testing

	Panel A: Small firms' sample		**Panel B: Medium firms' sample**		**Panel C: Large firms' sample**		**Panel D: Overall firms' sample**	
Hypotheses	**Path (t-value; p-value)**	**Result**	**Path (t-value; p-value)**	**Result**	**Path (t-value; p-value)**	**Result**	**Path (t-value; p-value)**	**Result**
H1-- SSC →FP	0.125 [0.868:0.046]	Yes	0.160 [2.101:0.036]	Yes	0.277 [3.152:0.01]	Yes	0.188 [2.275:0.024]	Yes
H2-- SSC →GSCM	0.198 [2.103:0.015]	Yes	0.222 [3.545:0.01]	Yes	0.336 [4.647:0.000]	Yes	0.299 [4.647:0.000]	Yes
H3--SSC →SSCP	0.046 [0.644:0.373]	No	0.084 [1.151:0.250]	No	0.189 [2.240:0.034]	Yes	0.070 [1.142:0.103]	No
H4--GSCM →SSCP	0.399 [3.989:0.000]	Yes	0.426 [4.868:0.000]	Yes	0.598 [5.506:0.000]	Yes	0.455 [4.102:0.000]	Yes
H5-GSCM→FP	0.044 [1.656:0.654]	No	0.074 [1.442:0.319]	No	0.091 [1.031:0.104]	No	0.081 [1.222:0.655]	No
H6-SSCP→FP	0.313 [4.464:0.001]	Yes	0.381 [4.546:0.000]	Yes	0.558 [7.236:0.000]	Yes	0.445 [5.757:0.000]	Yes
Moderation effect								
H7--SSC*CP →GSCM	0.268 [4.388:0.001]	Yes	0.283 [5.466:0.001]	Yes	0.401 [4.765:0.000]	Yes	0.315 [4.956:0.000]	Yes
Mediation effect								
H8—SSC→GSCM→ SSCP	0.344 [4.720:0.000]	Yes	0.385 [5.686:0.000]	Yes	0.551 [6.004:0.000]	Yes	0.497 [5.270:0.000]	Yes
H9a—SSC→GSCM→ FP	0.077 [0.943:0.232]	No	0.103 [0.834:0.543]	No	0.121 [1.232:0.112]	No	0.114 [0.919:0.112]	No
H9b—SSC→SSCP→ FP	0.265 [2.712:0.0282]	Yes	0.316 [3.532:0.01]	Yes	0.344 [5.565:0.000]	Yes	0.344 [3.567:0.01]	Yes
Sequential mediation effect								
H10—SSC→GSCM→ SSCP→ FP	0.216 [2.060:0.026]	Yes	0.416 [3.208:0.01]	Yes	0.599 [7.434:0.000]	Yes	0.424 [3.967:0.01]	Yes
Control factors								
Gender → FP	0.021 [1.026:0.323]		0.021 [1.026:0.323]		0.021 [1.026:0.323]		0.021 [1.026:0.323]	
Firms' age → FP	0.121 [2.313:0.041]		0.121 [2.313:0.041]		0.121 [2.313:0.041]		0.121 [2.313:0.041]	
Managers' Experience→ FP	0.005 [0.828:0.534]		0.005 [0.828:0.534]		0.005 [0.828:0.534]		0.005 [0.828:0.534]	
Sector → FP	0.315 [4.334:0.000]		0.315 [4.334:0.000]		0.315 [4.334:0.000]		0.315 [4.334:0.000]	
Number of firms	121		113		100		224	

Note 1: n=334, SSC- Smart Supply Chain, GSCM= Green Supply Chain Management, CP= Competitive Pressures, SSCP= Sustainable Supply Chain performance, FP= Financial Performance
Note 2. We also regressed the model on balance panels (100 each from each panel), and the results hold for that regression with negligible variation.
Note 3. We also created a dummy for robustness for small, medium, and large firms. The results demonstrate identical findings, but it was hard to compare them; therefore, we followed the separate panel approach.
Note 4. Control factors are included in all regression. For brevity, the results of sequential mediation effects are shown.

5. Artificial Neutral Network (ANN)

Multiple linear regression (MLR) is a popular decision-making tool because of its simplicity and interpretability. MLR lets researchers find and quantify independent variable effects on dependent variables by modeling linear connections. However, linearity dependence can be a drawback, especially in complicated datasets with non-linear connections. Non-linear

interactions produce more accurate and robust prediction models than MLR. This is especially important when non-linear influences impact variables' dynamics (Shaker Reddy & Sureshbabu, 2020). Due to its black-box nature, ANN cannot test hypotheses (Leong et al., 2020). Thus, the authors used SEM followed by ANN, like earlier studies (Asadi et al., 2021; Leong et al., 2020; Sharma, Antony, Sharma, & Daim, 2024). The Root Mean Square Error (RMSE) of training and testing data sets shows model accuracy. Both data sets' standard deviations and averages are also included. Table 6 provides RMSE and normalized priority values for predictor variables. The range of RMSE training and testing for all samples and their mean values are provided. The relative importance has been derived from the predictor variable importance, which is run ten times. The calculation for relative importance is carried out by finding the ratio between the individual and highest importance values (see Table 6). The ANN output shows SSCP is the strongest predictor for FP in Panels A, B, and D. In contrast, SSC is the strongest predictor of FP on Panel C. CP is the second predictor of FP as small-sized firms are under strong scrutiny of market pressure. In contrast, it is the least important factor for large-sized firms. GSCM is the least important factor of FP determination in large-sized firms. We find no difference in factor rating between the medium-sized firm and the overall sample. SSCP is the second most important factor for large firms in the emerging context of GCC. See Table 6 for the ranking of variables.

Table 6
RMSE Values

	Panel A: Small firms' sample		**Panel B: Medium firms' sample**		**Panel C: Large firms' sample**		**Panel D: Overall firms' sample**	
ANN	**Training**	**Testing**	**Training**	**Testing**	**Training**	**Testing**	**Training**	**Testing**
Iteration-1	0.134	0.068	0.139	0.070	0.128	0.067	0.125	0.065
Iteration-2	0.122	0.064	0.127	0.066	0.147	0.075	0.144	0.073
Iteration-3	0.141	0.071	0.146	0.074	0.166	0.054	0.162	0.053
Iteration-4	0.159	0.052	0.164	0.054	0.150	0.073	0.147	0.071
Iteration-5	0.144	0.070	0.149	0.072	0.149	0.075	0.146	0.073
Iteration-6	0.143	0.071	0.148	0.074	0.136	0.070	0.133	0.068
Iteration-7	0.130	0.067	0.135	0.069	0.145	0.068	0.142	0.066
Iteration-8	0.139	0.065	0.144	0.067	0.138	0.071	0.135	0.069
Iteration-9	0.132	0.068	0.137	0.044	0.156	0.051	0.152	0.050
Iteration-10	0.149	0.049	0.154	0.051	0.141	0.069	0.138	0.067
Average	**0.135**	**0.066**	**0.140**	**0.068**	**0.140**	**0.071**	**0.137**	**0.069**
S/D	**0.021**	**0.038**	**0.020**	**0.033**	**0.029**	**0.047**	**0.025**	**0.038**
Firms	**121**		**113**		**100**		**334**	
Independent variables ranking								
Variables	**Normalized**	**Rank**	**Normalized**	**Rank**	**Normalized**	**Rank**	**Normalized**	**Rank**
SCC	0.502	3	0.634	2	0.989	1	0.512	2
GSCM	0.378	4	0.314	4	0.444	3	0.365	4
CP	0.615	**2**	0.599	**3**	0.308	**4**	0.466	**3**
SSCP	0.982	1	0.996	1	0.628	2	0.980	1
Number	121		113		100		334	

Note 1: SSC- Smart Supply Chain, GSCM= Green Supply Chain Management, CP= Competitive Pressures, SSCP= Sustainable Supply Chain performance, FP= Financial Performance

6. Conclusion

This study sheds light on the complex linkages between smart supply chain (SSC), green supply chain management (GSCM), sustainable supply chain, and financial performance in GCC MNEs of various sizes. Analyzing 334 completed IT, operations, and financial managers questionnaires, we found a statistically significant association between SSC and financial performance across all firm sizes. This stronger association in larger organizations demonstrates that scale is crucial to the success of the SSC initiative. The strong findings at the 1% significance level for large MNEs compared to the 5% significance for small and medium enterprises support the idea that larger firms with more resources and capabilities can execute more successful SSC strategies. Further, the analysis shows that SSC affects GSCM practices across all company sizes, with larger MNEs aligned the most. This shows that larger firms may incorporate SSC practices with their sustainability programs to improve environmental and operational efficiency. Medium and small enterprises have acceptable ties, which may hinder resource allocation, technological uptake, and sustainability strategy. These findings show that targeted support methods may improve SSC and GSCM capacities in smaller enterprises.

However, GSCM also enhances SSCP across all panels, and the relationship continues to be robust. A significance level of 1% indicates that adopting GSCM practices ensures SSCP irrespective of firm size. The finding was contrary to our prediction that the impact of GSCM on SSCP may vary across sizes. However, the impact of GSCM does not affect financial performance across all Panels, thus rejecting our hypothesis. Applying GSCM cannot yield financial benefits for MNEs in the GCC region. The rejection of the hypothesis led us to test the mediation effect.

Our mediation analysis found interesting findings that provide insight into existing literature. While SSC mediates the relationship between SSC and sustainable supply chain performance across all firm sizes, the GSCM practices mediate SSC-financial performance relationships only in large firms. This suggests that the benefits of integrating SSC with GSCM

initiatives translate into tangible financial outcomes primarily for larger MNEs, which may possess the resources necessary to leverage these practices effectively. The sequential mediation analysis further corroborates these insights, indicating that the interplay between SSC, GSCM, and financial performance is multifaceted and contingent on firm size.

The study concludes that business size is crucial to SSC, GSCM, SSCP, and FP efficiency. These findings suggest that larger enterprises should invest in sustainable supply chain capabilities to maximize financial performance. Medium and small MNEs should explore collaborative relationships, invest in technology, and embrace sustainable best practices to overcome resource restrictions. To better understand how these processes interact in the sustainable supply chain ecosystem, future studies might examine industry context and geographical disparities. This research illuminates how MNEs can use their resources to drive sustainability and financial success in a competitive and environmentally concerned market.

7. Theoretical Contribution

Our research integrates the Resource-Based View (RBV) and Technology, Organization, and Environment (TOE) frameworks to examine how smart supply chain (SSC) practices affect financial performance (FP) in GCC small, medium, and large MNEs. Using this dual-theoretical perspective, The RBV states that a firm's unique resources and competencies give it a competitive edge. Our findings show that larger enterprises with more resources and infrastructures can better handle SSC-FP partnerships. This shows that SSC practices' advantages depend on a firm's resource endowment, validating the RBV's claim of resource heterogeneity across enterprises of different sizes. According to the TOE framework, technological, organizational, and environmental factors affect SSC realization and effectiveness. Further, small enterprises respond more to competitive pressures as the response ensures their survival in emerging markets. Our findings show that larger organizations better integrate SSC into financial performance. This supports the TOE perspective, implying that larger organizations are more technologically savvy and agile enough to adapt to competitive demands. Our study also uses GSCM and SSCP as mediating factors to show how these practices improve financial performance. The considerable linkages between SSC, GSCM, and SSCP support using RBV and TOE models to analyze evolving supply chain dynamics. This dual approach captures the intricacies of the GCC, where different firm sizes face different sustainability issues and possibilities. Our research enriches the theoretical landscape by showing how resources and environmental issues affect smart supply chain operations. Scholars and practitioners optimizing supply chain methods in varied corporate contexts need this detailed understanding.

8. Research Implications

Our research has several implications. These are as follows.

8.1 Research Implication for Firms

The results show that MNEs need size-specific tactics. SSC integration with financial performance and GSCM is easier for larger organizations. SMEs may need specific support, such as funding, training, and technology, to integrate SSC with their supply chain. In addition, firms need to integrate SSC, GSCM, SSCP, and FP relationships. The mediation and sequential mediation effect reveal that small and medium-sized firms should emphasize an integration approach to maximize the financial benefit. The interdependence of this relationship calls for specific measures that should align this mechanism to firm objectives. Hence, these firms should manage resources (financial and human resources) to optimize the use of technology for sustainable performance. Specifically, small and medium-sized MNEs should invest in training programs tailored to their specific firm size and context, which should equip employees with the skills necessary to implement SSC and GSCM effectively.

8.2 Research Implication for Policymakers

Policymakers should design initiatives that support small and medium-sized enterprises in adopting SSC practices, providing resources and incentives that facilitate the integration of sustainable practices. Developing regulatory frameworks encouraging all firms, especially smaller ones, to adopt GSCM practices can promote sustainability in supply chains and enhance overall industry performance. Further, SMEs need specific financial plans to boost their resource heterogeneity in aligning SSC, GSCM, and SSP to maximize financial gains.

8.3 Research Implication for Stakeholders

Stakeholders should engage with firms to promote awareness and understanding of the financial benefits of adopting SSC and SSCP, particularly for small and medium enterprises. Encouraging collaboration among firms of varying sizes can lead to knowledge sharing and best practice dissemination regarding SSC and sustainable practices, ultimately driving industry-wide

improvements. Stakeholders, including investors and government bodies, should prioritize funding for research and development focused on innovative SSC solutions that can be adapted across different firm sizes to improve financial performance. In conclusion, these implications highlight the need for tailored strategies and collaborative efforts among firms, policymakers, and stakeholders to optimize the benefits of smart and sustainable supply chain practices across diverse organizational contexts.

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