Garcia-Buendia, N., Moyano-Fuentes, J., and Maqueira, J.M. (2024), “Building bridges in uncertain times: supply relationships, lean supply chain management and performance”, *International Journal of Lean Six Sigma*, ahead-of-print, doi: https://doi.org/10.1108/IJLSS-08-2023-0133. Accepted 6 Dec 2024.

Building bridges in uncertain times: supply relationships, lean supply chain management, and performance

Abstract

Purpose. The purpose of this study is to examine how a focal firm’s supply relationships influence Lean Supply Chain Management (LSCM) implementation and its impact on operational performance.
Design/methodology/approach. An empirical study of 285 Spanish focal firms has explored the relationships between supply uncertainty, strategic supplier performance, LSCM implementation, and operational performance. A structural equation model (SEM) was utilized to test four hypotheses.
Findings. The results indicate that supply uncertainty and strategic supplier performance significantly impact on the decision to implement LSCM. The findings highlight the importance of strategic supplier performance for driving LSCM adoption. However, the study also suggests that LSCM implementation should be carefully considered in situations characterized by high supply uncertainty.
Practical implications. The study suggests that enhancing LSCM implementation and improving performance from key suppliers are crucial factors in achieving favorable operational performance in focal firms. Practitioners receive guidance on aligning their supply relationships, considering contextual factors, and leveraging strategic supplier performance to drive effective LSCM implementation.
Originality. This study offers novel insights by examining the antecedents to LSCM implementation from a contingency and relational perspective specifically focused on the context of supply relationships. This research contributes to the existing body of knowledge on supply chain management by shedding light on the interplay between supply uncertainty, strategic supplier performance, LSCM implementation, and operational performance.

Keywords Lean supply chain management, supply uncertainty, strategic supplier performance, operational performance, structural equation model

Article classification Research Paper

1. Introduction

In the continually evolving landscape of global supply chains, Lean Management (LM) has evolved from a production-centric approach into a comprehensive management philosophy that spans the entire supply chain (SC) (Shah and Ward, 2007). Lean Supply Chain Management (LSCM) extends the principles of LM beyond the boundaries of individual factories to include upstream and downstream partners to minimize costs and waste while enhancing overall efficiency (Reichhart and Holweg, 2007). LSCM seeks to optimize all SC activities from the perspective of the final customer, thereby ensuring quality improvement, cost reductions, and increased flexibility across the SC (Swenseth and Olson, 2016). A crucial component of successful LSCM implementation is collaboration and cooperation between SC members (Srinivasan *et al.*, 2020).

However, despite its potential benefits, previous research has highlighted a troubling trend: LSCM is often not implemented as effectively as anticipated (Marodin *et al.*, 2017), with reality frequently falling short of conceptual expectations (Jasti and Kodali, 2015; Rossetti *et al.*, 2023). One crucial element in the success of any SCM strategy lies in the context in which it is immersed, which shapes and influences every step of the process (Chen and Paulraj, 2004). Indeed, previous studies have revealed that inconsistencies in the implementation and outcomes of LM across the SC can often be traced back to the challenge of managing contextual factors specific to the operating environment (Bortolotti *et al.*, 2016).

As SCs face the dual challenge of delivering exceptional value to customers while contending with uncertainty and fierce competition, understanding the drivers of superior performance is paramount (Srinivasan *et al.*, 2020). To advance our understanding of LSCM in today's rapidly evolving environment, it is crucial to thoroughly explore its drivers and enablers as this will significantly enhance competitiveness and efficiency in the complex landscape of modern SCs. Supply relationships, in particular, have emerged as vital enablers that provide the stability and collaboration needed to navigate disruptions and maintain a competitive edge.

In this context, our study addresses two key research questions to deepen our understanding of LSCM through the lenses of Contingency Theory (CT) and the relational view of Resource-Based Theory (RBT):

RQ1: How do supply uncertainty and strategic supplier performance influence the level of LSCM implementation in the focal firm? Drawing on CT, which emphasizes the need for alignment between a firm's structure, processes, and external environment (Miller, 1987; Thompson, 1967), we explore how supply uncertainty —characterized by on-time performance delays, inconsistencies, and deficiencies (Chen and Paulraj, 2004)— impacts LSCM implementation. CT suggests that to achieve effective outcomes, a firm's response to external uncertainty must be well-coordinated with its internal management practices. The relational view of RBT complements this by highlighting the role of strategic suppliers in tackling uncertainty. Reliable and high-performing suppliers are essential to mitigate these challenges and foster the collaboration needed for successful LSCM adoption.

RQ2: To what extent do LSCM implementation and strategic supplier performance affect the focal firm's operational performance? Building on the relational view of RBT, we explore how strategic supplier performance can enhance not only LSCM implementation but also the focal firm's operational outcomes. RBT suggests that a firm's competitive advantage is derived both from its internal capabilities and from the performance and reliability of its strategic partnerships (Dyer and Singh, 1998; Lavie, 2006). High-performing strategic suppliers play a pivotal role in reducing supply uncertainty and reinforcing LSCM efforts and this is expected to contribute directly to superior focal firm operational performance.

While recent studies have explored various facilitators of LSCM such as the internal adoption of lean practices (Moyano-Fuentes *et al.*, 2021), information technologies (Oliveira-Dias *et al.*, 2022), and collaboration (Srinivasan *et al.*, 2020), the critical influence of supply uncertainty and strategic supplier performance remain underexplored. As supply uncertainty continues to have a growing impact on SCM outcomes, having efficient and reliable suppliers becomes increasingly critical. However, despite the clear significance of these factors, there has only been limited empirical research exploring their combined influence on LSCM strategy and performance. It is essential to address this gap to understand how these factors drive both the successful implementation of LSCM and improvements in operational performance.

Investigating these research questions, this study delves into the intricate interplay between supply uncertainty, strategic supplier performance, and LSCM implementation. This research seeks to uncover the often-overlooked factors that influence successful LSCM adoption through the lenses of CT and the relational view of RBT, with particular emphasis on supply uncertainty and strategic supplier performance as key drivers. By examining how these forces shape both LSCM implementation and its impact on performance, this study offers original insights that could reshape our understanding of SCM strategies in today's volatile environment.

This paper is organized as follows. Section 2 describes the theoretical framework and arguments leading to the hypotheses. Section 3 includes a description of the sample and methods used in the empirical analysis. Section 4 presents the analysis of the results. The study's theoretical and practical implications and limitations are offered in Section 5 along with some directions for further research. Finally, Section 6 gives the main conclusions.

2. Theoretical framework and hypotheses

2.1. Theoretical background

To understand the drivers of LSCM and its impact on performance, it is essential to establish a theoretical foundation that throws some light on how different factors shape these relationships. CT offers a lens through which we can understand how organizations adapt their practices to align with the specific circumstances that they face. As previously stated, the effectiveness of these practices hinges on the alignment between an organization's structure and processes and the external environment (Miller, 1987; Thompson, 1967). In the constantly changing landscape of SCs marked by growing complexity and uncertainty, this alignment is more crucial than ever.

As SCs become increasingly complex, with uncertainties and varying degrees of control over stakeholders (Ateş and Memiş, 2021), CT suggests that, for effective management, it is essential to understand the contextual factors that influence an SC (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023; Rossetti *et al.*, 2023). Recent studies have highlighted environmental uncertainty as a key factor that influences SCM and SC integration (SCI) (Rehman and Jajja, 2023; Zimmermann *et al.*, 2020), with supply uncertainty emerging as a particularly significant contingent variable that impacts business performance (Fadaki *et al.*, 2020; Zhao *et al.*, 2018). In this framework, it is logical to anticipate that supply uncertainty will affect both the selection and the outcomes of an SCM strategy such as LSCM.

Meanwhile, RBT emphasizes the importance of a firm's unique resources as the foundation for sustainable competitive advantage. The relational view of RBT extends this perspective, highlighting how inter-firm relationships and strategic alliances play a critical role in creating and leveraging valuable resources (Dyer and Singh, 1998). The relational view shifts the traditional RBT focus from individual firms to networks and partnerships, thus providing a more integrated understanding of how SC collaboration contributes to competitive advantage (Barney, 2018; Xiao *et al.*, 2019). According to the latter, a firm's success is not solely dependent on its internal resources but also on the capabilities and performance of its key suppliers.

Managing key SC partner relationships effectively is not just a strategic necessity but a powerful catalyst for organizational success. As Kim and Choi (2018) state, mastering these relationships is crucial to implementing new management practices successfully and enhancing overall performance. Building on this, previous studies have demonstrated that robust collaboration with these partners can significantly mitigate the adverse effects of supply uncertainty (Srinivasan *et al.*, 2020). This collaboration not only reduces uncertainty but, as Iyer *et al.*

(2019) demonstrate, it also actively boosts lean capabilities and operational efficiency. Therefore, strategic supplier performance could be expected to significantly influence the successful implementation of lean practices across the SC and the focal firm’s operational outcomes.

Combining CT and the relational view of RBT offers a comprehensive framework to address the complexities of supply uncertainty, strategic supplier performance, LSCM implementation, and operational performance. CT’s emphasis on the need for alignment between an organization’s structure and external environment makes it essential to understand how supply uncertainty influences LSCM strategy. Meanwhile, the relational view of RBT highlights the importance of strategic partnerships for leveraging external resources for competitive advantage, which is crucial for assessing how supplier performance impacts the success of LSCM implementation and overall operational outcomes. The following section proposes the hypotheses on these relationships.

2.2. Research hypotheses

Effect of supply uncertainty on LSCM implementation

According to CT, the focal firm’s external environment can determine both its decision on which operations strategy to adopt in the SC and the results that derive from implementing the chosen management system. In this line, increased uncertainty has been considered an integral part of the current SC context (Merschmann and Thonemann, 2011; Paulraj *et al.*, 2008) and has given rise to SCI as a response mechanism (Flynn *et al.*, 2016; Lyu *et al.*, 2022; Shukor *et al.*, 2021). Some authors have argued that the SC strategy choice is determined by the uncertainty of the environment in which firms compete (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023; Salam *et al.*, 2017; Zimmermann *et al.*, 2020).

Specifically, environmental uncertainty strongly affects the SC’s supply side as it influences the implementation of LM practices and firm performance, particularly (Azadegan *et al.*, 2013). Chen and Paulraj (2004) considered supply uncertainty to be one of the SC’s main dimensions, while González-Benito *et al.* (2010) studied empirically the environment’s role as a determinant of purchasing and supply strategy. Supply uncertainty refers to the uncertainties that come from supplier (un)reliability and (in)consistency (Chen and Paulraj, 2004), which, following the CT, can be expected to impact the buyer’s decision to adopt an SC strategy based on close relationship building. Supply uncertainty can lead a company to seek greater flexibility in its SC operations (Enrique *et al.*, 2022). Srinivasan *et al.* (2020) found that supply uncertainty facilitates LM strategy implementation. In this sense, deficient supplier performance epitomized by poor quality materials and an inability to meet buyer requirements could be a catalyst for the focal firm to extend the LM strategy upstream (Sangwa and Sangwan, 2018).

According to the relational view of RBT, the focal firm-supplier dyad should be characterized by mutual trust and commitment. Boonyathan *et al.* (2007) highlighted the role of close alignment with suppliers to reduce uncertainty while Chen *et al.* (2013) found that supply risk can be mitigated by supplier collaboration based on long-term cooperation. Supply fluctuations create a risk of failure in the delivery of goods, which may encourage integration with SC partners (Lii and Kuo, 2016). Further, the focal firm could be expected to make a concerted effort to address supply uncertainty issues such as the lack of consistent quality and reliability on the supply side by extending LM practices such as Value Stream Mapping (VSM), pull flow, and kanban systems upstream in the SC (Marodin *et al.*, 2017). Similarly, supplier development and commitment to advance upstream product and process standardization could be used as a tool to reduce supply uncertainty triggered by the focal firm's materials rejection rate (Srinivasan *et al.*, 2020). Thus, supply uncertainty motivates the focal firm to adapt to its context through a proactive supplier engagement approach (Sauer and Seuring, 2018), and one way to accomplish this could be by implementing the LSCM strategy.

Based on the above, a focal firm's supply uncertainty can be expected to influence LSCM implementation positively. The following hypothesis is, therefore, formulated:

H1: A higher level of supply uncertainty leads to a higher level of LSCM implementation

Effect of strategic supplier performance on LSCM implementation

Implementing LM leads to a change in companies' purchasing philosophies and policies based on a greater degree of confidence in supplier relationships (Moyano-Fuentes *et al.*, 2012). Therefore, building close relationships and increasing integration with key SC partners are the main challenges faced by companies embarking on lean initiatives (Jayaram *et al.*, 2008). Past empirical evidence has shown that greater cooperation with suppliers is positively related to internal LM implementation (Ciano *et al.*, 2021; Jayaram *et al.*, 2008).

On the one hand, this is in line with CT as organizations are embedded in and influenced by their supply networks (Flynn *et al.*, 2010), and the effectiveness of LM practices may be subordinated to the favorable or unfavorable contingent situation that firms face (Chavez *et al.*, 2015), including supplier and customer relationships. On the other hand, the relational view of RBT states that the SC's valuable and inimitable resources play a relevant role in achieving competitive advantage (Ketchen and Hult, 2007). So, LSCM implementation is influenced by the SC members' resources, competencies, and performance.

In the context of increasing competitive pressure demanding greater flexibility, lower costs, and better quality, LM principles have been incorporated into SC integrative approaches (Tortorella *et al.*, 2017). Collaborative relationships with key suppliers facilitate inter-organizational learning that, in turn, allows organizations to develop manufacturing flexibility along the SC and increase customer satisfaction (Sáenz *et al.*, 2018). So, LSCM implementation requires the SC structure to be reconfigured and long-term interactions with strategic agents in the SC to be built through mutual trust and engagement, regular information exchange, and win-win relationships (Bortolotti *et al.*, 2016; Moyano-Fuentes *et al.*, 2021; Ruiz-Benitez *et al.*, 2019).

Regarding SC collaboration, building strategic relationships with a limited number of key suppliers (Cousins and Spekman, 2003) and managing supplier relationships through the linkage between SCM practices and organizational strategies (Chen and Paulraj, 2004) have been proven to affect buyer-supplier relationships (Kim and Chai, 2017) and sourcing flexibility positively, and to secure effective supplier evaluation practices and higher levels of trust among SC members (Khan K and Pillania, 2008) and supplier integration (Adamides *et al.*, 2008), all of which would facilitate LM implementation throughout the SC.

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Consistent and reliable deliveries from suppliers could enable the implementation of LM practices such as an effective pull system and setup time reduction (Daine *et al.*, 2011), while a key supplier focus on cost control and quality could improve waste identification and elimination throughout the SC (Borgström and Hertz, 2011). Also, higher strategic supplier volumes and greater scheduling flexibility could enable the focal firm to benefit from LM features such as stock level reduction and increased inventory turnover. So, better upstream member performance could encourage buyers to fit their strategy to their suppliers, leading to collaboration with reliable suppliers in changing business environments (Kim and Chai, 2017) and driving supplier integration (Adamides *et al.*, 2008), which would facilitate LSCM implementation (Ciano *et al.*, 2021).

Joining up the previous reasoning, better strategic supplier performance would produce a higher level of collaboration and integration between the focal firm and its suppliers and facilitate the spread of lean principles and practices across the SC. We, therefore, propose the following hypothesis:

H2: The better the performance of a focal firm’s strategic suppliers, the higher the LSCM implementation level

Effect of strategic supplier performance on focal firm operational performance

The relational view of RBT shows that a focal firm’s performance depends on both its internal resources and the external resources in its relational network (Arya and Zhiang Lin, 2007; Dyer and Singh, 1998; Lavie, 2006). In this sense, when companies strategically select their partners, they are also selecting certain resources that will allow them to obtain the desired results (Lavie, 2006). This is why cooperative relationships with key suppliers are essential for improving a focal company’s operational and financial performance (Islami, 2023; Zhang *et al.*, 2024; Zimmermann and Foerstl, 2014).

Purchasing activities play a strategic role in the SC (Andersen and Rask, 2003). The literature shows that, compared to other agents in the environment, key suppliers play a crucial role in a focal company achieving important results such adopting innovative technology (Maqueira-Marín *et al.*, 2017). Thus, based on the relational view of RBT postulates, strategic suppliers selected because of their resources will achieve good performance outcomes precisely thanks to their resources. These same resources and outcomes will also have a direct impact on the focal firm’s performance (Lavie, 2006; Maqueira-Marín *et al.*, 2017), specifically on its operational performance and efficiency, *inter alia* (Danese *et al.*, 2012; Danese and Romano, 2011).

Some scholars have found that suppliers directly impact various competitive dimensions of a buying firm’s business strategy, including cost, quality, delivery, flexibility, technology, and profit (Krause *et al.*, 2000). So, operational performance measured through low manufacturing costs, reduced cycle time, and inventory turnover, i.e., focal firm efficiency (Danese *et al.*, 2012; Danese and Romano, 2011), would be affected by the performance obtained by the focal company’s strategic suppliers. A focal firm’s manufacturing costs will be low if its strategic suppliers command strong control over their costs as these could impact the price of their products for the focal company (Zsidisin *et al.*, 2003). If strategic suppliers achieve highly reliable on-time shipment delivery (Milgate, 2001) and manufacture quality products (Agus and Hassan, 2008), the focal company will also have low costs as it will not incur any non-quality costs or alterations to its production schedule (Yeung, 2008).

Other strategic supplier resources such as entrepreneurship, innovativeness, and learning function will also affect the focal firm by reducing its cycle time (Hult *et al.*, 2002). If strategic suppliers achieve volume and scheduling flexibility and fast on-time deliveries, this will allow the focal firm to work with reduced stock and increased inventory turnover (Milgate, 2001).

Therefore, based on the above arguments, the following hypothesis can be formulated:

H3: The better the performance of the focal firm's strategic suppliers, the higher the level of focal firm operational performance

Effect of LSCM on focal firm operational performance

LSCM aims to enhance operational performance by integrating resources to coordinate activities and exchange information and implementing a continuous improvement process across the SC (Mollenkopf *et al.*, 2010). The relevance of the LSCM-performance relationship has been broadly addressed by previous research (Garcia-Buendia *et al.*, 2021), which has confirmed that LSCM implementation has several implications for firm and SC performance.

Despite the interest generated by the study of LSCM performance, ambiguous results can be found in the research literature. Tortorella *et al.* (2018) recently stated that customer-supplier relationships in an LSCM context can lead to mixed results regarding cost, lead time, and delivery. Danese *et al.* (2012) found that firms should focus on Just In Time production to maximize efficiency or Just In Time supply to maximize delivery. These inconclusive findings might be due to the partial characterization of LSCM, different measures to address LSCM and performance, a limited focus on upstream SC levels, and a variety of contextual factors (Berger *et al.*, 2018). Previous empirical evidence has shed some light on the positive impact of implementing LSCM on efficiency (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023; Moyano-Fuentes *et al.*, 2021; Oliveira-Dias *et al.*, 2024) but further investigation is needed into LSCM's impact on operational performance.

According to CT reasoning, to maximize performance, organizations must adapt their structures and processes to their environment (Donaldson, 2001) and SC members are an important part of a firm's environment (Flynn *et al.*, 2010). To achieve better performance, the focal firm should maintain integrative and collaborative relationships with its SC agents by extending LM to its customers and suppliers (Moyano-Fuentes *et al.*, 2021). Researchers have shown that the inter-organizational improvement process is a key issue in SC integration with implications for performance (Ahmed *et al.*, 2019, 2017). Following the relational view of RBT, high SC process integration implies the integration of buyer and supplier firms' strategic resources to cultivate processes, capabilities, and interrelationships, which generates a source of competitive advantage for the firms (Prajogo *et al.*, 2016).

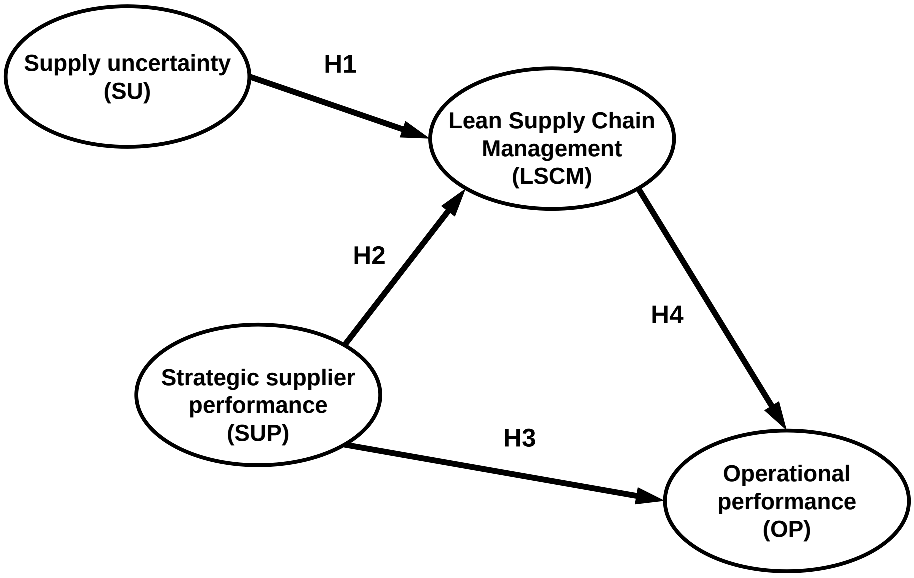
Some researchers have claimed that strategic integration with suppliers can bring down costs and boost overall LSC performance (So and Sun, 2010). Others have argued that operational and inventory costs can be reduced through upstream LSCM practices (Azevedo *et al.*, 2012). Prajogo and Olhager (2012) stated that integration in an LSC context leads to reliable order cycles, reduced inventory, and lower cost, among other advantages. In particular, using LM techniques such as VSM and setup time reduction along the SC could lead to improvements in the focal firm's cycle time from raw materials to delivery (Seth *et al.*, 2017). Similarly, frequent small lot deliveries along the whole of the SC are expected to contribute to higher focal firm stock turnover and low inventory levels (Klug, 2016; Rossini and Portioli-Staudacher, 2016). Using lean-driven techniques such as VSM and product and process standardization to reduce waste and non-value-added activities along the SC could reduce the focal firm's unit manufacturing cost (Wee and Wu, 2009). Therefore, the collaborative and integrative relationships with SC partners pursued by LSCM implementation, especially on the upstream side, could lead to operational performance improvements in a wide range of areas.

The following hypothesis is formulated based on the above reasoning:

H4: A higher level of LSCM implementation leads to a higher level of focal firm operational performance

Figure 1 presents the theoretical research model.

Fig. 1 Theoretical research model



Source: Authors own work.

3. Methodology

3.1. Population, questionnaire design, and data gathering

This study has focused on industrial firms in a single country, Spain, to mitigate the influence of cultural, legal, and socioeconomic variations, following the approach employed in prior research (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023). The SABI (Iberian Balance Sheet Analysis System) database was used to collect the study population, while the CNAE (National Classification of Economic Activities) catalog was used to classify the population into sectors. Following van der Vaart *et al.* (2012), only firms in industrial sectors in an intermediate position in their SCs were considered (industrial sectors purely related to extractive activities, raw materials and their transformation, transportation, and services were discarded). This yielded a total of 2,650 Spanish focal manufacturing firms with at least 50 employees.

Data were collected via a questionnaire. Five internationally recognized SC researchers tested the first draft of the questionnaire to guarantee the survey instrument's quality and validity and minimize response bias (Saunders *et al.*, 2009). A pilot survey subsequently ensured that the definitions of each item in the sample were comprehensive and significant. Survey instrument revisions involved rewording terms, reorganizing the question sequence, incorporating synonyms, enhancing clarity, and adding or removing some specific elements. Two methods were used to gather the data: a telephone survey using a computerized system (CATI) and a web questionnaire for non-responding interviewees to respond. Thus, every firm in the population was contacted either by telephone or email. The questionnaires were directed at the most informed respondents for each specific survey topic, i.e., SC managers, operations managers, and logistics managers. Respondents were specifically asked to provide answers on the SC practices and strategies adopted by their firms, their SC environment, and their performance. An unrelated variable included to mitigate common method bias was found to be statistically non-significant.

Non-responding companies were randomly followed up by telephone and no significant differences were found between the characteristics of non-respondents and respondents. In addition, a comparison of respondents and non-respondents confirmed the absence of response bias. A comparison of the first 40 and last 40 responses (Armstrong and Overton, 1977) revealed no significant differences in the questionnaire variables, effectively ruling out any late response bias. To address any bias that could arise from the data collection method, 40 responses were randomly selected from each data collection method and no significant differences were found for any of the study variables. Fieldwork was carried out between January and July 2018 and yielded 285 valid complete questionnaires and a 10.8 % response rate, which is in line with recent studies in SCM (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023; Iyer *et al.*, 2019; Moyano-Fuentes *et al.*, 2021; Oliveira-Dias *et al.*, 2022; Srinivasan *et al.*, 2020). The sample size was considered to be appropriate and not to compromise the reliability of the results.

Table I gives the distribution of the population and company sample according to sector classification. An analogous distribution of companies among the different sectors can be observed. A comparison of respondents and non-respondents showed no evidence of response bias regarding the number of workers, annual sales, and gross operating profit, while the absence of any significant differences between the first and last responses established that there was no late response bias. These analyses confirmed the random nature of the sample and the statistical representation of the population.

Table I Sample, population distribution, and response rate by sector

Sector	Companies in population		Companies in sample		Response rate
Foodstuffs and tobacco	543	20.49%	52	19.18%	9.57%
Chemical and pharmaceutical products	422	15.92%	49	17.13%	11.61%
Manufacture of metal products	322	12.15%	45	16.08%	14.29%
Manufacture of machinery and equipment	275	10.38%	34	11.89%	12.36%
Motor vehicles	273	10.30%	24	8.39%	8.79%
Meat industry	158	5.96%	6	2.10%	3.80%
Electrical machinery and materials	141	5.32%	14	4.90%	9.93%
Manufacture of beverages	106	4.00%	8	2.80%	7.55%

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Furniture industry	82	3.09%	8	2.80%	9.76%
Informatics, electronics, and optics products	81	3.06%	13	4.55%	16.05%
Manufacture of other transport material	77	2.91%	12	4.20%	15.58%
Shoes and leather	63	2.38%	5	1.75%	7.94%
Other manufacturing industries	60	2.26%	9	3.15%	15.00%
Fabrics and textile	47	1.77%	6	2.10%	12.77%
Total	**2,650**	**100%**	**285**	**100%**	**10.79%**

Source: Authors own work.

3.2. Variables and constructs

This study examined the relationships between four multi-item constructs: supply uncertainty, strategic supplier performance, LSCM, and operational performance. All items were assessed on a five-point Likert scale, which is common practice for measuring latent constructs or variables in the field and consistent with previous research (Ateş and Memiş, 2021; Marodin *et al.*, 2017; Rehman and Jajja, 2023).

Supply uncertainty (SU). Based on Chen and Paulraj (2004), this construct includes variables representing suppliers' compliance with requirements, quality conformance, timeliness, and inspection prerequisites. Respondents were asked to indicate on a five-point Likert scale (1 = "totally disagree" to 5 = "totally agree") their level of agreement with supplier inconsistency in meeting the buyer's requirements, the inadequate quality of the materials provided by suppliers, a high rejection rate of critical components by the buyer, and the thorough inspection of incoming materials.

Strategic supplier performance (SUP). This construct is formed of the items proposed by Chen and Paulraj (2004) and Paulraj *et al.* (2006, 2008) and provides information about the level of competence, reliability, and constancy of key suppliers' performance as enablers of the development of cooperative and strategic relationships pursued by LSCM. Specifically, respondents were asked to evaluate on a five-point Likert scale (1 = "decreased significantly" to 5 = "increased significantly") how strategic supplier performance measures such as delivery reliability/consistency, quality, cost control, volume and scheduling flexibility, and on-time delivery had evolved during the preceding three years.

Lean Supply Chain Management (LSCM). This construct was taken from Moyano-Fuentes *et al.* (2019) as a validated instrument that included three different dimensions of LSCM implementation: (i) tooling to eliminate waste in the SC (LSCM_T) such as Kanban and Value Stream Mapping (VSM), (ii) operationalization practices (LSCM_O), including minimum inventory and production and process standardization, and (iii) strategic planning (LSCM_P) related to long-term forecasting of customer demands and strategies to handle uncertainty. Corresponding items were measured perceptually on a five-point Likert scale (1 = "totally disagree" to 5 = "totally agree").

Operational performance (OP). This construct, inspired by Danese *et al.* (2012), was designed to include operational performance indicators and measured by manufacturing cost, inventory turnover, and cycle time from raw materials to delivery. Respondents were asked to compare their firms' operational performance to their competitors' on a five-point Likert scale (1 = "poor, low" to 5 = "much better than average").

Table II gives the survey items for each factor.

Table II Survey items and primary factors

Construct	Variable	Code	Source
Supply uncertainty (SU)	The suppliers consistently meet our requirements *(R)*	SU1	(Chen and Paulraj, 2004), *R: reversed*
	The suppliers produce materials with consistent quality *(R)*	SU2	
	We have a low rejection rate of incoming critical materials from suppliers *(R)*	SU3	
	We make an extensive inspection of incoming critical materials from suppliers	SU4	
Strategic supplier performance (SUP)	Delivery reliability/consistency	SUP1	(Chen and Paulraj, 2004; Paulraj *et al.*, 2006, 2008)
	Quality	SUP2	
	Cost control	SUP3	
	Volume flexibility	SUP4	
	Scheduling flexibility	SUP5	
	On-time delivery	SUP6	
Lean Supply Chain Management (LSCM)	*LSCM tooling:*	*LSCM_T*	(Moyano-Fuentes *et al.*, 2019, 2021)
	Value stream mapping is used to identify and eliminate waste throughout our supply chain	LSCM1	
	Our supply chain uses lean manufacturing techniques (such as pull flow, Kanban systems, and setup time reduction)	LSCM2	
	LSCM operationalization:	*LSCM_O*	
	Our supply chain generates high stock turnover and minimizes inventory	LSCM3	
	Process and product standardization is a common practice in our supply chain	LSCM4	
	Our supply chain delivers in small lot sizes	LSCM5	
	LSCM planning:	*LSCM_P*	
	Our supply chain does long-term forecasting of customer demands and only focuses on the current market segments	LSCM6	
	In our supply chain, the strategy for handling uncertainty consists of using queues and buffers to protect sub-processes	LSCM7	
	Our supply chain structure seldom changes	LSCM8	
Operational performance (OP)	Unit cost of manufacturing	OP1	(Danese *et al.*, 2012; Danese and Romano, 2013)
	Inventory turnover	OP2	
	Cycle time (from raw materials to delivery)	OP3	

Source: Authors own work.

4. Analysis and results

4.1. Measurement model

A questionnaire pretest with five researchers in the study area and the utilization of constructs drawn from the literature ensured content validity. Scale unidimensionality was assessed through Exploratory Factor Analysis (EFA) in SPSS, with eigenvalues higher than the unit, standardized factor loads higher than 0.5, significant explained variance for each extracted factor, and high values for Chi-squared/degrees of freedom in Bartlett's sphericity test ($p < 0.05$). LSCM was measured as a second-order factor. Reliability was tested with Cronbach's alpha, with values of 0.6 considered adequate and scores above 0.6, acceptable (Nunnally and Bernstein, 1967).

Table III reports the exploratory factor analysis results and briefly describes the observable variables. Items marked with an asterisk (*) were discarded after the exploratory factor and reliability analyses.

Table III Exploratory factor analysis

Construct		Variable	Standardized factor loading	Cronbach's α	Bartlett test	% explained variance
SU		SU1	0.89	0.77	χ^2 = *279.52*	68.97
		SU2	0.89		*df = 3*	
		SU3	0.70		*sig = 0.000*	
		SU4*				
SUP		SUP1	0.80	0.85	χ^2 = *566.96*	62.15
		SUP2	0.77		*df = 10*	
		SUP3	0.71		*sig = 0.000*	
		SUP4	0.83			
		SUP5	0.82			
		SUP6*				
LSCM	*LSCM_T*	LSCM1	0.89	0.69	χ^2 = *270.42*	72.45
		LSCM2	0.84		*df = 15*	
	LSCM_O	LSCM3	0.82		*sig = 0.000*	
		LSCM4	0.77			
		LSCM5*				
	LSCM_P	LSCM6	0.68			
		LSCM7	0.88			
		LSCM8*				
OP		OP1	0.69	0.62	χ^2 = *101.65*	57.13
		OP2	0.82		*df = 3*	
		OP3	0.76		*sig = 0.000*	

Source: Authors own work.

Cronbach's alpha coefficients for the scales were compared with correlations between scale items to test for divergent validity (Anand and Ward, 2009), which was confirmed. Finally, the scales' dimensionality and test convergent validity were verified with Confirmatory Factor Analysis (CFA) using EQS 6.4 software. First, the normalized estimation of Mardia's test was used for data exploration and confirmed multivariate non-normality. The model was estimated using maximum likelihood estimation with robust standard errors, with the non-normality in the indicators taken into account (Zhang *et al.*, 2021). Non-normal variables and the robust estimation method in covariance-based SEM analysis are common in Operations Management (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023; Moyano-Fuentes *et al.*, 2021). Factor loadings above 0.45 were considered following the literature's preference for retaining the highest possible number of items in variable/latent constructs (Tabachnick and Fidell, 2019) and previous empirical studies in the operations management field (Narayanamurthy and Tortorella, 2021; Tortorella *et al.*, 2019). The final fit of the CFA was highly satisfactory (Satorra-Bentler scaled χ^2 = 149.45 with 103 degrees of freedom, χ^2/df = 1.45; RMSEA = 0.04; MFI = 0.92; NFI = 0.89; NNFI = 0.95; CFI = 0.96; IFI = 0.96). Table IV gives standardized factor loads and R^2 for the variables. Figure 2 shows the measurement and structural model.

Table IV Confirmatory factor analysis

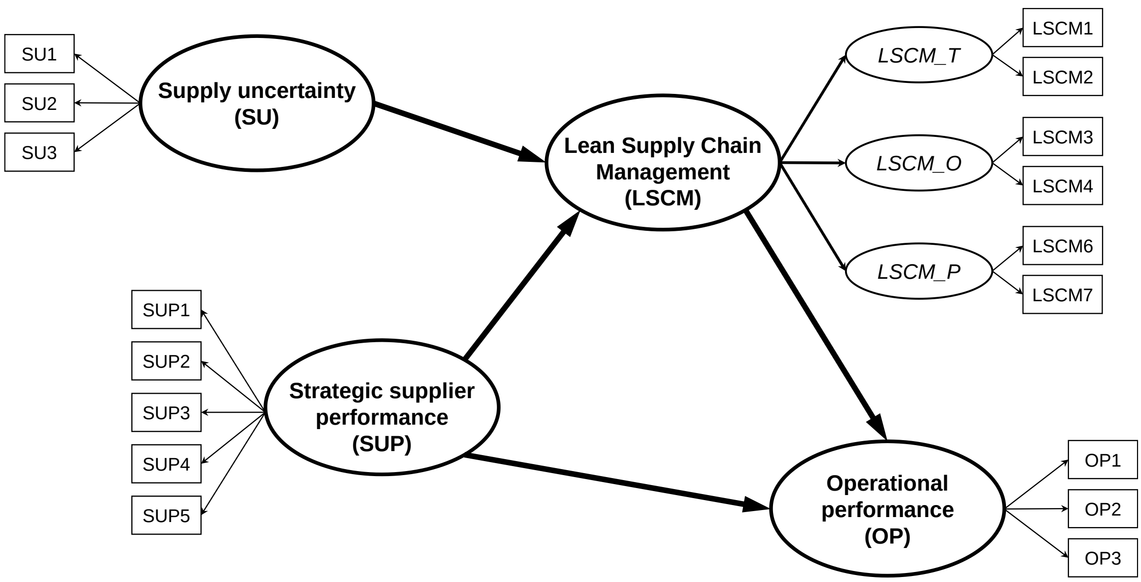
Construct	Variable	Standardized factor loading	R^2
SU	SU1	0.89	0.78

Garcia-Buendia, N., Moyano-Fuentes, J., and Maqueira, J.M. (2024), “Building bridges in uncertain times: supply relationships, lean supply chain management and performance”, *International Journal of Lean Six Sigma*, ahead-of-print, doi: https://doi.org/10.1108/IJLSS-08-2023-0133. Accepted 6 Dec 2024.

		SU2	0.83	0.70
		SU3	0.49	0.24
SUP		SUP1	0.73	0.54
		SUP2	0.68	0.46
		SUP3	0.62	0.38
		SUP4	0.80	0.65
		SUP5	0.80	0.63
LSCM	*LSCM_T*	LSCM1	0.64	0.41
		LSCM2	0.87	0.76
	LSCM_O	LSCM3	0.60	0.35
		LSCM4	0.63	0.40
	LSCM_P	LSCM6	0.75	0.57
		LSCM7	0.47	0.22
OP		OP1	0.45	0.20
		OP2	0.81	0.65
		OP3	0.55	0.31

Source: Authors own work.

Fig. 2 Measurement and structural model

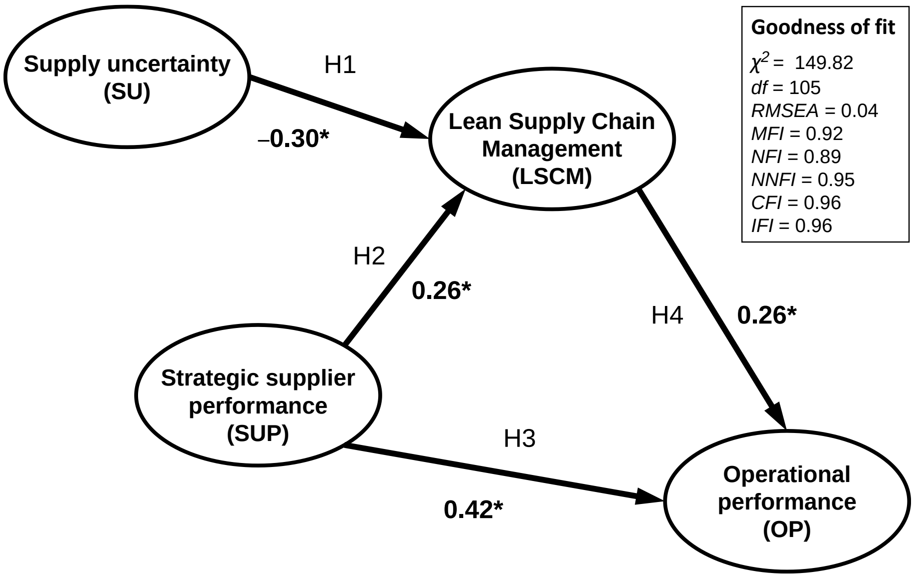


Source: Authors own work.

4.2. Structural equation model

The hypotheses were tested with SEM (Figure 3). Covariance-based SEM was preferred to variance-based SEM (e.g., Partial Least Squares – PLS) due to its parameter accuracy. The analysis results showed that the model yielded a good overall fit: Satorra-Bentler scaled χ^2 = 149.82 with 105 degrees of freedom, χ^2/df = 1.43; RMSEA = 0.04; MFI = 0.92; NFI = 0.89; NNFI = 0.95; CFI = 0.96; IFI = 0.96. Figure 3 shows the structural equation model’s factor loads.

Fig. 3 Structural equation model



Source: Authors own work.

The relationships in *H1*, *H2*, *H3,* and *H4* ($p < 0.05$) were significant. Three hypotheses received empirical support -*H2*, *H3,* and *H4*- while one -*H1*- was not supported. The relationship between supply uncertainty and LSCM was not supported given the negative and significant coefficient of -0.30 (*H1*). This would indicate that higher levels of supply uncertainty understood as an SC environment characterized by unpredictable and inconsistent supply partners, do not motivate and drive a higher level of LM implementation along the SC. This result contrasts with previous studies that suggest that supply uncertainty facilitates the implementation of lean practices (Srinivasan *et al.*, 2020). Nonetheless, it supports the view that unpredictability and instability hinder the effectiveness of lean operations (Azadegan *et al.*, 2013). The relationship between strategic supplier performance and LSCM was supported with a significant positive coefficient of 0.26 (*H2*), thus confirming that better performance of a focal firm’s strategic suppliers in terms of reliability, quality, cost, flexibility, and delivery drives a higher level of LSCM implementation. This finding aligns with earlier research demonstrating that cultivating strong collaborative relationships with suppliers significantly enhances lean capability development (Iyer *et al.*, 2019). The link between strategic supplier performance and firm operational performance was supported with a coefficient of 0.42 (*H3*), revealing that advantageous key supplier performance enables better operational outcomes in the focal firm. This result aligns with previous works that show that a strategic approach on the supply side can boost benefits for the focal firm (Ateş and Memiş, 2021). Lastly, the LSCM-operational performance relationship was also supported with a coefficient of 0.26 (*H4*), demonstrating that greater adoption of LM practices along the SC can improve the focal firm’s operational performance in terms of manufacturing cost, inventory turnover, and cycle time. This finding builds on previous studies that have reported positive outcomes of LSCM implementation (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023).

A mediation analysis was conducted to examine the relationships between SUP, LSCM, and OP. Mediation in SEM allows us to examine how an independent variable influences a dependent variable through one or more mediating variables, with the total effect broken down into direct and indirect components. So, in this context, mediation analysis helps assess whether the relationship between two variables is partially or fully mediated by a third variable. The steps proposed by Baron and Kenny (1986) were followed to test for mediation.

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The mediation analysis revealed that both the path from SUP to LSCM and the path from LSCM to OP had coefficients of 0.26. The direct effect of SUP on OP, bypassing LSCM, was stronger at 0.42. The LSCM-mediated indirect effect was 0.0676. Combining the direct and indirect effects, the total effect of SUP and LSCM on OP was 0.4876. Although LSCM mediated the SUP-OP relationship, the indirect effect was somewhat weaker than the direct effect. This indicates that while LSCM contributes to the relationship, the direct influence of SUP on OP plays a much more significant role.

5. Discussion

The purpose of our study was to advance knowledge on the role played by how the focal firm’s supply relationship context unfolds during LSCM strategy implementation. Specifically, we analyzed the role of two aspects of collaborative relationship building with suppliers and their impact on the implementation of the LSCM strategy in the focal firm and its operational performance. This empirical research shows the effect of the supply relationship context on LSCM, in particular of supply uncertainty and strategic supplier performance.

Our research offers valuable insights for researchers, practitioners, and policymakers that will be further developed in the following subsections. In summary, for researchers, it contributes to the academic understanding of how supply uncertainty and strategic supplier performance influence LSCM implementation and its outcomes, thus opening up new avenues for future research. Practitioners can benefit from the practical implications as the findings highlight the importance of building reliable and consistent supplier relationships for implementing LSCM successfully and improving operational performance. For policymakers, the study provides evidence to support the development of guidelines and frameworks that encourage effective SC practices that produce more resilient and competitive industries.

5.1. Implications for theory

Regarding RQ1, our findings show that supply uncertainty has a significant negative impact on LSCM implementation (*H1* is rejected). Specifically, higher levels of supply uncertainty lead to a lower degree of LSCM implementation. Suppliers failing to consistently meet the focal firm’s quality and timely delivery requirements (Chen and Paulraj, 2004) hinders the adoption and development of key LSCM practices such as setup time reduction, inventory minimization, and standardization along the SC (Moyano-Fuentes *et al.*, 2019). Consequently, extending LM strategies across the SC to strengthen relationships with partners and improve overall efficiency could be perceived as a risky and potentially unnecessary decision. In summary, supply uncertainty undermines the reliability and sustainability of supplier relationships and poses a significant barrier to the successful implementation of LM practices throughout the SC. Our results suggest that LSCM requires stable supply relationships, so any sources of instability in these relationships are detrimental to LSCM implementation. These findings are in line with Azadegan *et al.* (2013), who found that higher levels of unpredictability and instability in dynamic environments undermine the effectiveness of lean operations; with Zimmerman *et al.* (2020), who argued that an agile SC strategy is preferable to a lean strategy when firms compete in highly complex and dynamic environments, and with Flynn *et al.* (2016), who found that micro-level uncertainty (such as supply uncertainty) is negatively related to SCI. However, our results contrast with other authors who claim that supply uncertainty stimulates focal firm collaboration and proactive supplier engagement (Sauer and Seuring, 2018; Srinivasan *et al.*, 2020) -when seeking to extend LM along the SC, at least. Our results both challenge and expand upon previous findings, suggesting that supply uncertainty can act as a catalyst to enhance certain aspects of SC flexibility (Enrique *et al.*, 2022). By adopting a CT perspective our study sheds light on how environmental uncertainty linked to supplier operations influences the implementation of efficiency-oriented strategies such as LSCM.

Exploring the factors that drive and enhance LSCM strategy implementation is essential for advancing knowledge in the SCM field and significantly improving SC performance; a deeper understanding of these drivers enables firms to navigate challenges more effectively and improve the success of SCM initiatives in increasingly complex and unpredictable environments (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023). Of these factors, supply uncertainty has emerged as a critical antecedent to the implementation of various SCM strategies (Zimmermann *et al.*, 2020). Our study reinforces this by confirming the significant role that supply uncertainty plays in LSCM, and particularly by highlighting the negative relationship between supply uncertainty and the effective implementation of LSCM practices. From the relational view of RBT perspective, extending LM principles along the SC requires cooperative relationships with SC agents and cannot be successfully achieved if suppliers are unreliable and their performance is inconsistent. Therefore, our study demonstrates that successfully implementing LSCM must be founded on suppliers that are consistent and reliable, and whose performance is consistently strong. This result complements Moyano-Fuentes *et al.* (2021), which indicates that SC members must advance lean implementation internally to make headway in LSCM implementation. It also extends to previous works dealing with the impact of technology uncertainty on LSCM implementation and firm competitiveness (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023), the role of environmental complexity and dynamism in lean operations and lean purchasing (Azadegan *et al.*, 2013), the effects of product characteristics and risk alleviation competency on the selection of an LSC structure (Nishat Faisal *et al.*, 2006), and the impact of competitive strategy on choosing an LSC depending on environmental uncertainty (Qi *et al.*, 2011). Recent studies also include a learning orientation and strategic sourcing among the antecedents to LSCM implementation (Iyer *et al.*, 2019; Yildiz Çankaya, 2020). More generally, our results align with the research stream that highlights environmental uncertainty's role in the supply chain integration-operational performance (Wong *et al.*, 2011) and supply chain integration-buyer/supplier relationships (Gimenez *et al.*, 2012). Precisely, LSCM is related to supplier integration (Adamides *et al.*, 2008).

Our study identifies other key determinants of LSCM implementation and highlights the role of the firm's strategic supplier performance. On the one hand, strategic supplier performance is related positively to LSCM implementation (*H2* is supported). Time, quality, cost, and flexibility improvements in the outcomes achieved by the focal firm's strategic suppliers strongly impact LSCM implementation. Specifically, key supplier consistency and reliability are crucial for successful LSCM implementation. When suppliers consistently deliver high performance, they make it easier to deploy lean practices such as pull flow, setup time reduction, high inventory turnover, and standardization. This reliability fosters trust and encourages focal firms to put effort into strengthening collaborative relationships with these strategic suppliers. This, in turn, creates an optimal environment for extending lean principles along the SC. Our results corroborate previous works on SCI and supplier integration and LSCM's focus on external integration (Qi *et al.*, 2017) and the relevance of collaboration with SC partners to develop lean capabilities (Iyer *et al.*, 2019). Our findings reaffirm that supplier involvement and commitment are crucial for enabling the implementation of lean practices across the SC (Ciano *et al.*, 2021) while they also highlight the pivotal role of high-performing strategic suppliers in driving successful LSCM adoption (Garcia-Buendia, Moyano-Fuentes, Maqueira-Marín, *et al.*, 2023), which is a *sine qua non* for extending lean throughout the SC. Strategic suppliers must deliver sustained and reliable performance over time, i.e., the stable collaborative relationship with suppliers that lean advocates must be established with suppliers that are also lean and deliver consistently high reliable performance. This insight coincides with CT and the relational view of RBT as establishing strategic relationships with key suppliers helps generate a cooperative environment for the focal firm to operate in, thus increasing the likelihood of successful results.

Concerning RQ2, improvements in strategic supplier performance lead to better focal firm operational performance (*H3* is supported). The higher consistency and reliability of key suppliers demonstrated by our study results contribute to improving the focal firm's operational performance. A firm's costs, inventory turnover, and cycle time improve when its strategic suppliers accomplish delivery reliability, quality, cost control, and volume and scheduling flexibility. In reality, the focal firm's operational performance cannot be considered an issue restricted to the domain of the focal firm alone. These findings are supported by CT, which states that a group of leading firms that collaborate in a network and successfully adapt to the context in which they operate and, therefore, deliver good performance, could transmit their adaptation to the environment and their good performance to the main agents in the network (focal firm). Our results indicate that the consistency and reliability of the focal firm's strategic suppliers positively impact its operational performance. These factors catalyze mutual trust and commitment in the SC, leading to a win-win situation for all the parties involved. Our findings are also supported by the relational view of RBT, according to which the resources operationalized by strategic suppliers in the SC positively impact their operational performance and that of other important agents in the chain (i.e., the focal firm). The contribution made by key supplier performance to the focal firm's efficiency reveals the immense importance and implications of selecting the right suppliers and building strategic relationships with these based on mutual trust and commitment. This result complements the study by Ateş and Memiş (2021), which finds that high levels of a strategic approach on the supply side can suppress the negative effects of supply complexity while leveraging its benefits. Additionally, our results align with Saenz *et al.* (2018), who find that upstream relationships with key suppliers act as antecedents of manufacturing flexibility. Similarly, the present findings concur with the benefits of strategic purchasing (Zimmermann and Foerstl, 2014) and strategic sourcing (Kim and Chai, 2017)., Our results also align with the recent literature that identifies a positive relationship between strategic supplier partnership and financial performance (Islami, 2023), and between strategic supply management and operational performance (Zhang *et al.*, 2024).

Lastly, LSCM implementation affects the focal firm's operational performance positively (*H4* is supported). The impact of LSCM on the focal firm's operational performance has shown that extending LM practices along the SC and, particularly, involving key suppliers in the process, help to achieve better performance. Implementing practices such as VSM, pull flow, setup time reduction, inventory minimization, standardization, and strategic planning across the SC enables the focal firm to reduce manufacturing costs, increase inventory turnover, and shorten cycle times. These results demonstrate empirically the benefits advocated by LSCM and

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complement previous findings regarding efficiency (Moyano-Fuentes *et al.*, 2021; Oliveira-Dias *et al.*, 2024), inventory and quality (Marodin *et al.*, 2017), operational performance in terms of quality, cycle time, delivery, and flexibility (Garcia-Buendia, Moyano-Fuentes, Maqueira, *et al.*, 2023), and SC performance in terms of lead time, cost, inventory, quality, and delivery service level (Tortorella *et al.*, 2017). However, our findings contrast with previous studies that identified a non-significant impact of SC-level lean on business performance (Afum *et al.*, 2024). Competitive advantage could be obtained from the synergistic effect between LSCM implementation and better strategic supplier performance. Our results align with the relational view of RBT in showing that implementing an SCM strategy to eliminate sources of inefficiency along the SC can lead to performance improvements.

5.2. Implications for practice

From a practical perspective, our study offers valuable insights for managers and practitioners implementing SCM initiatives such as LSCM strategy to enhance operational performance. Managers should be aware of the characteristics of the context before choosing the LSCM strategy as its implementation process could be undermined by environmental uncertainty. The features of the upstream side of the SC have been shown to be essential both for successful LSCM implementation and for the focal firm to achieve efficiency. Our findings reveal that supplier inconsistency hampers the extension of lean practices such as waste reduction, inventory minimization, product and process standardization, and strategic planning across the SC. One clear implication is that it is better not to attempt to extend lean throughout the SC when there is a high level of supply uncertainty due to its negative effect on LSCM. Conversely, the strongest efforts should be made to extend LM to the SC when supplier behavior is very stable. Cultivating strong relationships with suppliers who consistently meet the focal firm's delivery, quality, and flexibility requirements significantly supports the implementation of these lean practices. Therefore, organizations should not extend or initiate LSCM implementation in contexts of volatility or a high degree of supply uncertainty but rather strengthen their relationships with key stakeholders (as "best friends forever") to create a buffer against instability and enable them to move forward with their LSCM implementation with some guarantee of success.

Similarly, the successful performance of strategic suppliers in terms of delivery, quality, and flexibility directly contributes to operational performance improvements in the focal firm. Purchasing managers should strengthen their collaborative relationships with suppliers with the best operational performance in recent years as they will be the catalyst for LSCM to deliver the expected outcomes. Our results also provide managers already using LSCM with insights into improving the derived performance by selecting a small number of key suppliers that demonstrate consistent operational performance over time. Strengthening these relationships with key suppliers would enable LSCs to guarantee a modicum of results in turbulent and volatile times. Regarding the advantages and benefits of implementing LSCM, our findings offer valuable guidance for managers seeking to incorporate said SC strategy. LSCM implementation has been shown to improve focal firms' operational performance significantly. LSCM practices are particularly effective in improving key areas such as manufacturing costs, inventory turnover, and cycle time.

5.3. Study limitations and future research directions

Some study limitations can be mentioned. Our study examines LSCM implementation from the focal firm perspective, which may give a distorted view of the analysis. The study's 10.8% response rate could potentially introduce non-response bias. However, this is a minor concern as it is in line with response rates observed in the SCM research field. Also, the data from Spanish industrial focal firms were cross-sectional; testing this model in a longitudinal cross-country analysis would be interesting and insightful. The operational performance measure utilized in this study relies on respondent subjectivity; incorporating objective firm performance indicators could offer more reliable and concrete insights and enhance our contribution's objectivity. Notwithstanding its limitations, this research fills a significant gap in the literature by illustrating the effects of the supply relationship context as an antecedent to LSCM implementation and operational performance.

Future research should explore the impact of environmental uncertainty on LSCM considering various sources such as demand uncertainty. Our study has concentrated on exploring supply uncertainty as a critical driver of LSCM implementation. However, expanding the focus to include uncertainty caused by demand fluctuations and unpredictability could broaden our findings and offer new insights into how environmental uncertainty influences the extension of LM practices across the SC. Extending the analysis to financial measures and contrasting aspects with the agile SC strategy would also be valuable. Since supply uncertainty stems from inconsistencies in supplier quality and delivery times, understanding how this contextual factor influences the implementation of different strategies such as the agile SC strategy could provide valuable insights. This analysis could help determine whether LSCM or another potentially more effective strategy is the most suitable selection for a given context. Investigating the role of Industry 4.0 technologies in addressing uncertainty and facilitating LM implementation across the SC is another avenue that could be explored. Recent studies have examined the impact of emerging technologies on implementing various SC strategies and their benefits for organizational performance. However, exploring how these technologies help manage environmental uncertainty in SCs could further advance our understanding of this field. Such research could pave the way for integrating SCM strategies with technological innovations and offer new avenues to increase SC efficiency and competitiveness.

6. Conclusions

Summarizing, this study has established that supply uncertainty and strategic supplier performance are critical antecedents of LSCM and performance. Our findings reveal that supply uncertainty negatively influences LSCM implementation, while better strategic supplier performance results in a higher degree of LSCM implementation. This research contributes to the existing literature by clarifying the role of uncertainty and strategic supplier performance in implementing an efficiency-oriented SCM strategy such as LSCM. Our findings shed light on the influence of supply uncertainty on adopting LM principles along the SC and confirm the relevance of building strategic relationships with key suppliers to enhance performance and achieve competitive advantage.

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