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## Greening of supply chain to drive performance through logical integration of supply chain resources

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## RESEARCH ARTICLE

# Greening of supply chain to drive performance through logical integration of supply chain resources

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## Abstract

Sustainability has always been a concern of humankind in one form or the other. Still, it has come into sharper focus after the promulgation of the sustainable development goals in 2015 and the disruptive forces unleashed by the COVID-19 pandemic. Supply chain management is an aspect of business operations wherein the need for sustainability has been felt more keenly. The academic and business understanding of various nuances of incorporating sustainability, particularly environmental concerns in the supply chain, is still evolving. Our study seeks to enrich the growing literature in the area by proposing to uncover a novel, logical sequence of intangible supply chain resources that can amplify the impact of green supply chain management practices (GSCMPs) on business performance. We use the dual-theoretical lens of a resource-based view and stakeholder theories to conceptualize the sequential mediational role of supply chain visibility, resilience, and robustness between GSCMP and performance. Analyzing data collected from 318 individuals working in the manufacturing sector in the United Kingdom, we found a positive direct association of GSCMP with performance and the serial mediational role of visibility and robustness between the two. The findings of our study are pertinent for theorists as well as managers.

## KEYWORDS

green supply chain management, resource-based view theory, SDGs, stakeholder theory

## 1 | INTRODUCTION

Countries worldwide frequently face serious sustainability risks and significant consequences due to inefficient corporate practices (Jan et al., 2019). Some commonly acknowledged threats posed by irresponsible corporate actions are global warming, climate change, natural resource depletion, generation of radioactive waste, food insecurity, and chemical accumulation, among others (Pawaskar

et al., 2018; Zahid et al., 2016). Scholars have particularly noted the seriousness of resource depletion, observing that over half of the available resources that should have been conserved for future generations have already been consumed (e.g., Dunphy, 2011). Such corrosive actions need to be controlled and assessed for their impact to protect environmental and societal resources from further depletion.

In a bid to make an organized, global-level effort to counter various environmental and societal challenges, in 2015, the United Nations announced the sustainable development goals (SDGs). The SDGs call for the revision and updating of strategies to make

List of abbreviation: SDGs, Sustainable Development Goals.

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economies sustainable and reduce risks to sustainability (Tseng et al., 2019). This call for global industrial transformation to a more sustainable functioning has pushed businesses to update their existing supply chain management (SCM) systems by adopting green supply chain management practices (GSCMP; Cousins et al., 2019; Green et al., 2019; Yildiz Çankaya & Sezen, 2019).

GSCMP refers to supply chain processes that address environmental issues by aiming to reduce CO<sub>2</sub> and other emissions, prevent waste generation, and protect biodiversity, among others, along the supply chain (Chin et al., 2015; Tseng et al., 2019). GSCMP has emerged as one of management's most significant decision-making challenges because it appreciably affects business performance (Cousins et al., 2019). Undoubtedly, transitioning to GSCMP brings many costs, as the existing scholarship acknowledges. For instance, Golicic and Smith (2013) contended that environmentally conscious SCM practices improve firms' operational, market-based, and accounting-based performance. Moving to specific geographic contexts, Green et al. (2012) noted that adopting GSCMP improved the environmental, economic, operational, and overall performance of the manufacturing firms in the United States. Interestingly, many studies have focused on Asian countries and Asia as a region to elucidate the positive outcome of GSCMP. For example, Zhu and Sarkis (2004) confirmed that GSCMP improved the economic and environmental performance of China's manufacturing sector. Zhu et al. (2005) also noted that GSCMP improved such firms' environmental and operational performance in China. Zhu et al. (2012) further elaborated that efficient coordination between the external and internal GSCMP improved the performance of the manufacturing sector in China. Mitra and Datta (2014) observed that sustainable SCM practices improved Indian manufacturing firms' economic and operational performance. Rao and Holt (2005) confirmed that GSCMP enhanced firms' financial performance and competitiveness in South East Asia. Geng et al. (2017) offered a broader view in this regard, revealing that GSCMP improved manufacturing firms' performance in emerging economies in South East Asia, evaluated on the basis of four dimensions: social, environmental, economic, and operational. Offering more evidence, Yang et al. (2013) showed that the external green collaboration and the adoption of internal green practices improved the firm performance of the shipping-logistic companies in Taiwan, and Yang et al. (2013) highlighted that GSCMP enhanced the environmental performance of OECD countries. All in all, scholars agree that the adoption of GSCMP improves firm performance in multiple ways (e.g., Digalwar et al., 2020; Gedam et al., 2020; Sharma et al., 2020).

Although transitioning to GSCMP is an indisputable way of enhancing business performance, the complexity of business models and supply chains, along with multiple intervening influences, can hinder or facilitate the positive impact of GSCMP on business performance. Understanding these paths or factors is all the more critical because firms are constantly pressured by stakeholders to enhance performance by adopting GSCMP. A comprehensive review of extant literature indicates that the available research findings offer quite linear insights on the association of GSCMP with business performance that do not factor in the issues and complexities of the changing

milieu. Building upon this contention, we speculate that unless the supply chains are strong enough to withstand disruptive forces, mere greening or transitioning into green practices may not produce the desired effect on business performance. In this regard, given that emerging technologies are making a disruptive impact on businesses, including supply chains (Brookbanks & Parry, 2022) and that the supply chains have become more vulnerable, as revealed by the pandemic (Meyer et al., 2021; Pournader et al., 2020), we posit that it would be more beneficial for firms to consider factors that enhance the efficiency of supply chains and increase their ability to endure disruptions. Taking this position forward, we draw upon the prior literature, which argues that managers need to focus more keenly on the conspicuousness, suppleness, and sturdiness of supply chains due to the rising complexities (Brandon-Jones et al., 2014), to speculate that key supply chain characteristics such as visibility (e.g., Rogerson & Parry, 2020), supply chain resilience (e.g., Reeves & Whitaker, 2020; Spieske & Birkel, 2021), and supply chain robustness (e.g., El Baz & Ruel, 2021; Simchi-Levi et al., 2018) may support the transmission of gains from GSCMP adoption to business performance.

Bringing the preceding narrative to a culmination, we suggest that considering how GSCMP can enhance business performance through key supply chain characteristics can be theoretically insightful and practically useful. Thus, we propose to examine the following: (a) the direct effect of GSCMP on business performance. The choice of GSCMP as independent variable and business performance as outcome variable is guided by the stakeholder theory (Freeman, 1984). As explained by the theory, stakeholders expect managers to improve firm performance and to gain a competitive advantage (Jones et al., 2018), and GSCMP offers a way to enhance performance (e.g., Digalwar et al., 2020), and (b) mediational role of visibility, resilience, and robustness between GSCMP and business performance. Our choice of these three characteristics is grounded in the theoretical premise of the resource-based view (RBV; Barney, 1991), since we conceptualize them as intangible resources that can be integrated logically to improve a firm or business performance.

Formally, we pursue the following two research questions (RQs): RQ1. How does GSCMP impact the business performance of manufacturing firms such that multiple stakeholders are pacified (stakeholder theory perspective)? RQ2. How do supply chain visibility, resilience, and robustness integrate logically (RBV perspective) to mediate the association of GSCMP and business performance?

To respond to the above-stated research questions, we collected data from 318 employees of manufacturing firms based in the United Kingdom (UK) and analyzed it using partial least squares structural equation modeling (PLS-SEM).

Our key contributions can be enumerated as follows. First, it offers a more practical view of the association of GSCMP with business performance by proposing a logically integrated mediational path flowing through supply chain visibility, resilience, and robustness between the two. To our knowledge, no prior study has considered supply chain visibility, resilience, and robustness as intangible resources that can be linked to better elucidate the GSCMP–business performance relationship. In sum, our proposed model offers a

rational convergence of different supply chain resources for improving firm performance. Second, our study extends the scope of the stakeholder and RBV theories by applying them in tandem in the previously unexplored context of integrating various supply chain resources to achieve better business performance.

## 2 | THEORETICAL FOUNDATION

### 2.1 | Stakeholder theory

According to this theory, proposed by R. E. Freeman (1984), an organization is not an *island*; rather, its operations go beyond its shareholders to other individuals or communities in a society who either control or are influenced by the organization's activities. The theory discusses three different approaches: descriptive, instrumental, and normative. The descriptive approach analyzes the nature and scope of firms' relationship with their multiple stakeholders; the instrumental process views stakeholders as means to improve performance; and the normative approach views them as an end, having a right to firms' revenue.

Largely, the theory purports that firms should operate for the betterment of their shareholders and the benefit of wider stakeholders. The theory also suggests that managers must always aim to pacify multiple stakeholders, including staff, clients, vendors, owners, environmental authorities, states, regulatory authorities, and the people at large who may be affected by firms' actions. In addition, the theory advocates that principles such as adhering to ethical guidelines and environmental compliance should be incorporated into firms' functioning to foster a stronger partnership with its multiple stakeholders (Freeman et al., 2004). Such a stakeholder-oriented approach can be expected to benefit firms in numerous ways. For instance, if managers work toward making their firms more visible, customers are more likely to view their sustainability engagement as genuine, which can help nurture healthy business partnerships.

Coming to the present context, we draw upon the instrumental approach of the stakeholder theory, which looks at stakeholders as a means to improve firm performance (De Colle, 2005; Jones, 1995), to suggest that addressing multiple stakeholders via sustainable business practices across the line of the supply chain (GSCMP in the present context) can be expected to improve business performance and subsequently give firms enhanced competitive advantage.

### 2.2 | RBV theory

It is a management paradigm that views the performance of an organization as a function of the resources it possesses (Barney, 1991; Ray et al., 2004). The RBV theory has been used in recent studies in various functional areas such as human resource management, strategy, entrepreneurship, operations management, and marketing (e.g., Potluri & Phani, 2020; Stefanelli et al., 2021; Yuen et al., 2019). The theory contemplates how a firm should use its strategic resources to gain an edge over its competitors (Barney, 1991). To explain further, the theory asserts that firms need to acquire various resources to enhance their competitiveness, which can be tangible and intangible (Formentini & Taticchi, 2016; Khan et al., 2018; Li et al., 2020). It is important to note here that although resources are necessary for business success (Gunasekaran et al., 2017), each resource cannot create value for the business in a standalone manner. This implies that to create value for organizations, resources need to be brought together and combined. Commenting upon a potential combination of resources, scholars contend that only when the business resources are prudently integrated can the business acquire strategic advantage (e.g., Sirmon et al., 2008).

Drawing upon this view, our study presents supply chain visibility, resilience, and robustness as intangible organizational resources and proposes to integrate them in the correct, rational order that would enhance the impact of GSCMP adoption on business performance.

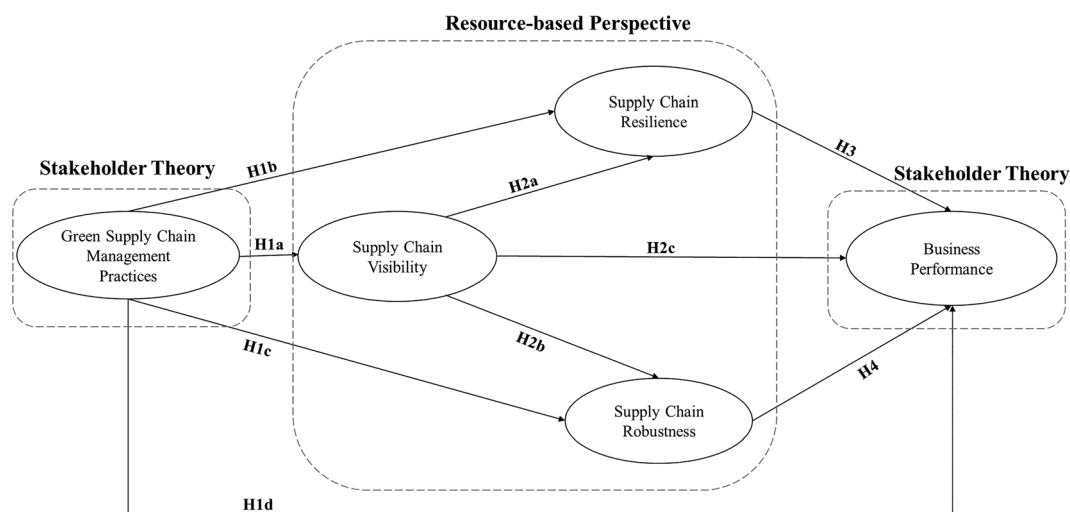


FIGURE 1 Conceptual model

## 2.3 | Proposed conceptual model

Bringing the above-discussed theoretical frameworks together, we propose the conceptual model of our study with GSCMP as the

**TABLE 1** Variable description

Variable	Description	Source
Green supply chain management practices (GSCMPs)	This refers to processes that integrate concern for the environment in the supply chain such that emissions are controlled, waste generation is reduced, and ecosystems are protected. GSCMPs include green purchasing, seeking active cooperation with suppliers and customers, practicing eco-design, strategically using reverse logistics, and consciously greening internal operations.	Chin et al. (2015); Tseng et al. (2019)
Supply chain visibility (SCV)	This refers to the ability to track inventory and its movement along the supply chain, the demand, and the changing customer needs.	H. L. Lee and Rammohan (2017);
Supply chain resilience (SCR)	This represents the ability to cope with changes brought by unanticipated internal and external disruptions by maintaining a high level of situational awareness at all times. It also captures the chain's ability to institute speedy responses to disruptions and ensure a fast rebound and recovery to resume normal operations.	Ribeiro and Barbosa-Povoa (2018)
Supply chain robustness (SCRo)	This captures the degree to which the chain can withstand the stress imposed by unanticipated disruptive events, thereby retaining a stable situation and continuing operations to meet targets and customer demands.	Durach et al. (2015); Vieira and Lemos (2009)
Business performance (BP)	This is a measure of any organization's ability to utilize its assets effectively, be in a strong competitive position compared to its peers, deliver on all profitability parameters, and ensure positive overall organizational performance.	

independent variable; supply chain visibility, resilience, and robustness as mediation variables; and business performance as the dependent variable. The model is illustrated in Figure 1, and the variables are operationally described in Table 1.

## 3 | HYPOTHESES DEVELOPMENT

### 3.1 | GSCMP

GSCMP is the independent variable in our study. Based on our study's conceptualization, it can also be seen as the first supply chain variable in the potential logical sequencing or integration of resources to explicate how business performance can be enhanced. To put it simply, GSCMP is not a radical idea; rather, it is a more contemporary version of the traditional concept of SCM (Chin et al., 2015) achieved by incorporating environmental concerns into operations. It is implemented through practices and processes sensitive to adverse environmental outcomes, such as emissions, waste generation, and biodiversity depletion, along the firm's supply chain (Chin et al., 2015; Tseng et al., 2019). Sustainable forms of product design, content selection and production, production process, product distribution, and post-delivery management are all part of GSCMP (Yildiz Çankaya & Sezen, 2019).

Firms are compelled to improve their internal environmental management to stay ahead of their peers (Zhu et al., 2017). Since designing and adopting an effective internal environmental policy can improve supply chain activities (Zhu et al., 2013), firms' efforts in this direction strengthen GSCMP from production to consumption (Rodrigue et al., 2017). In addition to internal environmental management, firms' endeavors to ensure green purchasing also strengthen GSCMP. Green purchasing refers to an environmentally sustainable purchasing approach that promotes the recycling of bought goods to reduce resource waste (González-Benito et al., 2016; Yen & Yen, 2012). Customer pressure and regulatory standards promote green purchasing (Yen & Yen, 2012). At the same time, scholars have noted that proactive firms seek to cooperate with suppliers and involve them in GSCMP to pacify customers' green demands (Walton et al., 1998). Scholars suggest that suppliers' involvement in GSCMP is directly linked to customers' environmental needs. Customers also put pressure on suppliers to follow GSCMP indirectly (Van der Valk & van Lwaarden, 2011), contributing to the effectiveness of GSCMP.

Taking the discussion forward, GSCMP also entails investment recovery, which entails systematically using approaches such as reverse logistics, redeployment, and reselling to extract more money from products and services (Kumar & Chandrakar, 2012). To elaborate, investment recovery is a method of sustaining and selling surplus assets and relocating unused assets to other locations to reduce additional resource acquisition (Atkinson, 2002).

Given that GSCMP entails managing internal operations in a green way, engaging with customers and suppliers for cooperation, and judiciously managing and recycling resources, we find it plausible to contend that the adoption of GSCMP would positively impact

supply chain visibility, resilience, robustness, and overall business performance. To explain further, GSCMP, which involves seeking the cooperation of customers and suppliers, will cause firms to track inventory and customer demands more diligently, thereby enhancing supply chain visibility. Further, focus on managing the internal environment, sustainable use and redeployment of assets as required, and general prudence in purchase and resource use is likely to make firms more resilient and robust in the face of disruption and enable them to maintain and improve their business performance. Hence, we over-archingly propose the following:

**H1a.** GSCMP has a positive association with supply chain visibility.

**H1b.** GSCMP has a positive association with supply chain resilience.

**H1c.** GSCMP has a positive association with supply chain robustness.

**H1d.** GSCMP has a positive association with business performance.

### 3.2 | Supply chain visibility

Supply chain visibility represents the ability to trace inventory in transit from the origin to the final destination (H. L. Lee & Rammohan, 2017). Such visibility can transform and expand the supply chain by making data accessible to all stakeholders. Apart from voluntarily making the data available, firms may also provide transparency of data on green practices due to the demands of stakeholders concerned with the environment. Not only do the stakeholders demand data transparency, but they also criticize business firms for their suppliers' inappropriate actions (including those related to the environment) (H. L. Lee & Rammohan, 2017). However, monitoring suppliers becomes difficult for firms due to the complexities created by outsourcing tasks/orders from first-tier suppliers to second-tier suppliers (Swift et al., 2019). In some cases, the firms are not even aware of their multilayered group of suppliers, which leads them to lose visibility of their suppliers (Swift et al., 2019), raising serious issues. Taking into consideration stakeholders' demands and complex supplier structures, visibility of the supply chain can become a critical resource. What is more important is that it also impacts firms' supply chain resilience, as discussed in past studies (e.g., Doorey, 2011; Mubarik et al., 2021; Walker & Merkley, 2017). To elaborate, supply chain visibility presents the relevant information to assess the demand and inventory levels, thereby enhancing the supply chain's preparedness and responsiveness, making it ready to cope with and respond to disruptions. Based on this evidence, we anticipate a similar association between visibility and resilience in the case of manufacturing firms. Hence, we propose the following:

**H2a.** Supply chain visibility has a positive association with supply chain resilience.

Scholarly literature has also acknowledged supply chain visibility for the purpose of reducing risks associated with SCM (e.g., Christopher & Lee, 2004). To explain further, visibility achieved through sharing relevant information enhances the firms' risk avoidance capability (Lavastre et al., 2012), thereby making them robust and giving them the ability to maintain stability in supply chain management. Scholars have confirmed the positive impact of information sharing and relationships supported by visibility on supply chain robustness (e.g., Wieland & Wallenburg, 2013). Based on the empirical evidence and conceptual argument suggesting a relationship between visibility and robustness (e.g., Durach et al., 2015), we speculate that such association can also be expected to exist in the case of the manufacturing sector. Hence, we propose the following:

**H2b.** Supply chain visibility has a positive association with supply chain robustness.

Coming to business performance, since supply chain visibility helps manage upstream and downstream supply chain relationships to improve the market value of the product at a lower cost (Singagerda et al., 2022), it can be said to contribute to business performance. Indeed, a positive association between visibility and performance is not only rationally viable but also empirically and conceptually supported by recent findings (e.g., Prahiawan et al., 2022; Hofman et al., 2020). Based on the preceding discussion and the practical importance of such an association, we propose to test the relationship between visibility and performance of manufacturing firms as a part of our larger aim to find logical and sequential integration of visibility, resilience, and robustness between GSCMP and business performance. Hence, we propose the following:

**H2c.** Supply chain visibility has a positive association with business performance.

### 3.3 | Supply chain resilience and robustness

Resilience is the capacity of a supply chain to be prepared to handle unforeseeable risk events and react and rebound quickly in the face of possible disturbances, either by reverting to its original state by expanding and shifting to a different, more attractive state in terms of outcomes for the firm and its customers (Ribeiro & Barbosa-Povoa, 2018). Scholars also observe that resilience enables firms to respond positively and maintain their balance when faced with external changes (Hohenstein et al., 2015; Mandal, 2020).

Robustness is a gauge of the degree to which a supply chain can function satisfactorily in the face of unanticipated disruptions in one or more logistics processes. More specifically, scholars consider robustness as a gauge of the extent to which the supply chain can

resist adverse events, absorb changes, and evolve incessantly while maintaining its functionality (Gunessee et al., 2018; Stone & Rahimifard, 2018). In other words, the fundamental principle of supply chain robustness is to make the production process resistant to noise (Vieira & Lemos, 2009). Scholars suggest that a prudent supply chain robustness framework works at operational, tactical, and strategic levels (Vieira & Lemos, 2009) and can substantially impact firms' ability to respond to their environment. In sum, robustness can be best seen as firms' proactive ability to manage unanticipated disruptions to maintain normal operations (Sturm et al., 2021).

Scholars note that enhancing resilience can be expected to increase business performance (e.g., Kwak et al., 2018). Such performance can be measured through effectiveness and efficiency in accomplishing any task or work (Gligor et al., 2015). However, they also caution that it is not correct to evaluate business performance through competitive advantage indicators; rather, it should be assessed in terms of financial and commercial parameters (Gonzalez-Benito, 2007).

Continuing the discussion, on the one hand, past studies have noted that supply chain disruptions lower performance from both operations and finance perspectives (Hendricks & Singhal, 2020; Stone & Rahimifard, 2018), and on the other, previous findings have documented a positive association of resilience with different measures of performance such as financial performance measured through an increase in return on assets and service performance (Liu et al., 2018). In essence, whether an adverse effect of disruption is gauged or a positive impact of resilience is considered, there is clear evidence that resilience impacts the performance of firms.

Moving to robustness, although the association of robustness and performance has not been examined as much as that between resilience and performance, the association is not difficult to anticipate by extrapolating the findings related to supply chain disruptions (unanticipated events included) (e.g., Bode et al., 2011). Since scholars have confirmed that disruptions cause deterioration in performance (Hendricks & Singhal, 2020; Stone & Rahimifard, 2018), we can say that the ability to withstand such disruptions, that is, robustness, will positively impact performance.

As a preliminary step in the direction of bundling or integrating the intangible resources of visibility, resilience, and robustness in a logical sequence to create a strategic capability that transmits the positive effect of GSCMP implementation on the business performance of firms, we seek first to confirm the direct association of resilience and robustness respectively with business performance. We are motivated to contemplate such associations considering similar findings in different contexts in the extant literature. Hence, we propose the following:

**H3.** Supply chain resilience has a positive association with business performance.

**H4.** Supply chain robustness has a positive association with business performance.

### 3.4 | Mediation effect

Since the focal objective of our study is to offer logical integration of intangible resources represented by supply chain visibility, resilience, and robustness, we propose to examine the following serial mediational effects: (a) visibility and resilience between GSCMP and business performance and (b) visibility and robustness between GSCMP and business performance. As discussed in the preceding part, while some evidence supports a direct association between visibility and resilience and resilience and performance, the other direct paths proposed by our study are less investigated. More importantly, to our knowledge, no study has tested the serial mediation effect along the proposed paths to seek a logical integration of the identified variables so far. The absence of a priori evidence notwithstanding, we contend that in the light of the hypothesized direct paths, it is plausible to anticipate the mediational effect of three intangible resources.

Confirming the logical and sequential integration of visibility, resilience, and robustness is also consistent with the proposition of the RBV (Barney, 1991). To elaborate, the RBV contends that merely possessing resources is not enough to have strong competitive standing; rather, firms need to bundle/integrate resources rationally such that they become strategic assets or capabilities (Hoopes et al., 2003). Past studies suggest that this view is also relevant in the case of supply chain-based resources, which can be leveraged to yield a competitive edge (e.g., Priem & Swink, 2012). Thus, in concordance with the view presented by Sirmon et al. (2008), we suggest that the three identified supply chain-related intangible resources can be bundled and integrated logically to help firms exploit the opportunities that arise from the implementation of GSCMP as well as counter the threats that come with it, such that performance is not adversely impacted. Hence, we propose the following:

**H5.** Supply chain visibility and supply chain resilience serially mediate the association between GSCMP and business performance.

**H6.** Supply chain visibility and supply chain robustness serially mediate the association between GSCMP and business performance.

## 4 | METHODOLOGY

### 4.1 | Data

We collected data for testing the proposed hypotheses through a cross-sectional survey. All variables except GSCMP were measured as reflective constructs using pre-validate scales. GSCMP was measured through five constructs: (a) internal environmental management, (b) green purchasing, (c) cooperation with customers and suppliers, (d) eco-design, and (e) investment recovery. This is consistent with recent studies that have measured GSCM through these constructs (e.g., Khan et al., 2022).

TABLE 2 Factor loadings

Item code	Factor loading
ITEM1: The senior managers of our organization are committed to green supply chain management practices	0.87
ITEM2: The mid-level managers of our organization support the green supply chain management practices	0.82
ITEM4: My organization has a total-quality environmental management	0.85
ITEM5: My organization has environmental compliance and auditing programs	0.86
ITEM6: My organization has ISO 14001 certification	0.69
ITEM7: My organization has environmental management systems	0.86
GP1: My organization offers eco-labeling of products	0.73
GP2: My organization has cooperation with suppliers for environmental objectives	0.87
GP3: My organization has an environmental audit for suppliers' internal management	0.86
GP5: My organization has a second-tier supplier of environmentally friendly practice evaluation	0.84
CC1: My organization has cooperation with customers for eco-design	0.95
CC2: My organization has cooperation with customers for cleaner production	0.94
CC3: My organization has cooperation with customers for green packaging	0.81
ECO1: My organization offers the design of products for reduced consumption of materials/energy	0.88
ECO2: My organization offers the design of products for reuse, recycling, and recovery of material and component parts	0.89
ECO3: My organization offers design of products to avoid or reduce the use of hazardous products and their manufacturing process	0.90
IVR1: My organization invests in green practices due to which they engage in the investment recovery (sale) of excess inventories/ materials	0.90
IVR2: My organization invests in green practices due to which they engage in the selling of scrap and used materials	0.86
IVR3: My organization invests in green practices due to which they engage in the sale of excess capital equipment	0.87
SCV1: In my organization, inventory levels are visible throughout the supply chain	0.83
SCV2: In my organization, demand levels are visible throughout the supply chain	0.80
SCV3: My organization informs our partners in advance about changing customer needs	0.82
SCV4: My organization informs our partners about customers' future needs	0.81
SCV5: My organization communicates future strategic needs	0.79
SCV6: My organization collaborates to monitor the movement of inventory with our partners	0.86
SCV7: My organization tracks information related to inventory in the supply chain	0.83
SCV8: My organization shares real-time information about inventory with supply chain members	0.80
RES1: My organization's supply chain can cope with changes brought by supply chain disruption	0.87
RES2: My organization's supply chain can adapt to supply chain disruption	0.90
RES3: My organization's supply chain can provide a quick response to supply chain disruption	0.87
RES4: My organization's supply chain can maintain high situational awareness at all times	0.86
RES5: My organization's supply chain has the knowledge to recover from disruptions	0.81
RES6: My organization can recover to normal operations speedily after the supply chain disruption	0.84
SCR1: My organization's supply chain can retain the same stable situation	0.82
SCR2: My organization's supply chain can continue operations even in unfavorable situations	0.85
SCR3: My organization's supply chain can perform well over a wide variety of possible scenarios without necessary adaptations, even in unfavorable situations	0.86
SCR4: My organization's supply chain, for a long time, can carry out its functions despite some damage done to it	0.82
SCR5: My organization's supply chain is still able to meet customer demand despite unfavorable conditions	0.84
SCR6: My organization's supply chain performance would not deviate significantly from targets despite unfavorable conditions	0.83
SCR7: My organization's supply chain would still be able to carry out its regular functions and achieve targets despite unfavorable conditions	0.84
BP1: Green supply chain management practices help my organization in better asset utilization	0.92
BP2: Green supply chain management practices help my organization acquire stronger competitive positions	0.93
BP3: Green supply chain management practices help my organization improve profitability	0.90
BP4: Green supply chain management practices help my organization improve overall organizational performance	0.93



Although the questionnaire comprised items drawn from the pre-validate scale, we followed due process to ascertain its face and content validity. Following recent publications (e.g., M. Talwar et al., 2021), we sought feedback from experts and target group representatives to prepare the final instruments for data collection. The final questionnaire collected responses on a 5-point Likert scale.

Data were collected online through a crowdsourcing platform—Prolific Academic—from individuals working in firms in the manufacturing sector in the UK. Prolific Academic is a popular platform for collecting data (e.g., Talwar et al., 2021). We stopped data collection upon receiving 318 complete responses from individuals in different positions in the UK manufacturing sector since a sample size of 318 is adequate for analyzing data to test the proposed hypotheses (Al-Aomar & Hussain, 2017).

We choose the UK as the geography of interest due to two key reasons: (a) Since most of the existing studies in the area are focused on the United States or Asian countries (e.g., Geng et al., 2017; Mitra & Datta, 2014), examining firms in the UK would expand the existing literature, and (b) the need for implementing GSCMP has intensified in the UK to counter the environmental cost of e-commerce, which surged by 36.6% in the year 2020 as compared with the year 2019. In the light of the growing challenges, it would be useful to understand how implementing GSCMP would impact the business performance of firms in the country.

## 4.2 | Method of data analysis

We used variance-based PLS-SEM in SmartPLS version 3.3.7 for data analysis. PLS-SEM, used by many recent publications (e.g., Begum et al., 2022), comprises two steps: (a) measurement model analysis, wherein the model is evaluated to confirm construct reliability and validity, including discriminant validity, and (b) structural model analysis, wherein hypotheses are tested to confirm statistical support, variance, and path coefficients. We choose PLS-SEM for analysis after confirming data suitability, as recommended (e.g., Hair et al., 2019; Talwar et al., 2021).

## 5 | RESULTS

### 5.1 | Measurement model

We assessed the measurement model to confirm the validity and reliability of the measures. To begin with, we examined factor loadings of the items measuring study constructs. Following Hair et al. (2011), we checked and confirmed that loading for each item exceeded the robust cut-off of 0.7 (Table 2). Next, we assessed Cronbach's alpha and composite reliability (CR) values to confirm internal consistency reliability. Both values were as per the recommended cut-off value of

**TABLE 3** Construct reliability and validity

	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Business performance	0.94	0.96	0.85
Cooperation with customers	0.88	0.93	0.82
Eco-design	0.87	0.92	0.79
Green purchasing	0.85	0.90	0.69
Internal environmental management	0.91	0.93	0.69
Investment recovery	0.85	0.91	0.77
Supply chain visibility	0.93	0.95	0.68
Supply chain robustness	0.93	0.94	0.70
Supply chain resilience scale	0.94	0.95	0.77

**TABLE 4** Discriminant validity

	1	2	3	4	5	6	7	8	9
1 Business performance	<b>0.92</b>								
2 Cooperation with customers	0.58	<b>0.90</b>							
3 Eco-design	0.52	0.67	<b>0.89</b>						
4 Green purchasing	0.63	0.68	0.66	<b>0.83</b>					
5 Internal environmental management	0.73	0.63	0.59	0.80	<b>0.83</b>				
6 Investment recovery	0.56	0.62	0.60	0.63	0.63	<b>0.88</b>			
7 Supply chain visibility	0.59	0.54	0.57	0.64	0.61	0.54	<b>0.83</b>		
8 Supply chain robustness	0.54	0.40	0.40	0.50	0.50	0.42	0.60	<b>0.84</b>	
9 Supply chain resilience scale	0.52	0.43	0.41	0.53	0.50	0.44	0.66	0.79	<b>0.88</b>

0.70 (Hair et al., 2011), ensuring reliability (Table 3). We used the popular metric, average variance extracted (AVE), to evaluate convergent validity. As presented in Table 3, the value for all constructs exceeded 0.50, as recommended (Hair et al., 2006).

Finally, we applied Fornell and Larcker's (1981) criterion to confirm discriminant validity. The criterion considers the value of the square root of AVE for each vector in the diagonal and the inter-construct correlations. As shown in Table 4, the square root of AVE exceeds inter-construct correlations in all cases, confirming discriminant validity (Fornell & Larcker, 1981).

## 5.2 | Hypotheses testing

The results of bootstrapping based on 5000 subsamples are presented in Table 5. The results indicate which of the 11 direct and mediational hypotheses are supported statistically. We have used the *t*-values and *p*-values exhibited in Table 5 to interpret whether a given idea is supported or not.

As seen in Table 5, hypotheses proposing a direct association of GSCMP with visibility (H1a;  $\beta = 0.68$ ;  $p < 0.001$ ), resilience (H1b;  $\beta = 0.18$ ;  $p < 0.05$ ), robustness (H1c;  $\beta = 0.21$ ;  $p < 0.001$ ), and performance (H1d;  $\beta = 0.57$ ;  $p < 0.001$ ) are supported. The results also confirmed a positive and significant association of visibility with resilience (H2a;  $\beta = 0.53$ ;  $p < 0.001$ ) and robustness (H2b;  $\beta = 0.45$ ;  $p < 0.001$ ) but not with performance (H2c;  $\beta = 0.07$ ;  $p > 0.05$ ), thus supporting H2a and H2b only. Similarly, the results revealed a statistically insignificant association between resilience and performance (H3;  $\beta = 0.012$ ;  $p > 0.05$ ), indicating that H3 is not supported. A statistically significant association was confirmed between robustness and

performance (H4;  $\beta = 0.18$ ;  $p < 0.05$ ), indicating support for H4. All but two hypotheses (H2c and H3) proposing a direct association between the variable under the study are supported.

We proposed two hypotheses (H5 and H6) to examine the serial mediation effect of visibility, resilience, and robustness on the association of GSCMP and performance. While H5, proposing the mediational effect of visibility and resilience, was not supported (H5;  $\beta = 0.004$ ;  $p > 0.05$ ), H6, proposing the serial mediation effect of visibility and robustness, was supported (H6;  $\beta = 0.056$ ;  $p < 0.05$ ). This result confirmed that resilience and robustness sequentially mediated the association of GSCMP and business performance positively and significantly. Thus, as reported in Table 6, H5 is rejected, and H6 is accepted.

## 6 | DISCUSSION

The primary aim of this study was to uncover the logical integration of three intangible supply chain resources—visibility, resilience, and robustness—by examining their sequential mediational effect on the association of GSCMP and business performance. We examined nine direct associations and two serial mediational paths to fully uncover the optimal sequential and logical integration of the identified variables. Analysis revealed statistical support for all but two proposed direct associations and one of the two serial mediation effects. The outcomes are discussed below in detail.

To begin with, H1a, proposing a positive association between GSCMP and visibility, was supported. This outcome suggests that incorporating environmental concerns in various aspects of operations enhances its commitment to providing better visibility of its inventory

**TABLE 5** Hypotheses testing (direct paths)

	Paths	Beta	<i>t</i> -values	<i>p</i> -values	Supported
H1a	GSCMP → supply chain visibility	0.68	18.83	0.000	Yes
H1b	GSCMP → supply chain resilience	0.18	3.11	0.002	Yes
H1c	GSCMP → supply chain robustness	0.21	3.55	0.000	Yes
H1d	GSCMP → business performance	0.57	10.03	0.000	Yes
H2a	Supply chain visibility → supply chain resilience	0.53	8.74	0.000	Yes
H2b	Supply chain visibility → supply chain robustness	0.45	7.09	0.000	Yes
H2c	Supply chain visibility → business performance	0.07	1.03	0.305	No
H3	Supply chain resilience → business performance	0.01	0.16	0.871	No
H4	Supply chain robustness → business performance	0.18	2.14	0.033	Yes

**TABLE 6** Serial mediation analysis

		Beta	<i>t</i> -value	<i>p</i> -value	Decision
H5	GSCMP → supply chain visibility → supply chain resilience → business performance	0.004	0.164	0.869	Not supported
H6	GSCMP → supply chain visibility → supply chain robustness → business performance	0.056	2.083	0.038	Supported

and demand levels throughout the supply chain. At the same time, GSCMP also positively impacts visibility best practices such as informing partners about anticipated changes in customer needs and future strategic needs and sharing real-time information with them about inventory levels. To elaborate, incorporating green practices into the supply chain positively impacts firms' willingness to not only track inventory-related information but also collaborate with key stakeholders to monitor inventory movement along the supply chain. Although this association has no a priori evidence in the scholarly literature, its plausibility, as supported by the empirical data, cannot be denied since the ability to trace the movement of parts, materials, or goods along the chain (Lee & Rammohan, 2017) will undoubtedly improve with increasing commitment of firms to sustainability.

Next, H1b, proposing a positive association between GSCMP and resilience, is also statistically supported. The result indicates that following practices like green purchasing, resource optimization, and seeking the involvement of customers and suppliers better enables firms to cope with and adapt to the changes brought by the supply chain disruptions, maintaining high situational awareness. To explain further, adhering to GSCMP increases firms' knowledge that can help them respond quickly to disruptions and enables them to respond and resume normal operations speedily after such episodes. Again, despite the absence of any a priori evidence, we anticipated this association and found empirical support for our extrapolation of the scholarly literature. Building on the past findings that resilient firms can respond more positively to and maintain their balance when faced with external changes (Hohenstein et al., 2015; Mandal, 2020), we suggested and confirmed that such resilience could be improved through committed adherence to GSCMP.

H1c, proposing a positive association of GSCMP with robustness, was also supported by statistical analysis results. While past studies have not examined this association explicitly, we expected that robustness, being a gauge of the extent to which the supply chain can resist adverse events, absorb changes, and evolve incessantly while maintaining its functionality (Gunessee et al., 2018; Stone & Rahimifard, 2018), is highly likely to be impacted positively by green practices that make overall operations efficacious. The empirical data supported our position, implying that focus on investment recovery, green purchasing, eco-design, internal environmental management, and seeking the cooperation of key stakeholders enhances firms' supply chain's ability to retain the same stable situation and continue operations in unfavorable situations. It also indicates that adherence to GSCMP enables firms' supply chain to carry out its functions, meet customer demand, and not deviate significantly from targets despite bearing the damaging effect of various unfavorable conditions.

Another hypothesis, H1d, proposing a positive association of GSCMP with business performance, was also statistically supported by the results of the analysis. This outcome is aligned with prior findings (e.g., Chin et al., 2015; Geng et al., 2017; Yang et al., 2013). The finding confirms that by incorporating environmental concerns through managing internal operations in a green way, seeking the cooperation of customers and suppliers, and focusing on investment recovery and recycling of resources, firms can achieve better asset

utilization, consolidate competitive position, and improve profitability and overall performance.

The next set of hypotheses, H2a, H2b, and H2c, proposing a positive association of visibility with resilience, robustness, and business performance, respectively, were tested to reveal statistical support for the former two, thereby indicating that empirical data did not statistically support H2c. The results for H2a and H2b are along the expected lines and aligned with prior scholarly literature (e.g., Durach et al., 2015; Mubarik et al., 2021; Walker & Merkley, 2017). To explain in detail, the support for H2a confirms that maintaining transparency about inventory and demand level, informing partners about changing customer and strategic needs, collaborating with key stakeholders to track the inventory along the supply chain, and sharing real-time information with them better enable firms to withstand and adapt to disruptions, empower them to maintain a high level of situational awareness, and strengthen their knowledge base to quickly resume normal operations after disruptive episodes. At the same time, as indicated by support for H2b, maintaining such visibility and transparency in supply chain operations improves firms' ability to sustain a stable situation and continue to function without noticeable deviation from targets when faced with damaging, unfavorable scenarios.

In comparison, the lack of statistical support for H2c is not as expected based on scholarly literature that empirically and conceptually supports the association (e.g., Prahawan et al., 2022; Hofman et al., 2020). The finding that keeping inventory and demand level data transparent and shareable with critical internal and external stakeholders has no statistically significant positive impact on profitability, competitive standing, or overall performance of firms by encouraging better asset utilization is somewhat surprising. A potential reason behind this outcome could be that in the particular geography and sector under investigation—the UK and manufacturing—inventory and demand level monitoring is an implicit part of SCM and not perceived to play a substantial role in impacting performance explicitly. Second, the more rational possibility could be that the effect of visibility on business performance is transmitted through some mediating variable. This explanation concurs with our expectation that there exists a sequential mechanism comprising logical order and integration of supply chain resources for transmitting effects on business performance.

Coming to the results of the last two hypotheses proposing direct associations, H3 and H4, statistical analysis supported only H4. Lack of statistical support for H3, suggesting a positive association of resilience with performance, contradicts prior findings that had uncovered a positive association between resilience with different performance measures (Liu et al., 2018). Such an outcome is difficult to fathom; therefore, before conclusively accepting it, we recommend more studies with varied samples, giving due consideration to the moderation effect of context-specific variables.

In contrast to the above results, H4, hypothesizing a positive association between robustness and performance, is statistically supported. Although this association has not been examined in the past, its plausibility is well-grounded in the existing evidence (e.g., Bode et al., 2011; Hendricks & Singhal, 2020; Stone & Rahimifard, 2018).

To elaborate, the result implies that the supply chain's ability to maintain stability, meet customer demand, and continue operations to achieve targets, even when faced with a wide variety of possible unfavorable scenarios, will enhance its asset utilization, leading to improved competitive standing, profitability, and overall performance.

In addition, we proposed two hypotheses, H5 and H6, contemplating the serial mediational effect of supply chain resources between GSCMP and business performance. Of the two, H5, suggesting the serial mediation effect of visibility and resilience between GSCMP and business performance, is not found to be statistically significant. However, H6, proposing the serial mediation effect of visibility and robustness between GSCMP and business performance, is found to be substantial. These results clearly and unambiguously confirm that apart from the direct effect, correct sequence for the flow of indirect effect from GSCMP to business performance is through two intangible supply chain resources—visibility and robustness.

## 7 | CONCLUSION

This study aimed to clarify how GSCMP would impact business performance to satisfy stakeholder demands in consonance with stakeholder theory and the logical coming together of the intangible supply chain resources of visibility, resilience, and robustness between GSCMP and performance in consonance with the RBV theory. The study proposed and addressed two research questions by analyzing data collected from 318 firms in the manufacturing sector in the UK. In response to RQ1, inquiring about the impact of GSCMP on the business performance of manufacturing firms, we examined a set of direct associations that could better explain the association between these two key variables of interest. The results indicated that GSCMP not only positively impacts performance but also impacts visibility, resilience, and robustness, of which robustness also directly and positively impacts performance. We provided a more nuanced and broader view in this context by examining and confirming that visibility positively impacted resilience and robustness but not performance. Further, we also found that resilience did not directly affect performance. In response to RQ2, seeking logical and sequential integration of intangible supply chain resources—visibility, resilience, and robustness—we examined two serial mediation hypotheses to confirm that the correct integration of these resources was that of visibility and robustness sequentially between GSCMP and business performance. The study offers several useful theoretical and practical implications as discussed below.

### 7.1 | Theoretical implications

The study has three key theoretical implications. First, it advances the research in the area by bringing together two key concerns: sustainability and performance. With the promulgation of SDGs in 2015 (United Nations, 2015), the focus of firms to incorporate environmental concerns in various aspects of their functioning has increased. The

fact is that the SDGs go beyond simple environmental concerns to make it incumbent upon firms to formulate strategies that can create sustainable economies (Tseng et al., 2019). Due to this, performance and profitability, which have always been a concern, have come into sharper focus. By examining GSCMP and business performance, our study underscores the key aspects that need attention for advancing the SDG agenda comprehensively through supply chain transition to a greener orientation. Due to this, our study's conceptualization and findings become more contextually relevant and can be expected to motivate future research in the area.

Second, the study uses the dual theoretical lens of stakeholder theory (Freeman, 1984) and RBV theory (Barney, 1991) to ground the conceptualization and contextualize the findings. By doing so, the study strengthens the theoretical foundations in an area where research is growing fast and in multiple directions, which could create confusion in the absence of sound theoretical grounding. From the perspective of the two theories, the study contributes by lending support for their suitability in operations and supply chain management. While RBV is already well-grounded in the related literature (e.g., Khan et al., 2022), our study serves to broaden its application to explicate the antecedents that can positively impact business performance. To explain further, we put forth various supply chain resources categorizing them as intangible resources in RBV terminology to explain how business performance can be positively driven. Such a theoretical extension of RBV can be expected to (a) serve as a foundation for future research linking other supply chain resources to the elements of the RBV and (b) serve as a foundation for managerial decisions related to key supply chain resources that can efficaciously improve business performance. Our study also provides evidence supporting the propositions of stakeholder theory. By emphasizing the role of internal and external supply chain stakeholders in the initiation and advancement of green practices that can transform business performance in manufacturing firms, our study extends the scope of stakeholder theory to conceptualize and examine contemporary concerns.

Finally, our study's conceptualization advances the evolving paradigm that the supply chain flows are too complex to be viewed as linear direct flow chains. Rather, the emphasis is now more on closed-loop supply chain (CLSC), as discussed by recent studies (e.g., Ribeiro & Barbosa-Povoa, 2018). The focus on CLSC creates scope for inclusion and consideration of innovative mediation and moderation variables along the supply chain line. In compliance with CLSC and acknowledgment of the rising difficulty of global supply chain management, our study examined the novel mediating role of supply chain visibility, supply chain resilience, and supply chain robustness between GSCMP and business performance to confirm supply chain visibility and robustness as the two key sequential mediators between GSCMP and business performance.

### 7.2 | Practical implications

The study makes three key contributions to strengthening managerial insights available for ground-level decision-making. First, the study

underscores the critical role that supply chain visibility and robustness can play in enhancing the effect of transitioning from traditional to GSCMP on business performance. To elaborate, the study uncovers the logical integration of these two intangible supply chain resources to aid managerial decisions related to the diversion of resources to more critical parts of the supply chain such that organizational performance, asset utilization, and competitive positioning remain sound and unchallenged. Based on the results of our study, we recommend that managers focus on enhancing supply chain visibility and robustness such that the effect of introducing GSCMP amplifies. Such logical integration can also help firms better navigate the challenges posed by global chains that are getting more complex by the day (Filser et al., 2021).

Second, by bringing forth the key antecedents aligned with the sustainability agenda that can positively drive business performance, our study better equips managers to satisfy a more extensive set of external stakeholders. For instance, by understanding how the GSCMP, visibility, and robustness sequence works to drive performance, firms can develop more incisive strategies to attract investors who monitor business performance and environmental concern as key metrics.

Finally, we underscore the benefits of GSCMP going beyond the macro-level societal and ecological gains arising from reduced CO<sub>2</sub> and other emissions and lower waste generation (Chin et al., 2015; Tseng et al., 2019) to micro-level gain for the firms in terms of improved business performance. By emphasizing their benefit, our findings incentivize firms to go through the effort and expense of transitioning to GSCMP for their gain rather than doing it unwillingly under regulatory and multi-stakeholder pressure.

### 7.3 | Limitations and future research direction

Although this study makes a useful contribution to theory and practice, it has certain limitations that need to be considered while evaluating its findings. First, the study has collected data for measuring all variables from the same respondents to examine the nexus between intangible supply chain resources and business performance. Such single-source data can lead to the potential threat of common method bias (CMB). However, we employed adequate procedural and remedial measures to avoid the risk of CMB. To safeguard against this potential risk, future researchers can use our model and test it by collecting data for measuring independent and dependent variables from a different set of respondents. Second, the study has collected data in a single wave, thereby missing out on the granularity that multi-wave, time-lagged data could have brought. Future studies can collect multi-wave data and perform cross-legged analysis. In addition to these methodological limitations, the study, like any other research endeavor, is confined in scope to keep it manageable, given the time and resource challenges. Due to this, many variables that could be pertinent mediators, moderators, and control variables have not been included in the study. Future research can expand our model by considering the congruent variables in this regard. Some of the variables that can be considered are environmental strategy and green

innovation (Kraus et al., 2020), green entrepreneurship (Melay et al., 2017), and environmental performance (Rehman et al., 2021). At the same time, our study's findings can be extended by incorporating variables to more explicitly assess the impact of SDGs on firms' decisions related to GSCMP.

### CONFLICT OF INTEREST

The authors do not have any competing interests to declare.

### AUTHOR CONTRIBUTIONS

Mahak Sharma and Amandeep Dhir participated in the Conceptualization, Formal Analysis, Methodology, Validation, Writing—Original Draft Preparation, and Writing—Review and Editing. Haseena AlKatheeri, Mehmood Khan, and Mian M. Ajmal participated in the Methodology, Validation, Writing—Original Draft Preparation, and Writing—Review and Editing.

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