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Escuela de Doctorado

TESIS DOCTORAL

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IMPACT OF LEAN SUPPLY CHAIN MANAGEMENT ON BUSINESS PERFORMANCE: THE ROLE OF THE CONTEXT

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To my family, for believing in me.

To you, for your invaluable support.

If one does not know to which port one is sailing, no wind is favorable — Seneca

It does not matter how slowly you go as long as you do not stop — Confucius

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Abstract

In recent decades, organizations have witnessed great changes in the environment that have led to an increase in the demands required to maintain a competitive position in the market, including the achievement of higher quality, reliability, flexibility, and customer satisfaction. The pursuit of greater efficiency and flexibility to meet these challenges, not only at the individual firm level but also at the supply chain level as a whole, is now a reality. In this sense, the extension of lean principles and practices along the supply chain (Lean Supply Chain Management – LSCM) can provide a competitive advantage in this changeable context. This doctoral thesis aims to contribute to the research on the impact of LSCM implementation on business performance. To achieve this purpose, a variety of methods from literature reviews to empirical studies have been used.

First, this thesis has enabled to map the literature on LSCM from a general perspective using bibliometric- and network-based analyses. This has provided novel literature classifications based on the identification of different research areas and topics related to the characteristics of the LSCM area of knowledge, the relationships between LSCM and other supply chain strategies, and some performance aspects. Next, a systematic literature review has characterized the extant research on LSCM-performance relationships, providing a more in-depth overview of this topic and its evolution. This systematic literature review provides a novel categorization of the literature into two main research lines: (1) LSCM performance-based models and (2) LSCM's impact on performance, and also detects research gaps and unexplored issues to be addressed empirically.

After mapping the literature on LSCM and analyzing the existing knowledge on LSCM and performance, this dissertation adopts an empirical approach based on the previously obtained knowledge. Therefore, it develops a two-stage Delphi study based on data provided by international scholars and managers with expertise in LSCM to propose a

LSCM performance assessment framework, which had been lacking according to the literature and which will facilitate the monitoring and evaluation of the application of lean principles throughout the supply chain, guiding managers to make the right decisions at the right time. Lastly, in line with the gaps identified in the previous stage, this thesis empirically constructs and validates theoretical models related to different aspects of the environment that may motivate the spreading of lean management from the focal firm to the entire supply chain using Structural Equation Modeling and hierarchical regression. In this line, the thesis addresses the driving power of technology uncertainty to motivate LSCM implementation and the improvement of operational performance and competitiveness; the impact of supply uncertainty and strategic supplier performance on LSCM implementation and its outcomes, and the role of the competitive intensity of the industry in the relationship between strategic supplier performance and LSCM implementation and its effect on focal firm operational performance. The academic and managerial implications of the results achieved from all these issues are provided and the challenges that research will have to address in the future within this field of research are identified.

Keywords lean supply chain management, bibliometrics, systematic literature review, performance measurement, technology uncertainty, supply uncertainty, competitive intensity, operational performance

Resumen

En las últimas décadas, las organizaciones han asistido a grandes cambios en el entorno que han propiciado el incremento de las exigencias requeridas para seguir manteniendo una posición competitiva en el mercado, que incluyen conseguir una mayor calidad, fiabilidad, flexibilidad y satisfacción del cliente. La carrera por alcanzar mayor eficiencia y flexibilidad para hacer frente a estos retos, no ya a nivel individual de empresa sino de cadena de suministro en su conjunto, es hoy en día un hecho constatado. En este sentido, la extensión de los principios y prácticas de la gestión *lean* a la cadena de suministro (Gestión *Lean* de la Cadena de Suministro, GLCS) puede proporcionar una ventaja competitiva en este contexto cambiante. En esta línea, esta tesis doctoral pretende contribuir a la investigación sobre el impacto que la implantación de la GLCS tiene en los resultados empresariales. Para lograr este propósito, se han utilizado diferentes métodos que van desde revisiones de la literatura hasta estudios empíricos.

Así, en primer lugar, esta tesis ha permitido mapear la literatura sobre GLCS desde una perspectiva general utilizando análisis bibliométricos y de redes, proporcionando nuevas clasificaciones de la literatura basadas en la identificación de diferentes áreas de investigación y temas relacionados con las características de la GLCS, las relaciones entre la GLCS y otras estrategias de cadena de suministro, y aspectos relacionados con los resultados. En segundo lugar, una revisión sistemática de la literatura ha caracterizado la investigación existente sobre las relaciones GLCS-resultados, proporcionando una visión más profunda sobre el conocimiento de esta cuestión de investigación y su evolución en el tiempo. Esta revisión sistemática de la literatura aporta una clasificación novedosa de la literatura que trata sobre la relación GLCS-resultados, clasificando los trabajos existentes en dos líneas de investigación principales: (1) Modelos basados en los resultados de GLCS y (2) Impacto de GLCS en los resultados, y detecta campos inexplorados y cuestiones que deben abordarse de forma empírica.

Una vez mapeada la literatura sobre GLCS y analizado el conocimiento existente sobre GLCS y resultados, esta tesis adquiere un enfoque empírico basado en el conocimiento previo adquirido. Así, se desarrolla un estudio Delphi en dos fases, basado en datos aportados por académicos y directivos internacionales expertos en GLCS, para proponer un marco de evaluación de los resultados de GLCS, del que se carecía según la literatura y que facilitará el seguimiento y la evaluación de la aplicación de los principios *lean* a lo largo de la cadena de suministro, guiando a los directivos para que tomen las decisiones adecuadas en el momento oportuno. Posteriormente, esta tesis construye y valida empíricamente modelos teóricos relacionados con diferentes aspectos del entorno, en línea con los *gaps* identificados en la fase anterior, que pueden motivar la expansión de la gestión *lean* desde la empresa focal a la cadena de suministro en su conjunto, utilizando Modelos de Ecuaciones Estructurales y regresión jerárquica. En esta línea, se aborda el poder impulsor de la incertidumbre tecnológica para motivar la implantación de GLCS y la mejora de los resultados operativos y la competitividad; el impacto de la incertidumbre en el suministro y de los resultados de los proveedores estratégicos sobre la implantación de la GLCS y sus resultados; y el papel que desempeña la intensidad competitiva de la industria en la relación entre los resultados de los proveedores estratégicos y la implantación de GLCS y su efecto sobre resultados operativos de la empresa focal. De todas estas cuestiones se aportan implicaciones académicas y de gestión de los resultados alcanzados y se identifican los desafíos que la investigación tendrá que atender en un futuro dentro de este campo de investigación.

Keywords gestión lean de cadena de suministro, bibliometría, revisión sistemática de literatura, evaluación de resultados, incertidumbre tecnológica, incertidumbre del suministro, intensidad competitiva, resultados operativos

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List of Acronyms

AI	Artificial Intelligence
ANP	Analytic Network Process
ASCM	Agile Supply Chain Management
AVE	Average Variance Extracted
BIM	Building Information Modeling
BSC	Balanced Scorecard
CATI	Computer-Assisted Telephone Interviewing
CFA	Confirmatory Factor Analysis
CI	Competitive Intensity
CNAE	National Classification of Economic Activities
COM	Competitiveness
CT	Contingency Theory
EFA	Exploratory Factor Analysis
ESCI	Emerging Sources Citation Index
ESG	Environmental, Social, and Governance
HRM	Human Resource Management
I4.0	Industry 4.0
IoT	Internet of Things
IT	Information Technologies
JCR	Journal Citation Report
JIC	Just in Case
JIF	Journal Impact Factor
JIT	Just in Time

KPI	Key Performance Indicator
LM	Lean Management
LSC	Lean Supply Chain
LSCM	Lean Supply Chain Management
MRO	Maintenance, Repair, and Overhaul
OM	Operations Management
OP	Operational Performance
PLS	Partial Least Square
PRC	People's Republic of China
RBT	Resource-Based Theory
RFID	Radio-frequency identification
ROA	Return on Assests
ROI	Return on Investment
ROS	Return on Sales
RQ	Research Question
SABI	Iberian Balance Sheet Analysis System
SC	Supply Chain
SCI	Supply Chain Integration
SCIE	Science Citation Index Expanded
SciMAT	Science Mapping Analysis software Tool
SCM	Supply Chain Management
SEM	Structural Equation Modeling
SLR	Systematic Literature Review
SME	Small and Medium Enterprise
SO	Specific objective
SSCI	Social Sciences Citation Index
SU	Supply Uncertainty
SUP	Srategic Supplier Performance
Sus-VSM	Sustainable Value Stream Mapping

TFN	Triangular Fuzzy Number
TPS	Toyota Production System
TQM	Total Quality Management
TU	Technology Uncertainty
US	United States
VIF	Variance Inflation of Verification
VSM	Value Stream Mapping
WoS	Web of Science

Introduction

This doctoral dissertation aims to contribute to the research on the impact of the implementation of lean management strategy along the supply chain on business performance by considering the influence of the supply chain context. To achieve this general purpose, several specific objectives have been established ranging from a broad mapping and characterization of the literature on this topic to the construction and validation of theoretical frameworks related to different aspects of the environment that may motivate the spread of lean management from the focal firm to the supply chain as a whole.

This introductory section is organized as follows. First, a review of the theoretical background in which the work is framed is provided together with a justification of the need to investigate and deepen the different issues addressed by this doctoral dissertation. Then, the specific objectives of this work are established and the research design necessary to achieve these goals is detailed. Finally, the structure of the research in this dissertation is presented.

I. Research background

Nowadays, organizations seek to improve their efficiency and flexibility to successfully meet major market challenges and maintain their competitiveness. At the same time, the way of competing has evolved from the level of the individual firm to the level of the supply chain (SC) as a whole. The relentless pursuit of higher quality, reliability, flexibility, and customer satisfaction has led companies and SCs to consider implementing management strategies that will enable them to achieve the desired results (Ding et al., 2021).

In this context, the lean strategy has proven to provide the firm with important benefits in terms of efficiency and flexibility (Womack & Jones, 1996) and its adoption by SC members is a relevant factor in the potential

improvement of performance (Lamming, 1996). Emerging during the 20th century within the Japanese Toyota Motor Corporation and its Toyota Production System (TPS) (Holweg, 2007), lean began to gain popularity as a production system to compete with western systems with the publication of the book entitled *The Machine That Changed The World* by Womack et al. (1990) (Samuel et al., 2015).

In the late 1990s, the term *lean*, coined by Krafick (1988) and associated with a production system that used less of everything compared to mass production (Womack et al., 1990), began to be conceived more as a philosophy or way of thinking (Womack & Jones, 1996) and as an accepted operations management strategy (Hines et al., 2004). However, up to the present day, many authors have stated that there is no clear definition of lean (Bhamu & Sangwan, 2014), apart from which, interpretations of lean have also evolved (Samuel et al., 2015).

Lean Management (LM) consists of a reduction of non-value-adding activities with the aim of improving organizational performance and gaining a competitive advantage (Womack & Jones, 1996). Originally envisioned as a production system focused on eliminating waste and reducing variability on the shop floor of vehicle manufacturers, LM has evolved into a more wide-ranging management system that includes other functional areas in the organization and non-manufacturing firms and has extended its activities and objectives to both an internal and an SC perspective (Hines et al., 2004; Lamming, 1996; Shah & Ward, 2007). Moreover, there has also been a recent discussion as to whether lean is, in fact, a theory, with different expert viewpoints on the role of theory in lean research and practice (Åhlström et al., 2021).

A lean supply chain (LSC) can be defined as a set of enterprises directly connected by product, service, information, and financial flows working together upstream and downstream to reduce costs and waste and meet the needs of individual customers (Lamming, 1993; Reichhart & Holweg, 2007). The key to adopting LM and making progress in its implementation is for each member of the SC to adopt lean internally and then move forward to achieve lean goals at the SC level (Moyano-Fuentes et al., 2021). In other words, lean principles and practices need to be applied throughout the SC to optimize all activities from the end customer's point of view and eliminate waste, improve quality, reduce

costs, and increase efficiency and flexibility throughout the chain. This is known as Lean Supply Chain Management (LSCM) (Swenseth & Olson, 2016).

LSCM strategy differs from other kinds of SC strategies such as agile (Qamar et al., 2018; Qrunfleh & Tarafdar, 2013; Zimmermann et al., 2020), for example, which is more associated with market sensitivity, responsiveness, and adaptability (Ben Naylor et al., 1999; Tarafdar & Qrunfleh, 2017). The extant literature has frequently addressed the study of both strategies focusing on their similarities, divergences, and trade-offs (Qamar et al., 2018). Some authors have argued that LSCM is advisable with predictable and stable demand and low product variety (Christopher, 2000; Qi et al., 2011) focused on a mid-term response to changes in the environment, while agile supply chain management (ASCM) is preferred in contexts characterized by higher demand and supply uncertainties (H. L. Lee, 2002) where a short-term response is needed. Nevertheless, both strategies share the aim to meet customer demand at the lowest total cost (Goldsby et al., 2006) and achieve flexibility and/or agility along the SC (Moyano-Fuentes et al., 2019). Although conceptually it is clear what an LSC is, until relatively recently there had been no accepted measure to determine the degree of lean implementation in the SC (Moyano-Fuentes et al., 2019).

As can be observed, the relevance of performance outcomes and assessment in any supply chain management (SCM) strategy is indisputable. Past empirical evidence has shown that LSCM significantly improves performance (Moyano-Fuentes et al., 2021; Tortorella et al., 2017), yet some inconclusive findings can be found in the literature (Danese et al., 2012; Fearne & Fowler, 2006; Tortorella et al., 2018). As already stated by some authors, the lack of a clear understanding of lean and performance management relationships can hinder lean implementation and lead to conflicting results (Sangwa & Sangwan, 2018b). Since the main purpose of LSCM is to reduce waste and achieve greater efficiency, one core aspect of this strategy is its impact on performance. In fact, recent research has confirmed that a suitable performance measurement system can foster lean implementation (Akmal et al., 2022; Zanon et al., 2021). For this reason, it is essential to evaluate the research dealing with this issue (Berger et al., 2018; Jasti & Kodali,

2015a) to advance development in the field. Furthermore, additional empirical studies are required on the impact of LSCM on performance to move forward the knowledge on the benefits of extending LM along the SC in different contexts.

A. Literature review: antecedents

After several years of prolific investigation in the area of LSCM, the previous research has reviewed the literature on this topic with different objectives. Some authors have analyzed this topic conceptually from a general point of view (Jasti & Kodali, 2015a; Ugochukwu et al., 2012), while others have put the focus on certain aspects of LSCM such as practices, barriers, and contextual factors (Berger et al., 2018), and one particular sector, healthcare (Borges et al., 2019; Khorasani et al., 2020). Additionally, some authors have dealt with the relationships between internal and external LM and sustainability (Martínez-Jurado & Moyano-Fuentes, 2014), the interrelationships between LSCM and other SC strategies (Ciccullo et al., 2018), and the existing relationships between Industry 4.0 information technologies and LSCM (Núñez-Merino et al., 2020; Oliveira-Dias et al., 2022). As can be observed, there are numerous literature reviews that have decided to pool the existing knowledge on specific aspects of LSCM by examining the extant literature.

Although all of these studies provide valuable information about the state-of-the-art of LSCM, an additional analysis of the literature using rigorous bibliometric methods can provide further insights not previously evaluated in other reviews to construe the elements of LSCM as a multidimensional concept. Bibliometric studies are mainly used to evaluate research results and contribute to determining the progress achieved, the results obtained by academia, the most reliable sources of scientific publications, the most prominent scientific actors, and the evolution of research in the area, among others (Cobo et al., 2011a). This approach has been used successfully in the past in both the SCM field (Ben-Daya et al., 2019; Fahimnia et al., 2015; Kazemi et al., 2018; Mishra et al., 2018; Xu et al., 2018) and the LM area (Ciano et al., 2019; Filser et al., 2017; Pinho & Mendes, 2017; Redeker et al., 2019).

Similarly, the identification of the most influential works on LSCM can offer relevant and valuable information about the research lines most prioritized by the scientific literature. According to Garfield (1979), the more often a paper is cited, the greater its influence in the field. Therefore, highly cited papers can be considered relevant in the development of a research field as they have attracted the interest of the scientific community (Moral-Munoz et al., 2016). Citation classics (or highly cited papers in a field) offer a panoramic summary of the articles that have received the greatest interest from researchers in a given field of study, so they can be considered the basis of that area of knowledge (Martínez et al., 2014). Consequently, a comprehensive overview of the research on LSCM was essential to provide a scientific landscape map capable of supporting exploration and description of the state and development of scientific knowledge on LSCM.

Despite the fact that LSCM research has been reviewed by numerous authors who have focused their attention on different aspects (Ciccullo et al., 2018; Khorasani et al., 2020; Núñez-Merino et al., 2020), there was no work to date that reviewed all the knowledge about the relationships between LSCM implementation and business performance. The relevance of this relationship has already been mentioned in this section. Given the large number of publications that have studied the effects of LSCM on performance, a more detailed literature review is required that encompasses these issues and allows academics and practitioners to identify the current state of the research. This study would be especially relevant for understanding the comprehensive research efforts focused on the relationship between LSCM and performance.

B. Theoretical framework

While it is important to measure the performance derived from LSCM, the use of inappropriate monitoring and control systems for these results can lead organizations to question whether the transformation to LSCM is worthwhile, with the consequent lack of motivation in the transformation process and its failure. Some authors have highlighted the lack of a systematic understanding at the intersection of lean and performance management (Bellisario & Pavlov, 2018), while others emphasize that the absence of a clear understanding of lean performance assessment and the

nonavailability of appropriate performance measures have led to conflicting results from lean implementation (Sangwa & Sangwan, 2018a). Performance assessment is decisive for evaluating the success of LM implementation. In this line, recent studies have affirmed that an appropriate performance measurement system can have a great impact on the adoption and implementation of lean practices (Akmal et al., 2022; Zanon et al., 2021). The use of a structured performance measurement design process has been found to overcome many of the implementation obstacles highlighted in the literature, such as the strategy and vision being unfeasible and poorly defined metrics (Bourne et al., 2002).

Some previous works have proposed assessment frameworks for evaluating LM performance along the SC, but they have been broader and not oriented toward assessing the outcomes of LSCM alone but in combination with other SC strategies (Agarwal et al., 2006; Carvalho et al., 2011; Duarte & Cruz-Machado, 2015; Kainuma & Tawara, 2006; Thanki & Thakkar, 2018). In addition, there was no consensus in the literature on the elements, principles, and practices that make up an LSC until recently, when a validated measure able to assess the level of LSCM implementation was provided (Moyano-Fuentes et al., 2019), thus enabling to investigate its impact on performance. Consequently, scarce attention had been paid to the singularities of LSCM itself, which prevented the value derived from coordination initiatives involving the application of lean principles, practices, and tools throughout the SC from being captured. Therefore, it was essential to develop a system that allows the results achieved with LSCM to be evaluated concretely and gives practitioners the control required to achieve the expected benefits from the implementation of LM principles, practices, and techniques by SC members.

Furthermore, it becomes necessary to identify the strategic drivers that can stimulate firms to extend the LM principles and practices along the SC in search of performance improvements and greater competitiveness. The study of these issues could shed light on the dimensions of LSCM and provide valuable information that enables a better understanding of the benefits of LSCM and demonstrates the best way to evaluate them. The preceding literature has found a series of drivers and enablers to extend LM along the SC. Qi et al. (2011) demonstrated that

cost leadership strategy leads to LSCM irrespective of the level of uncertainty, while Zimmerman et al. (2020) explored the role of SC complexity/dynamism and product characteristics in the implementation of LSCM. Yildiz Çankaya (2020) investigated the role of strategic sourcing in developing a lean SC. More recently, Moyano-Fuentes et al. (2021) focused on internal lean implementation as a driver of LSCM.

As can be observed, a few contextual elements of the firm and the SC have been proven to influence the decision of adopting LSCM. However, the understanding of the potential advantages of adopting LSCM is still limited, which has resulted in deficiencies in LSCM implementation (Jasti & Kodali, 2015b) and undesired outcomes (Swenseth & Olson, 2016). Additionally, although some performance outcomes of LSCM implementation have already been addressed empirically (Moyano-Fuentes et al., 2019, 2021), the inclusion of the context in which the SC operates may provide additional insights into the drivers of LSCM implementation.

At the SC level, the interest in understanding the context in which the SC operates has been emphasized so that it can be managed appropriately (Ketchen & Hult, 2007). Some authors have stated that the choice of the SC strategy is determined by the uncertainty of the environment in which firms compete (Salam et al., 2017; Zimmermann et al., 2020). Uncertainty has been considered a significant phenomenon intrinsically connected to the most varied of organizations' activities (Courtney et al., 1997; López-Gamero et al., 2011; Wernerfelt & Karnani, 1987) and an inherent condition of inter-organizational interactions (Miller, 1987). As environmental uncertainty appears to be a fundamental challenge for organizations (Thompson, 1967) and SCs, several studies have included it as a critical driver of SCM (Chen & Paulraj, 2004; Zimmermann et al., 2020).

Environmental uncertainty involves the inability to determine the likelihood of future events and to accurately predict the consequences of decisions (Beckman et al., 2004; Downey et al., 1975), which introduces variability at the firm and SC levels. According to Qi et al. (2011), environmental uncertainty plays a major role in the choice of SC strategy and makes it necessary to increase the understanding of uncertainty in the SCM domain, given the inconclusive findings reached (Flynn et al., 2016).

Thus, the context in which the SC operates may determine the selection of the best SC strategy. Persson (1995) stated that the greater the uncertainty associated with a process, the more waste there will be in the system. In this line, the variability and unpredictability of the context in which the firm and the SC operate may influence the implementation of a strategy such as LSCM in order to face up to this challenge and remain competitive.

Different sources of environmental uncertainty have been addressed by the extant literature (Chen & Paulraj, 2004; Zimmermann et al., 2020). In recent years, technological change and, specifically, the emergence and meteoric development of Industry 4.0 (I4.0) has shaken up the traditional idea of competition and further emphasized the role of the SCM strategy in achieving competitive advantages. Technology uncertainty measures the extent of evident technological changes in industry (Chen & Paulraj, 2004) and involves significant challenges to manufacturers as rapid changes in product and/or process standards and specifications can disrupt the smooth flow of materials in extended SCs (Xiao et al., 2019). In a context characterized by increased competition and rapidly evolving production and information technologies, technology uncertainty can drive the implementation of SC strategies such as LSCM which are oriented toward achieving efficient and stable processes.

Another source of uncertainty that plagues SCs is supply uncertainty arising from deficiencies in on-time performance, average lateness, and degree of inconsistency (Chen & Paulraj, 2004; Davis, 1993). Supply uncertainty generally reduces a supplier's ability to meet buyer requirements due to the increased likelihood of product and service shortages, supplier delivery delays, and even potential supply disruptions (Feng et al., 2019; Li et al., 2017) impacting relational investments and the resulting performance (Liu et al., 2021). Recently, the COVID-19 crisis has shown that cooperation with SC partners can facilitate coordination between a wide range of stakeholders to respond to supply disruptions. In this light, it could be expected that supply uncertainty in the SC context can encourage the extension of LM adoption among the SC members as a tool to reduce variability and unreliability.

Lastly, the presence of high competitive pressures in the industry in which the SC operates and the repercussions of the competition's behavior can influence not only firm strategy and performance (Hallgren

& Olhager, 2009; Qi et al., 2011) but also SC partners' decisions and outcomes (S. M. Lee & Rha, 2016). Competitive intensity can be understood as the power that an organization has on other firms' survival chances (Barnett, 1997) and is likely to persuade firms to adopt several strategies to strengthen their position (Burgers et al., 1993). Therefore, the competitive intensity of the industry can motivate the SC members to defend themselves against a hostile environment by implementing lean principles along the SC.

II. Research objectives

This doctoral dissertation aims to provide an overview of the LSCM field to date, focusing on analyzing the LSCM-performance relationships deeply. Additionally, it intends to propose a performance measurement framework to evaluate LSCM performance while empirically studying the influence of contextual drivers that could affect LSCM-performance relationships such as environmental uncertainty and strategic supplier performance. In this regard, the following specific objectives (SOs) have been established:

SO1. To map the research on the LSCM field from a general point of view. The objective is to analyze the attributes of the literature in the field, the most prestigious and highest contributing actors, the main lines of research addressed by the scientific community, and the current and future trends in this area of knowledge.

SO2. To characterize the existing research on the interrelationships between LSCM and performance. The purpose is to examine the current findings regarding the relationships between LSCM and different dimensions of business performance and provide a novel classification of this literature.

SO3. To provide a performance measurement framework to evaluate the results derived from LSCM implementation.

SO4. To empirically research the impact of technology uncertainty in LSCM implementation and the latter's contribution to operational performance and competitiveness.

SO5. To empirically investigate the role that supply uncertainty and strategic suppliers play in LSCM implementation and focal firm performance.

SO6. To empirically study the influence exerted by strategic external drivers in LSCM implementation and its effect on performance.

III. Research design

The research methods adopted to achieve the above mentioned objectives can be structured into two different parts. Part I pursues to theoretically characterize and establish the state-of-the-art of LSCM research from a broad perspective, and then focus on LSCM-performance relationships in detail. Bibliometric and network analyses, citation classics, and the Systematic Literature Review (SLR) have been used to address SO1 and SO2 through literature reviews. The accomplishment of SO1 and SO2 in Part I enables to identify particular aspects to be addressed by the research on this topic and to determine the issues that need to be dealt with empirically to advance the knowledge in this field. Then, Part II investigates and empirically analyzes a variety of key aspects identified in the previous part. Fuzzy Delphi and Fuzzy DEMATEL, Structural Equation Model (SEM), and hierarchical regression analysis are the methods used to accomplish SO3, SO4, SO5, and SO6 through empirical studies. Figure I describes the research design followed.

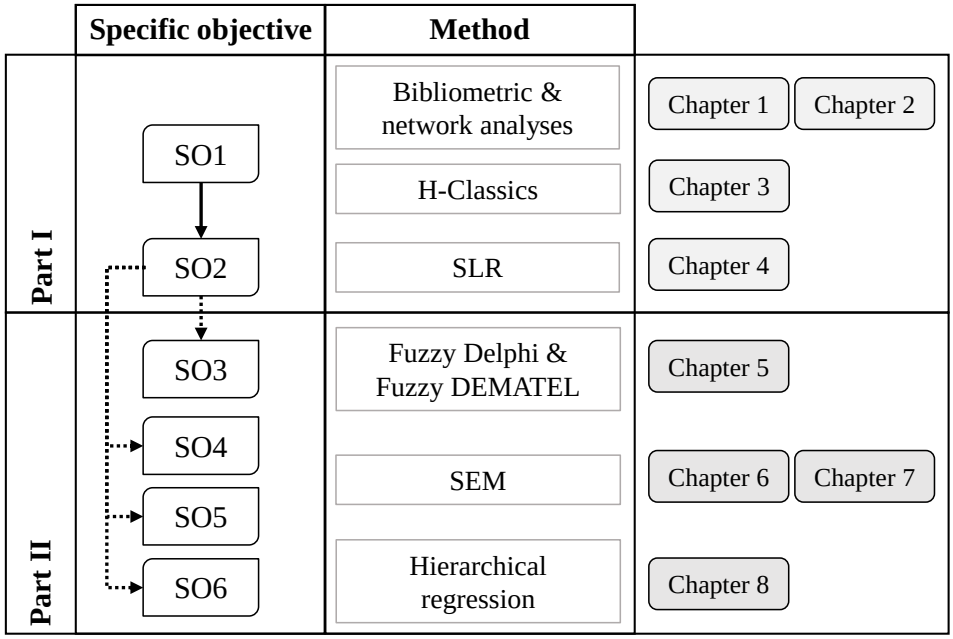

Figure I. Research design

Three bibliometric analyses have been carried out to achieve SO1: a study focused on the longitudinal evolution of LSCM from 1996 to 2018 using SciMAT software; a work focused on network analysis of LSCM up to 2020 using BibExcel and VOSviewer software, and a study combining citation classics and network analysis of the LSCM field using the H-Classics method and SciMAT and VOSviewer software. The SciMAT software tool (Cobo et al., 2012) was used to identify topics in a longitudinal science mapping analysis (Cobo et al., 2011a, 2011b) based on co-word bibliographic networks. BibExcel (O. Persson et al., 2009) was used to perform the bibliometric and statistical analyses and to prepare the input data for an additional network analysis in VOSviewer. VOSviewer (van Eck & Waltman, 2014) was then used to generate graphs of the bibliographic material, collect data and generate maps and different types of bibliographic data-based analyses: co-authorship, co-occurrence, citation, bibliographic counting, and co-citation.

An SLR was performed to achieve SO2, the identification and classification of the research conducted on the relationships between LSCM and business performance. For this, the method proposed by Tranfield et al. (2003) was chosen. This consists of five stages aimed to ensure that the review process is reproducible, scientific, and transparent, so all existing information on a given topic can be synthesized in a complete and unbiased manner (Denyer & Tranfield, 2009; Tranfield et al., 2003): question formulation, location of studies, study selection and evaluation, analysis and synthesis, and reporting of the results. This methodology was complemented by the guidelines established to develop a rigorous SLR in the Operations Management (OM) field (Thomé et al., 2016) and SCM domain (Durach et al., 2017) and to ensure the reliability and validity of the results. This literature review closes Part I with SO1 and SO2 having been duly concluded, and enables to carry out Part II through the investigation of empirical issues derived from the studies included in the previous part in order to meet SO3, SO4, SO5, and SO6.

A two-stage Delphi study was used to achieve SO3. The study was based on data collected from international academics and practitioners with expertise in LSCM and using Fuzzy Delphi and Fuzzy DEMATEL methods to refine the most relevant goals and metrics and their interrelationships. Fuzzy Delphi and Fuzzy DEMATEL were chosen since the fuzzy logic theory (Zadeh, 1965) addresses any lack of precision and incorporates the uncertainty of human decision-making behavior, thus reducing the gap between theory and reality (Caiado et al., 2021). The Fuzzy Delphi method combines fuzzy set theory and the traditional Delphi technique to improve the proficiency of expert judgment, while the Fuzzy DEMATEL method was used to convert the cause-effect relationships into an intelligible model.

Regarding the empirical studies in SO4, SO5, and SO6, a database developed in the framework of a Spanish Ministry of Science and Innovation-funded research project was used. Said database was compiled from a survey addressed to a population of 2,660 industrial companies with more than 50 workers that occupy an intermediate position in the SC. To accomplish SO4 and SO5, covariance-based SEM was used through EQS 6.4 software. Covariance-based SEM was preferred to variance-based SEM (e.g., Partial Least Squares – PLS) due to its parameter accuracy.

Hierarchical linear regression was used through SPSS software to achieve SO6. Thus, this doctoral dissertation collects two of the most used and suitable empirical study methodologies to analyze and interpret data in the field of OM.

IV. Dissertation structure

This doctoral dissertation is structured as follows. The present section provides the Introduction, specifying the motivation and antecedents of this research, the proposed objectives, and the methods used to accomplish them.

Part I presents a series of literature reviews. Chapters 1, 2, and 3 provide bibliometric studies on the LSCM field. More specifically, Chapter 1 (Garcia-Buendia, Moyano-Fuentes, Maqueira-Marín, et al., 2021) examines how research on LSCM has evolved over the period 1996-2018 with the identification of the main issues explored. In this chapter, a research map on LSCM is developed using SciMAT, with the LSCM literature analyzed from a longitudinal perspective focusing on different time periods. However, this study was carried out when the field was receiving growing interest from the scientific community and experiencing a significant increase in the number of publications, so new trends may well have appeared since then. Therefore, Chapter 2 (Garcia-Buendia, Moyano-Fuentes, & Maqueira-Marín, 2021b) presents a comprehensive analysis of the LSCM literature up to 2020 to understand the influence, basic research characteristics, interrelationships, and productivity in this area of knowledge over the last few years of research. For this, VOSviewer software was used. Chapter 3 (Garcia-Buendia et al., 2022) focuses on the most influential works on LSCM and provides a citation classics study that systematically identifies the most significant intellectual developments in the LSCM field and an analysis of how these have evolved over time. Examining and analyzing the most influential articles was required since the insights provided by these documents have already been recognized and highlighted by the scientific community. Although the LSCM literature since 1996 had been widely analyzed, there had been no study that identified the most influential contributions with a view to

understanding the most relevant research on LSCM. Chapter 4 (Garcia-Buendia, Moyano-Fuentes, & Maqueira-Marín, 2021a) identifies and analyzes the studies that focus on LSCM and performance interrelationships and proposes a novel classification of the associated literature. This study facilitates the analysis of this issue and pinpoints gaps in the existing literature, thus providing valuable information on any research lines that need to be developed or expanded in the future, some of which are investigated in Part II of this doctoral dissertation.

Part II offers the empirical works studied in this dissertation. Chapter 5 identifies the most relevant LSCM goals and performance measures and proposes a performance measurement framework that aligns the two dimensions of an organization's strategy, i.e., strategic objectives and operational level measures in a balanced scorecard to evaluate LSCM performance. Chapter 6 uses SEM to study the driving power of technology uncertainty to motivate LSCM implementation and the latter's impact on operational performance and firm competitiveness. Chapter 7 researches the role of supply uncertainty and strategic supplier performance in the implementation of LSCM and the resulting performance using SEM. Chapter 8 researches the moderating role of competitive intensity of the industry in the relationships between strategic supplier performance and LSCM implementation, and the potential effect on focal firm operational performance using hierarchical regression analysis.

Finally, the Conclusions section gives the main conclusions of this dissertation, the work's limitations, and some directions for further research.

Figure II presents a graphical representation of the abovementioned research structure.

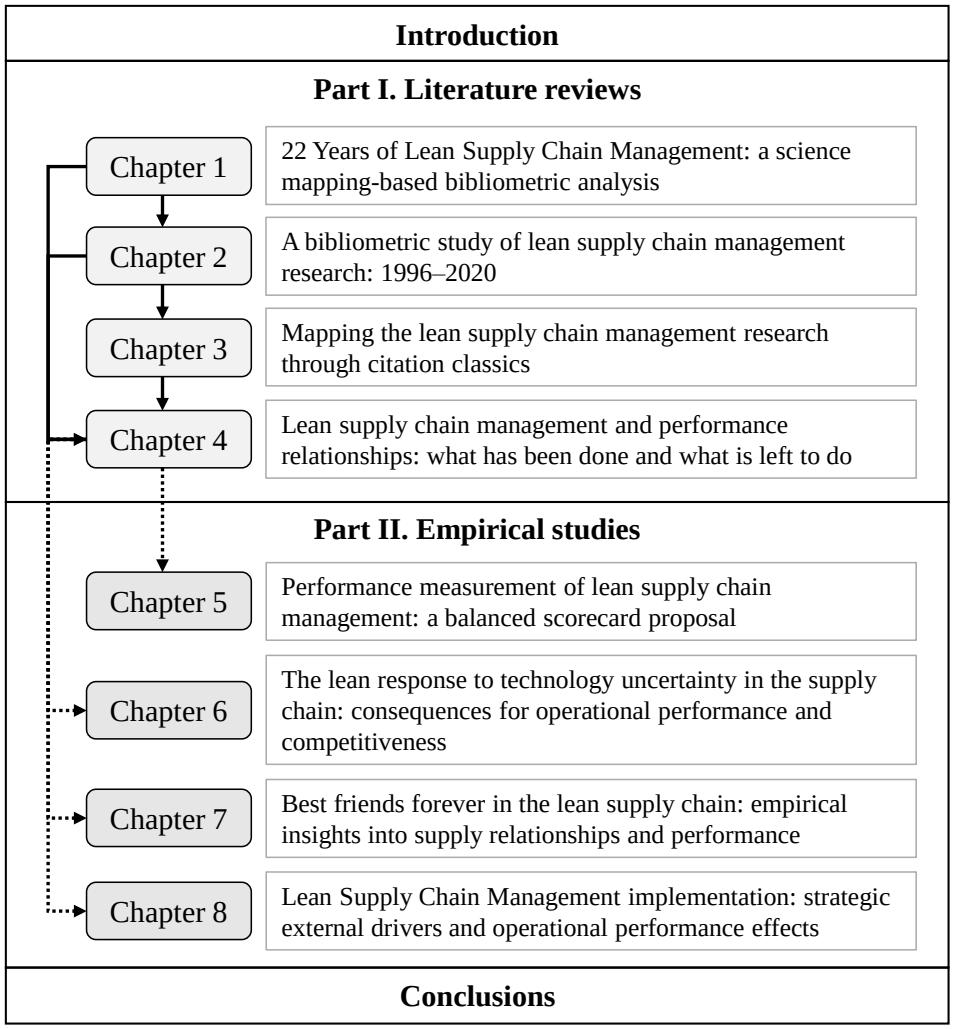

Figure II. Research structure

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Chapter 1

22 years of Lean Supply Chain Management: a science mapping-based bibliometric analysis

Contribution

Garcia-Buendia, N., Moyano-Fuentes, J., Maqueira-Marín, J. M., & Cobo, M. J. (2021). 22 Years of Lean Supply Chain Management: a science mapping-based bibliometric analysis. *International Journal of Production Research*, *59*(6), 1901–1921. https://doi.org/10.1080/00207543.2020.1794076

Abstract

This article examines how the research into Lean Supply Chain Management (LSCM) has evolved over the period 1996-2018 with the identification of the main issues explored and future trends. A performance bibliometric analysis has been conducted through a study of published documents, citations, journal impact factor, h-index, most cited papers and authors, and data on the geographic distribution of publications. More relevantly, a science mapping analysis has been performed with SciMAT bibliometric analysis software using co-word networks in a longitudinal overview. The large number of studies of LSCM published has enabled a conceptual evolution map to be constructed of the way that this research has developed. The results have enabled us to identify four thematic areas in the LSCM field: Methods, Key factors, Internal efficiency, and Performance.

Keywords lean supply chain management, bibliometrics, science mapping, citations, co-word analysis, state-of-the-art

Chapter 2

A bibliometric study of Lean Supply Chain Management research: 1996-2020

Contribution

Garcia-Buendia, N., Moyano-Fuentes, J., & Maqueira-Marín, J. M. (2021). A bibliometric study of lean supply chain management research: 1996–2020. *Total Quality Management & Business Excellence*, 1–24. https://doi.org/10.1080/14783363.2021.2007071

Abstract

Lean Supply Chain Management is an emerging research field in Operations Management that is attracting growing attention from researchers and practitioners. This paper aims to present a comprehensive analysis of the Lean Supply Chain Management literature to understand the influence, basic research characteristics, interrelationships, and productivity of the research in this field. The present study uses BibExcel and VOSviewer software to conduct thorough bibliometric and network analyses of 715 papers published in the Web of Science database over the period 1996-2020. The use of bibliometric methods has enabled the identification of current and emerging research clusters to detect some key research topics, interrelations, and collaboration patterns. Moreover, this analysis has enabled to draw numerous conclusions and propose a roadmap for future research in the field. This paper, therefore, provides some new insights not previously evaluated in other reviews of Lean Supply Chain Management that can help researchers to understand the evolution of research trends through a proposed classification of the literature on this topic.

Keywords lean supply chain management, bibliometrics, network analysis, citation, literature review

Chapter 3

Mapping the Lean Supply Chain Management research through Citation Classics

Contribution

Garcia-Buendia, N., Moyano-Fuentes, J., & Maqueira, J. M. (2022). Mapping the lean supply chain management research through citation classics. *International Journal of Lean Six Sigma*, *13*(2), 428–456. https://doi.org/10.1108/IJLSS-01-2021-0006

Abstract

Purpose. The purpose of this paper is to systematically identify the key intellectual developments of the Lean Supply Chain Management (LSCM) field from its very first beginning by analyzing the publications that have been highly cited.
Design/methodology/approach. The Citation Classics method has been used to examine the origins and evolution of the research field. Seventy-four articles have been identified as having the highest impact on LSCM research published from its beginnings to the present day. Key aspects and links among the scientific contributions are studied by descriptive, bibliometric, network, and content analyses.
Findings. Publication and citation trends, methodologies used, top journals, most influential authors, institutions, and countries, collaboration patterns, and evolution of the most used keywords are some of the aspects studied. Three main research areas are identified: (1) LSCM foundations and implementation, (2) Lean-agile supply chain and performance assessment, and (3) The role of sustainability, which offer a holistic view of the field and enable the identification of potential avenues for future research susceptible to contribute to advancing the knowledge on LSCM.
Originality. This study provides a useful insight into the development of

the LSCM field and can help researchers as it explores the state-of-the-art of LSCM by identifying the most relevant contributions in the area, the main research lines addressed by the scientific community in this topic, and opportunities for further research on LSCM for years to come.

Keywords lean supply chain management, bibliometrics, citation classics, h-index, network analysis

Chapter 4

Lean Supply Chain Management and performance relationships: what has been done and what is left to do

Contribution

Garcia-Buendia, N., Moyano-Fuentes, J., & Maqueira-Marín, J. M. (2021). Lean supply chain management and performance relationships: what has been done and what is left to do. *CIRP Journal of Manufacturing Science and Technology*, *32*, 405–423. https://doi.org/10.1016/j.cirpj.2021.01.016

Abstract

This paper presents a systematic literature review (SLR) of the current knowledge about Lean Supply Chain Management (LSCM) and performance relationships. The purpose is to identify the studied aspects set and to propose a novel classification of the literature on LSCM and performance relationships and to discuss the conceptual and empirical evidence that identifies existing interrelationships. The analysis has enabled two research lines to be addressed: (a) LSCM performance-based models, and (b) LSCM's impact on performance. These findings allow us to identify gaps in the literature and to determine directions for future research.

Keywords lean supply chain management, performance, systematic literature review, content analysis, future research directions

Chapter 5

Performance measurement of lean supply chain management: a balanced scorecard proposal

Contribution

Garcia-Buendia, N., Kristensen, T. B., Moyano-Fuentes, J., & Maqueira-Marín, J. M. (2022). Performance measurement of lean supply chain management: a balanced scorecard proposal. *Production Planning and Control*, in press. https://doi.org/10.1080/09537287.2022.2114960

Abstract

The purpose of this paper is to propose a performance measurement framework to evaluate Lean Supply Chain Management (LSCM) performance. A literature review was performed to identify the main goals and performance indicators in LSCM. A questionnaire was designed that included the identified goals and measures. Next, based on data collected from international academics and practitioners with expertise in LSCM, a two-stage Delphi study using Fuzzy Delphi and Fuzzy DEMATEL methods was carried out to refine the most relevant goals and metrics and their interrelationships and establish benchmark values that are useful for managers to evaluate the performance achieved through the deployment of lean principles, practices, and techniques throughout the supply chain. Finally, an integrated performance measurement framework based on the balanced scorecard approach is proposed with a discussion of the academic and practical implications of the proposed framework.

Keywords lean supply chain management, balanced scorecard, performance measurement, fuzzy Delphi

Chapter 6

The lean response to technology uncertainty in the supply chain: consequences for operational performance and competitiveness

Contribution

Garcia-Buendia, N., Moyano-Fuentes, J., Maqueira-Marín, J. M., & Avella, L. (2022). The lean supply chain management response to technology uncertainty: consequences for operational performance and competitiveness. *Journal of Manufacturing Technology Management, 34*(1), 67–86. https://doi.org/10.1108/JMTM-07-2022-0250

Abstract

Purpose. This study aims to analyze the Lean Supply Chain Management (LSCM) strategy's role as a mechanism to address technology uncertainty and provide organizations with a competitive advantage.
Design/methodology/approach. An empirical study was conducted of 276 Spanish focal firms in industrial sectors that occupy an intermediate position in the supply chain to investigate the influence of technology uncertainty on LSCM implementation and the latter's effect on operational performance and competitiveness. A structural equation model (SEM) was used to test the hypotheses.
Findings. Technological uncertainty encourages progress in the implementation of lean throughout the supply chain and so is a mechanism that not only brings stability to the focal company but also improves its performance and puts it in a better competitive position.
Practical implications. Managers are suggested to consider the strategic integration with supply chain partners and establishment of long-term relationships based on trust and commitment advocated by LSCM to enhance organizations' capabilities and effectively and flexibly respond to technological changes.

Originality. This study focuses on the effects of environmental uncertainty on the supply chain. The past literature has focused on the behavior of individual firms to deal with uncertainty but this work shifts the level of analysis to the supply chain. As such, the strategic change to deal with what is happening in the environment is now switched to the supply chain level.

Keywords lean supply chain management, technology uncertainty, operational performance, competitiveness, structural equation model

Chapter 7

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

Contribution under review

Garcia-Buendia, N., Moyano-Fuentes, J., & Maqueira-Marín, J. M. (NA). Building bridges in uncertain times: supply relationships, lean management, and performance. Under review in the *International Journal of Lean Six Sigma*.

Abstract

Purpose. This study aims to investigate the influence of the supply relationships' context of the focal firm in the implementation of the Lean Supply Chain Management (LSCM) and its performance outcomes. For this, supply uncertainty and strategic supplier performance are addressed in relation to LSCM implementation and focal firm performance.
Design/methodology/approach. An empirical study was conducted of 285 Spanish industrial focal firms to investigate the role of supply uncertainty and strategic supplier performance in LSCM implementation and operational performance. A covariance-based structural equation model analysis was used to test a theoretical model made up of four hypotheses.
Findings. Our results suggest that supply uncertainty and strategic supplier performance are drivers for the focal firm moving forward with the extension of lean principles and practices along the whole supply chain. While our findings support the positive role of strategic supplier performance in making progress in LSCM implementation, they also show that LSCM implementation should not proceed in times of supply uncertainty. Finally, our study demonstrates that greater level of LSCM implementation and better performance from key suppliers are important

drivers for focal firms' operational performance.
Originality. This research provides novel insights into the drivers for LSCM implementation by adopting a contingency and relational perspective and focusing on the supply relationships' context.

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

Chapter 8

Empirical insights into lean supply chain management and strategic supply relationships in a competitive context

Contribution

Garcia-Buendia, N., Moyano-Fuentes, J., Maqueira-Marín, J. M., Romano, P., & Molinaro, M. (2023). Strategic supplier performance in a competitive landscape: Enhancing organizational performance through lean supply chain management. *BRQ Business Research Quarterly*, in press. https://doi.org/10.1177/23409444231210566

Abstract

In a context characterized by increasing competitive pressure, supply chain collaboration has gained greater relevance and lean principles have been integrated into supply chain management to address the challenge of achieving better organizational performance. The purpose of this study is to understand the roles of strategic supplier performance and competitive intensity in Lean Supply Chain Management (LSCM) implementation and its performance. We use a variance-based Structural Equation Model analysis with empirical data from a sample of 273 Spanish companies to analyze the relationships among strategic suppliers, competitive intensity, LSCM implementation, and performance. Our findings indicate that strategic supplier performance is positively associated with LSCM implementation and that this relationship is heightened in highly competitive industries. Our results also reveal the indirect association of LSCM implementation in the strategic supplier performance-organizational performance relationship.

Keywords lean supply chain management, competitive intensity, strategic supplier, operational performance, structural equation model

Conclusions

This doctoral dissertation contributes to the research on the impact of LSCM implementation on business performance by considering the influence of the SC context. This study has characterized and classified the research in the LSCM field from a general perspective and provided a more in-depth overview of the research on LSCM-performance relationships. Additionally, this dissertation provides a balanced scorecard to evaluate the results derived from LSCM, which had been lacking in the literature until now and which facilitates the monitoring and evaluation of the application of lean principles throughout the SC by guiding managers to make the right decisions at the right time. Lastly, the present dissertation empirically confirms different drivers of LSCM implementation related to strategic aspects of the context in which the firm and SC operate.

The main insights and contributions of this doctoral dissertation are given, followed by research and managerial implications, limitations, and future research directions.

I. Main contributions

This section set out the main contributions of the doctoral dissertation. Regarding Part I, Chapters 1, 2, and 3 cover SO1 by using bibliometric- and network-based analyses to provide an overview of the LSCM field, while Chapter 4 digs deeper into the interrelationships between LSCM and business performance in the extant literature to cover SO2. Concerning Part II, Chapter 5 covers SO3 through the proposal of a balanced LSCM scorecard, an issue that had not been addressed in the literature despite being recognized as necessary; Chapter 6 covers SO4 by researching the driving power of technology uncertainty to motivate LSCM implementation and the latter's effect on operational performance and competitiveness; Chapter 7 investigates the impact of supply uncertainty

and strategic supplier performance on LSCM implementation and operational performance to cover SO5, and Chapter 8 covers SO6 by focusing on the role of the competitive intensity of the industry in the relationship between strategic supplier performance and LSCM implementation.

SO1 is related to mapping the research in the LSCM field from a general point of view and has been covered through three bibliometric analyses: a study focused on the longitudinal evolution of LSCM from 1996 to 2018 using SciMAT (Chapter 1); a work focused on network analysis of LSCM until 2020 using BibExcel and VOSviewer (Chapter 2), and a study combining citation classics and network analysis of the LSCM field using the H-Classics method and SciMAT and VOSviewer software (Chapter 3). By covering SO1, this dissertation provides some novel literature classifications based on the identification of different research areas and topics related to the basic characteristics of the LSCM area of knowledge (foundations, key factors, internal efficiency, methods, principles, and tools, benefits, etc.), the relationships between LSCM and other SC strategies (e.g., agile, resilient, Six Sigma), the relevance of performance aspects (organizational, operational, financial, and environmental), and the increasing prominence of sustainability (LSCM-sustainability relationships, green practices, etc.).

SO2 aimed to characterize the existing research on the interrelationships between LSCM and business performance and was covered through a Systematic Literature Review (SLR). This dissertation identifies the issues addressed by the research in this field using an SLR and provides a novel classification of the literature into two main research lines: *LSCM performance-based models*, which included papers proposing decision support models, assessment models, and improvement models, and *LSCM's impact on performance*, which consisted of studies focused on different kinds of performance such as financial and operational, among others. Some common features were found within the articles in each subline, so different groups were made based on the context in which the study is developed (e.g., the sector/industry and the specific characteristics of the firm/SC), the OM strategies that are studied in these works in combination with LSCM (e.g., agile, green, resilient, and Six Sigma strategies), and the role of cooperation and collaboration in these

investigations (e.g., upstream/downstream SC and SC integration). One of the gaps detected was the lack of a reliable system for monitoring and evaluating the results derived from LSCM. Additionally, a more detailed study of the influence of environmental uncertainty was shown to be required to advance the knowledge on LSCM and performance.

SO3 was intended to provide a performance measurement framework to evaluate the results derived from the LSCM implementation as a need identified in Part I and was covered through a two-stage Delphi study based on data collected from international academics and managers with expertise in LSCM. This dissertation has proposed a balanced LSCM scorecard based on the consensus between scholars and practitioners with expertise in the field to evaluate LSCM performance. A two-stage Delphi study using the Fuzzy Delphi and Fuzzy DEMATEL methods was carried out to refine the most relevant goals and performance indicators that should be used to evaluate the accomplishment of the goals in the four BSC dimensions and their interrelationships. The financial perspective focuses on cost reduction, while the customer perspective deals with delivery efficiency and customer value and satisfaction including metrics related to timeliness, quality, and customer requirements fulfillment. The business process dimension has waste reduction, process optimization, and supplier relationships as its objectives and covers measures related to productivity, inventory, and supplier consistency. Lastly, the learning and growth perspective emphasizes the information flow and focuses on human resources issues. Moreover, this study also provides benchmark targets for the identified performance metrics, useful for managers to evaluate the performance achieved through the deployment of LM principles, practices, and techniques along the SC, and compares the expected outcomes and the real results achieved.

SO4, SO5, and SO6 aimed to investigate empirically the role of the SC context and SC strategic relationships in LSCM implementation and its performance outcomes to dig deeper into the research needs identified in Part I.

SO4 was covered by identifying a new driver for LSCM implementation: technology uncertainty, which was found to be a source of variability that can be tackled through LSCM implementation. This dissertation has demonstrated that technology uncertainty positively

affects LSCM implementation and that the extension of LM principles and practices along the SC has a positive effect on the focal firm's operational performance, which in turn leads to firm competitiveness.

SO5 was covered by emphasizing the importance of supply relationship management in LSCM implementation and the performance derived from its implementation. This dissertation has revealed that supply uncertainty negatively influences the implementation of LSCM, while better strategic supplier performance results in a higher degree of LSCM implementation and better focal firm operational performance. Moreover, LSCM positively impacts the focal firm's operational performance.

Finally, SO6 was covered by identifying new strategic external drivers related to the search for competitive advantage through the implementation of LSCM and the results derived from its implementation. This doctoral dissertation finds that the relationship between strategic supplier performance and LSCM implementation gains greater importance in contexts characterized by high competitive intensity, while LSCM was confirmed to have a positive effect on firm operational performance.

II. Implications for theory and practice

This dissertation has relevant academic and managerial implications.

The literature reviews intended to cover SO1 and SO2 in Part I offer a guide that can facilitate work for scholars. After numerous years of fruitful investigation in the LSCM field, the previous research has reviewed the literature on LSCM with different objectives, either conceptually from a general perspective (Jasti & Kodali, 2015a; Ugochukwu et al., 2012) or focusing on specific aspects related to LSCM (Khorasani et al., 2020; Martínez-Jurado & Moyano-Fuentes, 2014; Núñez-Merino et al., 2020). However, additional analysis of the literature using rigorous bibliometric methods can provide further insights not previously evaluated in other reviews. The accomplishment of SO1 provides general and useful insights into the development of the LSCM field as they reveal the scientific actors that have made the most leading and influential contributions to its advancement. Particularly, scholars can

benefit from this information when seeking to identify the best journals to submit their works on LSCM to and the institutions and authors with which they could establish collaborative networks in the study of LSCM. Additionally, these works provide an overview of the main research areas addressed in the literature on this topic and its evolution, thus enabling academics to better understand where the greatest interest lies and what the unaddressed issues are. Specifically, scholars can easily access the key aspects to which the LSCM research has been devoted and the main methods used to address this area, thus providing a path for new contributions in the field.

Regarding SO2, a more detailed overview of the LSCM-performance relationships area of knowledge is presented. This review differs from previous reviews in multiple ways. First and foremost, the focus has specifically been placed on LSCM-performance relationships, which enables a more accurate analysis of the literature rather than a review of the research from a broad perspective. Second, this study considers all the past and present documents on the addressed topic. Third, the use of a systematic structured approach to review the research literature following the Denyer & Tranfield (2009) and Tranfield et al. (2003) guidelines and the Thomé et al. (2016) and Durach et al. (2017) recommendations enables to reduce researcher bias and assure the reliability and validity of the results. This study can help researchers seeking to delve into this issue to obtain a comprehensive view of the interrelationships between LSCM and different kinds of performance and, more importantly, to easily identify and examine the opportunities for further investigation. The findings have revealed that great relevance has been given to the study and proposal of performance assessment frameworks, even though most of these are purely theoretical and based on the literature. Moreover, the influence of contextual uncertainty and the different nature of the SC members' relationships on LSCM and performance deserve more attention.

Concerning the empirical studies in Part II, a variety of implications for research can be discussed regarding SO3, SO4, SO5, and SO6. As regards SO3, the previous research has highlighted the lack of a systematic understanding at the lean-performance management intersection (Bellisario & Pavlov, 2018) and emphasized that the lack of a

clear understanding of lean performance assessment, and the non-availability of appropriate performance measures have led to conflicting results from lean implementation (Sangwa & Sangwan, 2018). Previous proposals of assessment models are broader and do not focus on the outcomes of LSCM alone but on studying the performance derived from the combination of LSCM with other SC strategies (Agarwal et al., 2006; Carvalho et al., 2011; Duarte & Cruz-Machado, 2015; Kainuma & Tawara, 2006; Thanki & Thakkar, 2018), so limited attention has been paid to the particularities of LSCM itself. This was due to the lack of a validated measure of LSCM implementation (Moyano-Fuentes et al., 2019) until recently. This dissertation proposes a balanced LSCM scorecard based on the knowledge of experienced scholars and managers from different sectors and countries using qualitative and quantitative approaches to cover SO3 and solves the challenging task of assigning targets to performance measures. This dissertation has revealed the importance of customer relationships in LSCM assessment, highlighted the relevance of considering supplier relationships as a strategic objective when implementing LM along the SC, and emphasized the need to evaluate not only focal firm performance but also supplier performance in this context.

Regarding SO4, SO5, and SO6, the previous research had investigated a few drivers and enablers of LSCM implementation, including the competitive strategy selected (Qi et al., 2011), the strategic sourcing approach (Yildiz Çankaya, 2020), the complexity and dynamism of the SC (Zimmermann et al., 2020), and internal lean implementation as a preceding step (Moyano-Fuentes et al., 2021). Despite the insights provided by these works, a better understanding of the potential benefits and challenges of adopting LSCM in particular contexts was still needed, which could be the cause of failed LSCM implementations (Jasti & Kodali, 2015b) and undesired outcomes (Swenseth & Olson, 2016). Additionally, although some performance outcomes of LSCM implementation such as efficiency have already been addressed empirically (Moyano-Fuentes et al., 2021), the inclusion of sources of variability associated with the context in which the SC operates and the selection of different performance measures related to flexibility and reliability could provide additional insights.

This dissertation sheds light on the drivers that can explain LSCM implementation motivation and interest. Particularly, the attainment of SO4 stated the role of LSCM implementation as a mechanism for addressing technology uncertainty through stability and efficiency and improving business performance and firm competitiveness. Regarding SO5, supply uncertainty has been found to be a detrimental driver of LSCM implementation, while improvements in strategic supplier performance can enhance LSCM implementation and lead to better firm operational performance, which can also be achieved through LSCM adoption. Lastly, the achievement of SO6 showed that the effect of strategic supplier performance in the implementation level of LSCM is strengthened in an industry characterized by high competitive intensity.

From the managerial point of view, the accomplishment of SO1 offers managers and practitioners several insights that can be useful for practical reasons. On the one hand, these studies make it easier to find academic support and create partnerships and collaborative links to address the practical implications of the extension of LM along the SC. Precisely, these literature reviews may serve as the basis for developing practices such as collaborative research, university-industry research projects, academic consulting, financial support, and contract research, thus enabling the transfer of research results from academia to industry. Additionally, the main benefits and advantages resulting from LSCM implementation can encourage managers to adopt this strategy in their organizations when seeking to achieve a competitive advantage. The identification and exploration of critical success factors for the adoption and development of LM practices along the SC can help practitioners in the decision-making process. Moreover, managers could find the presented information regarding the synergistic effects of lean and other operations strategies useful.

Regarding SO2, this dissertation identifies, evaluates, and analyzes the literature on LSCM and performance relationships, thus providing practitioners with useful information in this field. As managerial implications, the existing performance-based models can be compared to examine the effectiveness of extending LM along the SC depending on different contextual factors or SC characteristics. Managers can also use

this information to discover which SC strategies can boost performance in combination with LSCM.

Concerning the practical implications of Part II, the attainment of SO3 can help managers to select and prioritize the best-suited performance indicators to achieve their organization's strategic goals, enabling practitioners to monitor and evaluate the LSCM implementation process and providing a system that allows easy and timely detection of deviations from the established benchmark values. The objective was to provide managers with a reliable and adequate instrument that informs them whether the implementation of LM along the SC is providing the desired outcomes and, if not, to allow them to make the appropriate decisions at the appropriate time.

As regards SO4, SO5, and SO6, this dissertation recommends managers strategically analyze the environment in which their firms and SC operate since the choice of the right SC strategy can determine its success and the competitiveness of the firm under the current circumstances. Specifically, the achievement of SO4 has indicated that the extension of LM along the SC is advisable to provide the efficiency and flexibility needed to respond to an environment characterized by technological change and variability. Regarding SO5, this dissertation shows that it is better not to make efforts to extend LM along the SC in a context of high levels of supply uncertainty due to the negative impact on LSCM, while it is highly advisable to strengthen the relationships with key stakeholders to create a buffer against this instability. Lastly, the accomplishment of SO6 makes managers and practitioners aware of the crucial contribution of utilizing key suppliers that continuously improve their performance when competitive pressure is high and organizations aim to achieve competitive advantages through the implementation of strategies such as LSCM.

III. Limitations and future research

Finally, there are some limitations to the works presented in this doctoral dissertation. Some common limitations can be mentioned regarding Part I, which was intended to achieve SO1 and SO2: the use of a single database,

the subjectively-defined inclusion and exclusion criteria (publication type, publication year, research areas, language), and the literature classification based on subjective processes, i.e., the researchers' own criteria based on their knowledge and experience. Nevertheless, the above-mentioned limitations are considered inherent to literature review methods since appropriate restrictions need to be specified for the review to be feasible. Some limitations can also be noted regarding Part II, which aimed to accomplish SO3, SO4, SO5, and SO6: the potential difficulty of applying effectively and efficiently the proposed balanced LSCM scorecard when the focal firm does not have an overview of the entire chain; the use of cross-sectional data from firms in industrial sectors in a single country (Spain), which potentially limited the generalizability of the results, and the assessment of LSCM from the widely used focal firm perspective. However, these limitations have been considered to have a minor relevance since these drawbacks are typical of this kind of study. It is common for the literature to use the focal firm perspective to assess upstream and downstream SC relationships.

Several future research directions can be suggested from the literature reviews in Part I. Regarding SO1, this dissertation has shown that researchers could contribute to advancing the knowledge on LSCM by investigating its adoption in less studied contexts such as the service sector, finance, and education, among others, to gauge the potential of LSCM. Scholars are also encouraged to bring the barriers and drivers to LSCM implementation up to date and test these relationships empirically. Moreover, deep research into relevant issues for LSCM implementation such as the lean learning process, organizational cultural change, and leadership strategies is advisable to enable the effective and efficient extension of LM along the SC in practice. Academics are suggested to move from the exclusive use of the focal firm perspective to collect empirical data on LSCM to including relevant information from other SC partners that could be missed otherwise. Additionally, the inclusion of cross-country data is advised in empirical works given the current global context. Exploring the combination of LM with other SC strategies such as agile, green, resilient, and Six Sigma in real scenarios is required to verify their theoretically stated benefits and consequences. Emphasis should be put on the study of strategic human and social aspects related to LSCM and their part in achieving competitive advantages. Further

research is needed on the integration of I4.0 technologies and LSCM and how LSCM implementation can influence and/or be influenced by these information technologies. Concerning SO2, this dissertation adds some future research lines specifically related to the LSCM-performance relationship such as the study of LSCM and performance according to the country/ies where the SC operates, the influence of the current degree of implementation of LM at the internal and external levels, major attention to social and environmental outcomes of LSCM, and the need to empirically address the role of environmental uncertainty and complexity in light of the new circumstances around the world.

The empirical works in Part II of this dissertation have also enabled to propose some future research lines. Regarding the above-mentioned limitations, scholars are encouraged to investigate the upstream and downstream perspectives in the LSCM implementation to achieve a more comprehensive view, to carry out longitudinal studies that can provide further insights, and to extend the scope of the analysis to other countries and sectors to provide a more complete perspective of the issues explored. Concerning SO3, the proposed assessment framework should be adapted and used in representative case studies in different industrial sectors. Moreover, the adequate measurement of issues related to the organization of learning in the LSCM context requires further attention. As regards SO4, SO5, and SO6, scholars are recommended to extend the empirical analysis of LSCM's effects on performance by including financial and sustainable aspects. Specifically, regarding SO4, future research should address the deployment of mature and emerging technologies as a mechanism for tackling technology uncertainty and delve into their role in LM extension along the SC. Concerning SO5, researchers are suggested to explore different contextual drivers of LSCM implementation and performance such as demand and process variability. Regarding SO6, the impact of environmental munificence and complexity in the motivation to adopt LSCM could be investigated to widen the knowledge of the contextual elements that could drive and enable LSCM implementation. The study of these issues could provide interesting insights and help to move the knowledge on LSCM's drivers and outcomes forward.

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