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

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

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1. Introduction

Lean is a management system that has gradually evolved from its original purpose as a set of tools in the production area (e.g., Just in Time - JIT) to a human-centric system approach universally applicable to any process and in any context (i.e., Lean Management - LM) (Danese *et al*. 2018). Thus, LM has developed from a production system primarily focused on eliminating waste and reducing variability at the factory plant level into a more widely extended management system that addresses these two main objectives from both the internal and the supply chain perspectives (Hines *et al.* 2004; Shah & Ward 2007), with numerous authors researching the subject.

The application of LM along the supply chain (SC) to optimize all activities and information, material and financial flows from the point of view of the end customer is known as Lean Supply Chain Management (LSCM). LSCM enables the elimination of waste, improvements to quality, cost reductions, and increased flexibility throughout the supply chain (Lamming 1996; Martínez-Jurado & Moyano-Fuentes 2014; Swenseth & Olson 2016; Womack & Jones 1996).

In the past few years, the research has reviewed the LSCM literature with different objectives. Some of these literature reviews have been general, covering the entire field (Garcia-Buendia *et al*. 2020; Jasti & Kodali 2015; Ugochukwu *et al.* 2012), while others have focused on specific aspects of LSCM implementation such as practices, barriers, and contextual factors (Berger *et al.* 2018; Borges *et al.* 2019; Khorasani *et al.* 2020; Li *et al.* 2020), the links between internal and external LM and sustainability (Martínez-Jurado & Moyano-Fuentes 2014), the study of the interrelationships between LSCM and other supply chain management strategies (Ciccullo *et al.* 2018), and the role of Industry 4.0's information and digital technologies on LSCM (Núñez-Merino *et al.* 2020). As can

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be observed, multiple previous literature reviews have focused on compiling the existing knowledge on some specific aspects of LSCM.

As the purpose of LSCM is to reduce waste and achieve efficiency, one core aspect of LSCM is its impact on performance and so it is essential to evaluate the research studies dealing with this issue (Berger *et al.* 2018; Jasti & Kodali 2015), determine their common and distinguishing elements, and draw proper conclusions to continue the development of this area of knowledge. Given the large number of publications that have empirically studied the effects of LSCM on performance, a literature review is required that encompasses these issues and allows academics and practitioners to identify the current state of the research. This study is especially relevant for understanding the comprehensive research efforts focused on the relationship between LSCM and performance, providing a snapshot of the situation, and affording insights for further research.

Considering the above, this paper aims to answer the following research question: what are the main findings and research directions to date in relation to LSCM and performance relationships? A series of specific objectives are set to achieve this main goal. First, to evaluate the state-of-the-art of research about LSCM and performance relationships using the Systematic Literature Review (SLR) methodology (Denyer & Tranfield 2009; Tranfield *et al.* 2003). The SLR provides an overview of the state-of-the-art for academics who decide to make a start in this field and lays the theoretical foundation for improving knowledge on LSCM assessment. Second, to identify the research lines addressed in the literature and provide an original classification of existing literature on the topic through the interrelationships between the content of the different

articles. Finally, to identify gaps and research areas that remain unexplored in the scientific literature proposing future lines of research.

Therefore, this paper aims to contribute to advancing research by identifying and analyzing studies that focus on this topic, their interrelation and classification to facilitate their analysis and pinpointing gaps in the existing literature, so as to provide valuable information on any research lines that need to be developed or expanded in the future. Our review differs from previous reviews in multiple ways. First and foremost, the focus has been specifically placed on LSCM - performance relationships, thus enabling a more accurate analysis of the literature rather than reviewing the research from a broad perspective. Second, this study considers all the past and present documents of the addressed topic since LM adoption along the SC was first addressed by the scientific community in 1996. Third, we use 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) guidelines to reduce researcher bias and assure the reliability and validity of the results.

Concerning the structure of this study, the paper is organized as follows. The next section presents the key concepts of this study. This is followed by an explanation of the methodology used. Then, we report a descriptive analysis of the literature and provide an overview of past research in which we identify and classify the main research lines and define different research sublines by interrelating groups of papers. Finally, findings are discussed, some gaps are identified, and future research lines are established. The final section summarizes the paper and offers some conclusions.

2. Key concepts

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Clearly defining the key concepts involved is prerequisite for a systematic literature review. For this, the object and boundaries of the review have to be defined, clarified, and refined.

2.1. Lean Management

"Lean manufacturing" or, alternatively, "lean production" were popular terms used to refer to the Toyota Production System (TPS) as a new manufacturing paradigm that contrasted with Fordism (Danese *et al.* 2018). Lean has evolved from a specific set of tools used in the production area to a management system applicable to a wide range of organizations and sectors (Danese *et al*. 2018). Some authors have likened lean to JIT (Mistry 2005a), while others have adopted a more accurate approach to lean as a set of management tools and practices (Bhamu & Sangwan 2014; Moyano-Fuentes *et al*. 2012; Shah & Ward 2007).

2.2. Supply Chain Management

A supply chain can be considered to be a network of facilities and activities that carry out the functions of product development, the procurement of materials by one facility from another, the manufacture of products, and goods distribution to customers (Beamon 1998). The supply chain scope includes suppliers, manufacturers/focal organization, distributors, and end customers (Beamon 1998). Therefore, the SC is considered to be a set of interdependent organizations that act together to control, manage and improve the flow of materials, products, services, and information from the point of origin to the point of delivery (the end customer). Supply Chain Management (SCM) consists of planning and controlling materials and information flows, internal and external logistics activities, and processes with other companies (Cooper *et al*. 1997).

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2.3. Lean Supply Chain Management

LM has been dominant in manufacturing, extending all the way from customer needs to raw-material sources (Hines *et al.* 2004; Reichhart & Holweg 2007). The extension of the production pull outside the boundary of the single factory to include upstream and downstream SC partners created the link between LM and SCM (Hines *et al.* 2004). Thus, LM can be adopted by organizations seeking to integrate their SC members and activities (Lamming 1996; Vonderembse *et al*. 2006). The practices and interpretations of what constitutes LSCM indicate that it is a broad, multidimensional concept that involves a range of supply chain management-related aspects and elements (Moyano-Fuentes *et al.* 2019). We, therefore, decided to consider studies referring to lean management in the SC from a broad point of view, i.e. those works analyzing the LSCM as an integrated system. This included several types of lean articles regarding, for example, the implementation of LM in different contexts (not just manufacturing but also service industries, healthcare, construction, food, etc.) and their extension up and down the SC, encompassing different organizations.

2.4. Performance

Choosing appropriate performance measures is a hard task due mainly to the complexity of supply chains (Beamon 1999). Hence, performance can be measured in multiple ways (Gunasekaran *et al.* 2001; Trattner *et al.* 2019; Yang *et al.* 2011). This study addresses both internal and external performance, i.e., organizational and SC performance. In this research, we will focus on the most traditional measures of organizational performance, i.e., operational (Marodin *et al.* 2016; Shah & Ward 2007) and financial (Fawcett *et al.* 2016; Hofer *et al.* 2012) aspects to evaluate LSCM - performance relationships. Operational performance represents the company's flexibility and delivery performance

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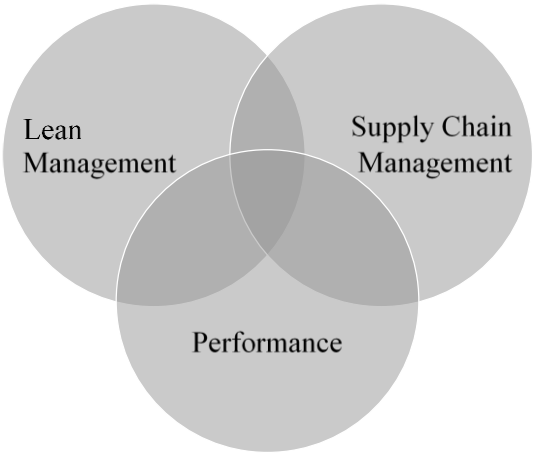
results (Flynn *et al.* 2010; Wong *et al.* 2011), including aspects such as delivery time, production costs, lead time, inventory level, responsiveness, quality, and flexibility, among others. Financial performance includes the firm's value-creating capability (Flynn *et al.* 2010; Yu *et al.* 2013), considering aspects such as return-on-sales (ROS), profit, market share, and return-on-investment (ROI), for example.

The research objective is, therefore, in the area where the Lean Management set, the Supply Chain Management set, and the Performance set intersect. As a result, the search has specifically been designed to locate the documents in this intersection area (see Figure 1).

Figure 1. Key concepts in the SLR of LSCM and performance relationships



Source: Prepared by the authors

3. Methodology

The methodology chosen to evaluate the state-of-the-art of research into the LSCM-performance relationship is the SLR (Denyer & Tranfield 2009; Tranfield *et al.* 2003). This methodology aims to ensure a reproducible, scientific, and transparent literature review approach, synthesizing all existing information on a given issue in a complete and

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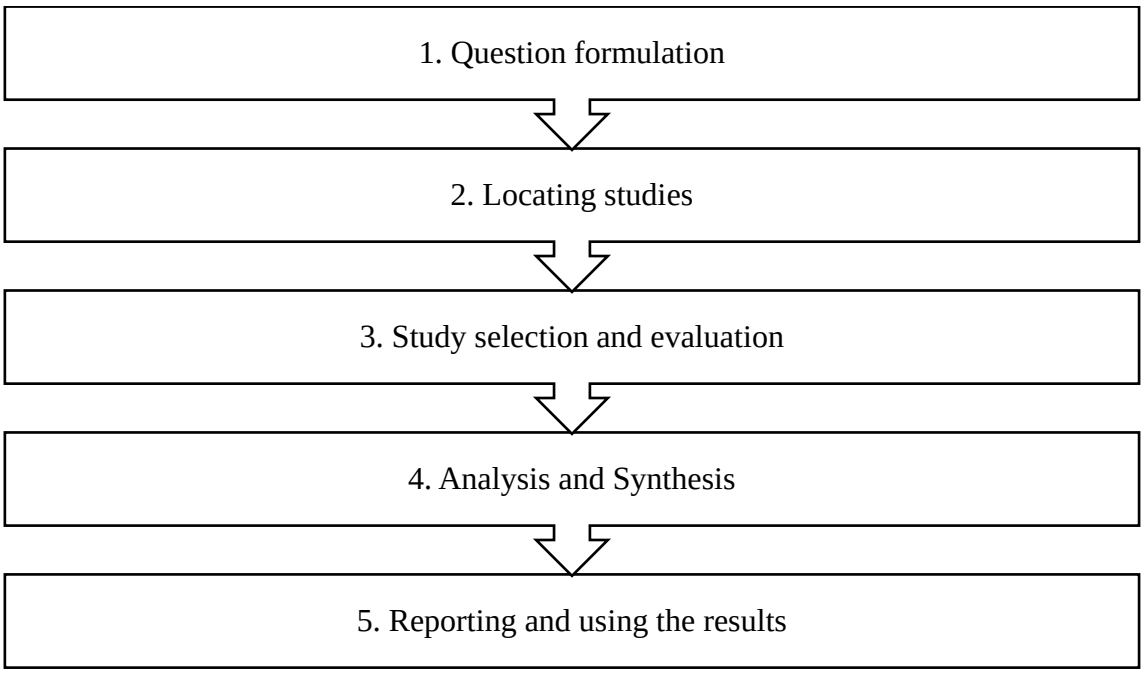
unbiased manner (Denyer & Tranfield 2009). The chosen method consists of five stages proposed by Tranfield *et al.* (2003), based on the principles of transparency, integration, and an explanatory and heuristic nature (see Figure 2). This methodology has been complemented by the guidelines established to develop a rigorous SLR in the Operations Management (OM) field (Thomé *et al.* 2016) and Supply Chain Management domain (Durach *et al.* 2017) and to assure the reliability and validity of the results. The five steps are summarized below.

Figure 2. Systematic Literature Review process



Source: Adapted from Denyer & Tranfield (2009)

3.1. Question formulation

The first step in any SLR is to formulate the research question (RQ) by identifying the question(s) the research needs to answer. The following research questions have been established for the purpose of this study: What are the main findings and research

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directions to date regarding LSCM assessment? This general RQ has been divided into three separate questions relating to the more specific objectives of this research: (RQ1) What is the existing literature on the interrelationships between LSCM and performance? (RQ2) What are the interrelationships between LSCM and performance and their main research directions? (RQ3) What gaps and future research lines can be identified in the existing literature?

3.2. Locating studies

The second stage consists of locating the most significant studies related to the RQ. This stage is essential as, if the selected literature is inappropriate or irrelevant, the contribution made by the following phases will be flawed (Sangwa & Sangwan 2018). Two key issues are therefore considered: search engines and search strings. With respect to the former, the following databases have been chosen as the most appropriate to answer our research questions: Web of Science, Scopus, and ABI. These databases have been regularly used in OM, and the selection of two or more is highly recommended to reduce the possibility of publication bias in the systematic review (Thomé *et al.* 2016).

The search string has been defined by selecting keywords related to the fundamental concepts of the research. Initially, the search string was composed of the words "lean", "supply chain", and "performance". After an initial search using this combination of keywords, the authors realized that the search string was too broad, despite which some JIT- and logistics-related papers continued to be missing. The authors then detected some other keywords in the literature, which were added to the initial search string to make it as precise as possible. The keywords were determined jointly by the authors—all of whom have specialized knowledge of LSCM—in a brainstorming session

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to give the search greater validity. As a result, the Lean Management set was expanded to include the keywords "just in time" and "JIT" based on the fact that LM was approximated to the concept of JIT in the germinal literature. JIT has frequently been associated with the TPS and lean strategy, including a variety of practices and tools (Kanban, SMED, pull system) included in the wider meaning. Other lean-related keywords used for specific tools and practices such as TQM, 5S, and VSM were not included in the search string as the authors considered that LM is a global management system that already includes a set of practices and tools (Shah & Ward 2007). The keyword "logistics" was added to the Supply Chain Management set search string to include papers focused on the distribution function along the supply chain, i.e., external logistics activities. Concerning the Performance set, the authors decided to address the traditional meaning of organizational performance with the inclusion of words related to operational and financial performance, such as "operational performance", "financial performance", "responsiveness", "flexibility", and "lead time".

Thus, the search keywords most frequently used in the LM, SCM, and Performance literature to cover and delimit the intersection area between lean, supply chain, and performance were selected. Similar keywords have previously been used in papers that have studied topics akin to this literature review (Jasti & Kodali 2015; Negrão *et al*. 2016; Núñez-Merino *et al.* 2020; Trattner *et al.* 2019).

These keywords have also been combined to generate several main search strings. Simple operators, such as truncated characters (*) and exact phrases (",") or {,}), as well as Boolean operators (AND and OR), have been used to generate specific, complex searches. The search string has been designed so as to ensure that the located articles contain at least one of the key search words for each of the three blocks (Lean

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Management, Supply Chain Management, and Performance) either in the title, abstract or author's keywords (in the case of Scopus and ABI) or in the broader topic (in the case of WoS; title, abstract, author's keywords, expanded keywords). Since each of the databases has its own particular features, as can be seen in Table 1, separate search strings have been defined accordingly. For the sake of clarification, several pilot tests were carried out in the three databases to refine the search strings and eliminate the appearance of any false positives or false negatives (Denyer & Tranfield 2009; Durach *et al.* 2017).

Table 1. Search strings for databases

Database	**Search string**
Web of Science	TS=("lean" OR "just?in?time" OR "JIT") AND TS=("supply chain*" OR "logistic*") AND TS=("performance evaluation" OR "balanced scorecard" OR "evaluation model" OR "organizational performance" OR "operational performance" OR "financial performance" OR "economic performance" OR "responsive*" OR "inventory" OR "cost*" OR "delivery" OR "flexibility" OR "lead time")
Scopus	TITLE-ABS-KEY ({lean} OR {just in time} OR {just-in-time} OR {JIT}) AND TITLE-ABS-KEY ({supply chain} OR {supply chains} OR {logistic} OR {logistics}) AND TITLE-ABS-KEY ({performance evaluation} OR {balanced scorecard} OR {evaluation model} OR {organizational performance} OR {operational performance} OR {financial performance} OR {economic performance} OR {responsive} OR {responsiveness} OR {inventory} OR {cost} OR {costs} OR {delivery} OR {flexibility} OR {lead time})
ABI	AB,TI("lean" OR "just?in?time" OR "JIT") AND AB,TI("supply chain*" OR logistic*) AND AB,TI("performance evaluation" OR "balanced scorecard" OR "evaluation model" OR "organizational performance" OR "operational performance" OR "financial performance" OR "economic performance" OR "responsive*" OR "inventory" OR "cost*" OR "delivery" OR "flexibility" OR "lead time")

Source: Prepared by the authors

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3.3. Study selection and evaluation

In the third stage, the criteria for including and excluding papers have been defined to identify and evaluate the most relevant literature related to the research question. The process by which these criteria have been applied consists of various steps.

First, the search string was designed to ensure that the selected papers contain at least three key concepts (Lean Management, Supply Chain Management, and Performance) in the title, abstract and/or list of keywords, resulting in a total of 4,886 papers. Second, filters have been applied to define the search more precisely. Thus, only articles in press and papers and literature reviews published in journals with a peer review process and written in English have been considered. The search period was also limited, with studies selected from 1996 onwards. This time horizon has been judged suitable since that was the year that research on LSCM began with the publication of "Squaring lean supply with supply chain management" (Lamming 1996). The application of these filters reduced the total number of papers to 1,995. Next, duplicate studies detected due to searches being conducted in the different databases were eliminated. Since Web of Science is the most prestigious database of scientific production, results from the search in this database have been used as the main reference and duplicate studies found in subsequent searches in the other databases eliminated. This left a total of 1,427 papers.

The title, the abstract, and the keywords of the resulting papers were then independently examined by each of the researchers and the results pooled to ensure their relevance and alignment with the research questions. If there was any doubt, the introduction and the conclusions were read (Durach *et al.* 2017; Thomé *et al.* 2016). As good SLR practices in Operations Management advocate, article selection, and evaluation

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were conducted jointly by the researchers in an interactive review process (Thomé *et al.* 2016) in order to prevent any coding bias. So, the review process was interactive with a high level of agreement among the researchers. Multiple researchers were involved at this stage to reduce selection bias and any risk of the criteria being applied subjectively (Durach *et al.* 2017; Thomé *et al.* 2016). The analysis of the title, abstract, and keywords, and the introduction and conclusions when required, enabled to identify the articles most related to the research question and those that were clearly unrelated. A total of 1,092 papers were identified that were not directly related to the research question being addressed and discarded. This process reduced the number of papers to be considered to 335 papers.

Finally, these 335 papers were read in full to guarantee that they fully conformed to the research question. Studies were observed to exist that only made a tangential reference to the research topic or that did not conduct a study of the three main concepts (Lean Management, Supply Chain Management, and Performance) together. After the application of all the inclusion and exclusion criteria, the final result was a total of 162 papers, which form the object of this literature review (see Figure 3).

The application of the exclusion criteria ruled out any papers that did not primarily accomplish the pursued triad (LM, SCM, and Performance). Many of the discarded papers focused on a single practice or tool related to LM such as waste reduction, JIT, VSM, and TQM, and lacked the perspective of lean strategy as a combination of diverse practices. Some papers focused mainly on other supply chain strategies such as agile, green, resilient, and six sigma, in which the presence of lean is anecdotal. Others were observed to only approach LM from the perspective of the internal level of the firm or internal logistics processes, so the holistic perspective that includes the whole supply

chain was not present. Some works were not devoted to specifically studying the effects or impact of LSCM on performance. Lastly, a few papers addressed "lean" in its medical sense, which is quite distinct from the lean concept in the OM field.

3.4. Analysis and synthesis

The papers selected and evaluated in the previous step were analyzed and synthesized in the fourth stage. Pre-defined structured coding of the information was carried out in this phase to mine the relevant details in each of the studies and enable multiple researcher involvement in the process (Denyer & Tranfield 2009; Thomé *et al.* 2016) and so reduce all single researcher bias (Thomé *et al.* 2016) and assure the reliability and validity of the results. Therefore, the authors relied on consensus in this coding and data gathering phase to achieve greater objectivity in the results and limit selection bias (Durach *et al.* 2017; Thomé *et al.* 2016). During the article coding process, a database was created in an Excel spreadsheet that contained the thematic, methodological, and descriptive content of the study. Elements were taken into account such as the main contribution of the paper, the objectives pursued, the area of application of the study, the methodology and techniques used, and the findings and conclusions. Thus, the main contribution of each research study was taken into consideration, and this enabled the key thematic aspects of each study to be determined. Next, the different key thematic aspects of a similar nature were connected to the research lines. Following this, papers in each of the research lines were grouped into research sublines based on the interrelationships observed in the research questions. Finally, the papers were grouped according to their purpose to better delimit the content of each research subline and ensure that the classification was homogeneous. The results were subsequently discussed by the authors to classify and define these connections in

greater detail, which guaranteed sufficient objectivity in this step (Durach *et al.* 2017; Thomé *et al.* 2016). The interactive process was carried out by the researchers to enhance the reliability and validity of the results (Durach *et al.* 2017; Thomé *et al.* 2016) by comparing the data collected by authors and discussing solutions to any differences.

This process has enabled us to determine the core elements of the considered studies and to group these into two main lines of research, with subdivisions into specific sublines and groups of papers. Dividing the literature into research lines and sublines has been frequently used in SLRs (Garza-Reyes 2015; Vural 2017). This classification is of the interrelationships between the content of the different articles. Hence, this classification goes beyond the merely descriptive approach and connects the papers on the basis of their contributions.

3.5. Reporting and using the results

The last stage of an SLR involves the presentation of the final results of the analysis and synthesis of the literature review. First, a summary of the SLR process and the proposal for the literature classification are given. In the following section, a descriptive analysis of these studies and the literature classification are presented and discussed according to the identified and proposed research lines.

Figure 3 shows the literature review process following the SLR stages (Denyer & Tranfield 2009; Tranfield *et al.* 2003) and the Durach *et al.* (2017) and the Thomé *et al.* (2016) guidelines.

Figure 3. Stages and Results of Literature Review process

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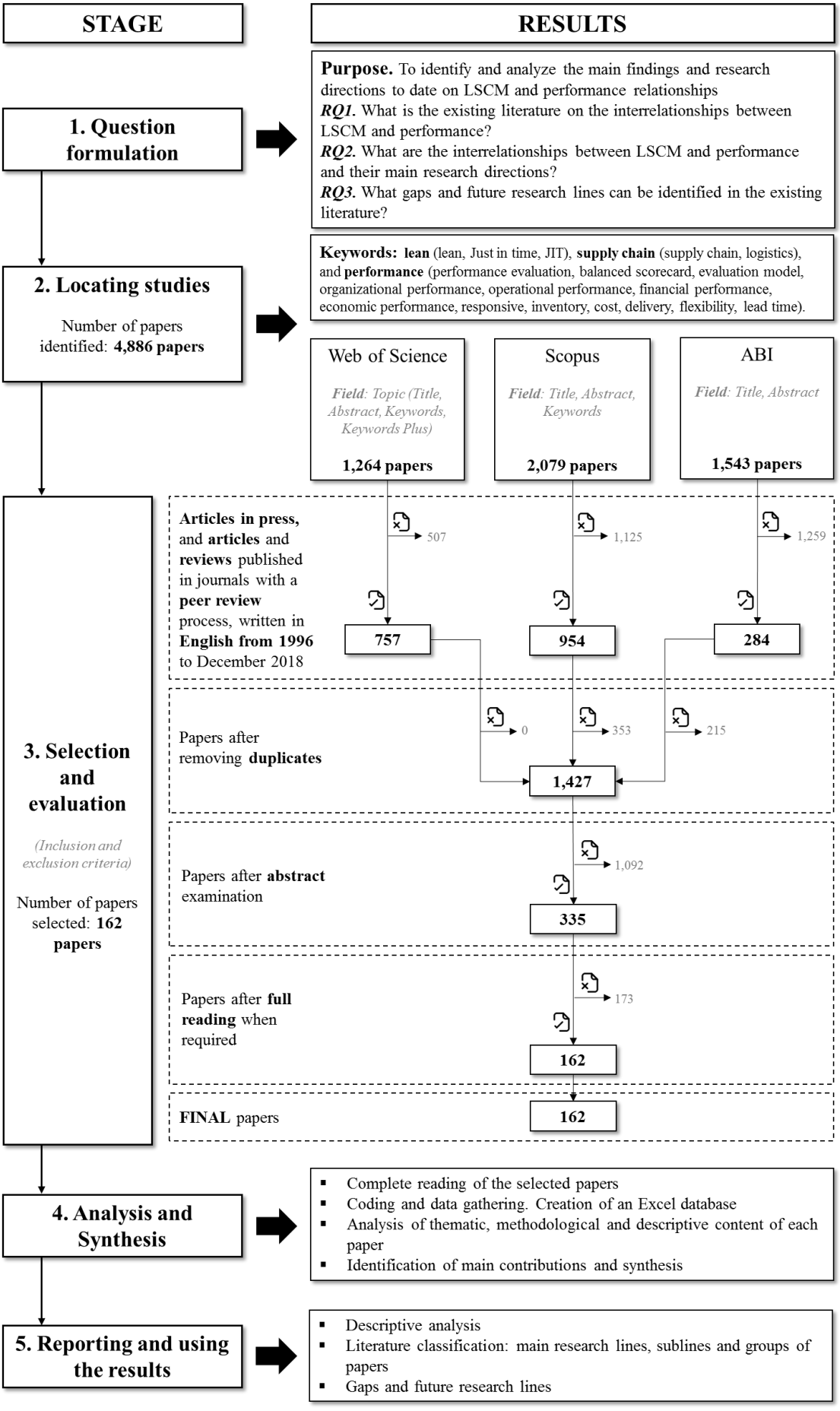

Garcia-Buendia, N., Moyano-Fuentes, J. and Maqueira-Marín, J.M. (2021), "Lean supply chain management and performance relationships: what has been done and what is left to do", *CIRP Journal of Manufacturing Science and Technology*, Vol. 32, pp. 405–423, doi: https://doi.org/10.1016/j.cirpj.2021.01.016.

Source: Prepared by the authors

3.6. Proposed literature classification

In stage 4, the authors analyzed the main contributions of the papers on LSCM and performance. Then, they synthesized and classified the papers according to their common features. Classifying the literature according to the main topics and identifying different research lines and sublines is normal SLR practice (Garza-Reyes 2015; Vural 2017). The first level of the literature classification, the research line, is the result of a general broad-perspective overview of the LSCM and performance relationships in the literature that focuses on the key thematic aspects of these relationships. The next level, the research subline, encompasses the more specific and common thematic issues in the papers in the same line according to the research questions. Finally, papers in each subline are grouped by identifying similar purposes. This particular literature classification is the result of a consensus among this work's authors, as has been the case with previous literature reviews (see Novais *et al*. 2019; Núñez-Merino *et al.* 2020).

The first line includes papers that develop LSCM performance-based models, while the second includes studies that have analyzed LSCM's impact on performance. A panoramic view of the literature showed that, from a general perspective, papers focusing on LSCM and performance relationships tend to either propose some kind of performance-based model or analyze and study the impact and effects of LSCM on performance. Papers proposing a performance-based model and also addressing the impact of LSCM on performance have been included in one of the two research lines according to their predominant research question and focus. Therefore, papers can only belong to one research line. These research lines have also been divided into more specific

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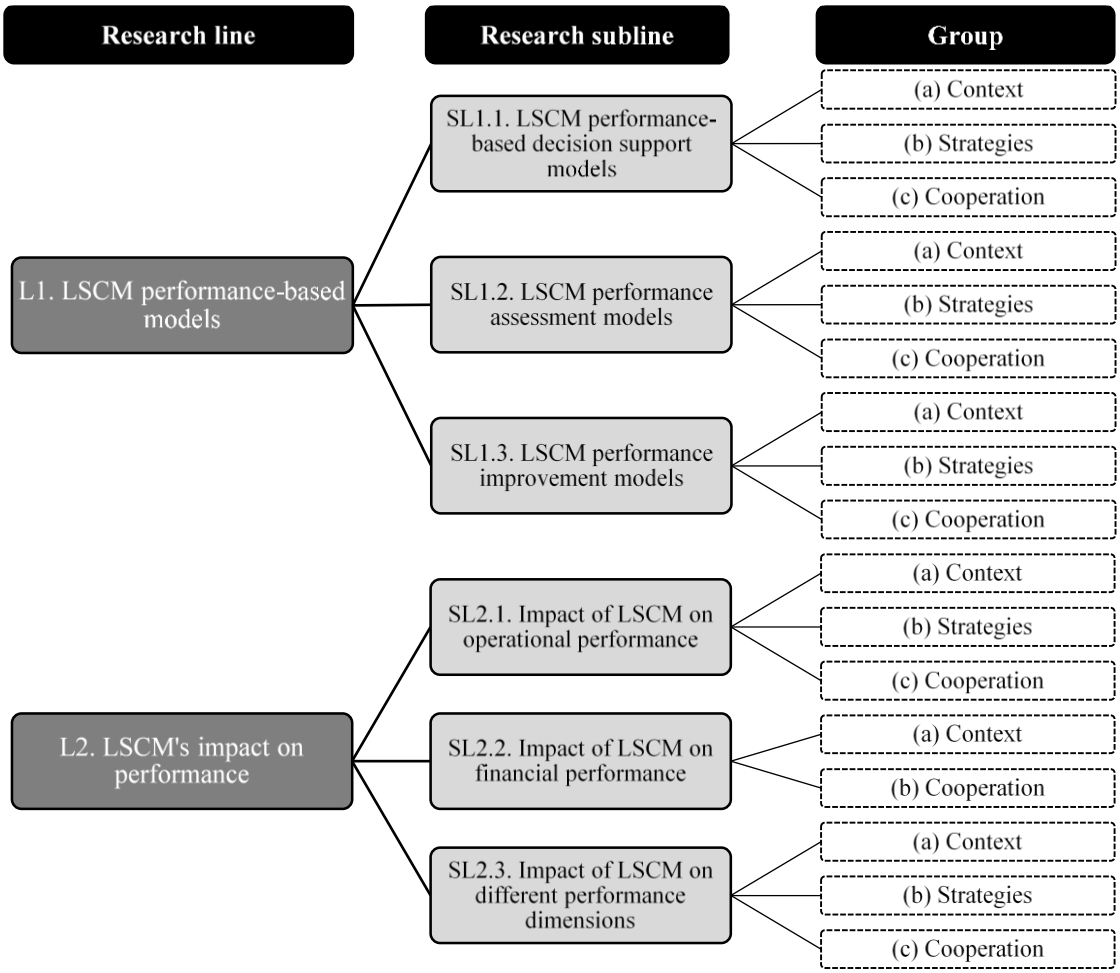
sublines according to similarities observed in the research questions addressed in the various studies. More specifically, the literature analysis has shown that when papers propose performance-based models, their purpose is usually to contribute to the decision-making process, to evaluate performance or to improve performance. Regarding the papers focused on LSCM's impact on performance, the research has frequently highlighted the type of performance and distinguished between various dimensions. The sublines can be further subdivided into specific groups of papers according to the specific purpose addressed, which allows a deeper analysis of the connections between the different papers to identify the research gaps and the challenges that research will have to pay attention to in the future. The aim of linking the papers was to add value to the literature classification and make it easier for the reader to understand the main topics addressed by the literature on LSCM and performance.

Figure 4 and Table 2 show the analyzed papers classified according to the proposed research lines and sublines and provide an integrated view of the proposed classification.

Figure 4. Proposed literature classification



Source: Prepared by the authors

Table 2. Literature classification proposed with references

Research Lines	Research Sublines	Group of papers	Papers
L1. LSCM performance-based models	SL1.1. LSCM performance-based decision support models	(a) Context	Polat *et al.* (2007)
		(b) Strategies	Carvalho *et al.* (2017); Drake *et al.* (2013); Fahimnia *et al.* (2015); Kazmane (2018); Okongwu *et al.* (2010); Swenseth & Olson (2016); Wang & Ye (2018)
		(c) Cooperation	Beheshti *et al.* (2010); Rossini & Portioli (2018); Yao *et al.* (2007)
	SL1.2. LSCM performance assessment models	(a) Context	Arif-Uz-Zaman & Nazmul Ahsan (2014); Behrouzi & Wong (2011); Behrouzi & Wong (2013); Galankashi *et al.* (2018); Gonçalves *et al.* (2005); Kojima *et al.* (2008); Marlow & Casaca (2003)

		(b) Strategies	Agarwal *et al.* (2006); Brown *et al.* (2014); Carvalho *et al.* (2011); Duarte & Cruz-Machado (2014); Kainuma & Tawara (2006); Orjuela Castro & Adarme Jaimes (2017); Thanki & Thakkar (2016); Thanki & Thakkar (2018)
		(c) Cooperation	Faria (2008)
	SL1.3. LSCM performance improvement models	(a) Context	Amirjabbari & Bhuiyan (2014); Huang & Liu (2005); Kong *et al.* (2018); Kreng & Wang (2005); Mathaisel (2005); Mistry (2005a); Savino *et al.* (2015); Singh (2009); Singh & Chand (2009); Singh & Chand (2010); Wang *et al.* (2004); Wang *et al.* (2018); Wangphanich *et al.* (2010)
		(b) Strategies	Banerjee & Mukhopadhyay (2016); Cherrafi *et al.* (2017); Hill *et al.* (2018); Zainuddin *et al.* (2018)
		(c) Cooperation	Banerjee *et al.* (2007); Cao *et al.* (2007); Chen & Sarker (2010); Jain *et al.* (2011); Jong & Wee (2008); Kim & Ha (2003); Nie *et al.* (2006); Ouyang *et al.* (2007); Pan & Yang (2008); Parveen & Rao (2009); Tuli & Shankar (2015); Wang & Sarker (2004); Yang & Pan (2004)
L2. LSCM's impact on performance	SL2.1. Impact of LSCM on operational performance	(a) Context	Al-Tit (2016); Apte & Goh (2004); Arbulu *et al.* (2003); Avelar-Sosa *et al.* (2018); Bortolotti *et al.* (2013); Danese *et al.* (2012); Ding *et al.* (2014); Griffiths *et al.* (2000); Habidin *et al.* (2014); Jayaram *et al.* (2014); Kisperska-Moron & de Haan (2011); Marodin *et al.* (2016); Matt *et al.* (2018); Panwar *et al.* (2017); Taj & Morosan (2011); Tortorella *et al.* (2017); Tortorella *et al.* (2018); Wee & Wu (2009)
		(b) Strategies	Ahmed & Huma (2018); Kumar *et al.* (2012); Lotfi & Saghiri (2018); Osman *et al.* (2015); Qamar *et al.* (2018); Rajagopal *et al.* (2016); Rana *et al.* (2016a); Ruiz-Benítez *et al.* (2018); Sundram *et al.* (2018); Wu (2003); Zhang & Qi (2013); Zelbst *et al.* (2010)
		(c) Cooperation	Alshahrani *et al.* (2018); Avittathur & Swamidass (2007); Dong *et al.* (2001); Furlan *et al.* (2011); Karakadılar & Hicks (2015); Kusmantini *et al.* (2018); Marodin *et al.* (2017); Pozzi *et al.* (2017); Prajogo *et al.* (2016); Rana *et al.* (2016); Zelbst *et al.* (2014)
	SL2.2. Impact of LSCM on financial performance	(a) Context	Azadegan *et al.* (2013); Fawcett *et al.* (2016); Hofer *et al.* (2012); Polat & Arditi (2005); Qi *et al.* (2011)
		(b) Cooperation	Abbas *et al.* (2018); Abuhilal *et al.* (2006); Al-Shboul *et al.* (2018); Elking *et al.* (2017); Green Jr & Inman (2005); Green Jr *et al.* (2014); Keane & Feinberg (2007); Mistry (2005b); Nozari & Mojdehi (2016); Pasquire *et al.* (2011); Qi *et al.* (2017)

	SL2.3. Impact of LSCM on different performance dimensions	(a) Context	Abushaikha *et al.* (2018); Adebanjo *et al.* (2016); Ball & Lunt (2018); Bevilacqua *et al.* (2017); Chen *et al.* (2010); Chen *et al.* (2013); Cook & Rogowski (1996); Daine *et al.* (2011); Dobrzykowski *et al.* (2016); Fearne & Fowler (2006); Genc & De Giovanni (2018); Jakhar *et al.* (2018); Koh *et al.* (2007); Lau & Wang (2014); Manzouri (2012); Mefford (2011); Nikolaeva (2018); Pearce *et al.* (2018); Ponpakdee *et al.* (2014); Promngurn *et al.* (2014); Salhieh *et al.* (2018); Shah & Naghi Ganji (2017); Taylor (2009); Zhang *et al.* (2016)
		(b) Strategies	Azevedo *et al.* (2012); Chan & Burns (2002); Ghobakhloo & Azar (2018); Inman & Green (2018); Kurdve *et al.* (2015); Mishra *et al.* (2018); Mohammed *et al.* (2008); Morash (2001); Qi *et al.* (2009); Qrunfleh & Tarafdar (2013); Qrunfleh & Tarafdar (2014); Thanki *et al.* (2016); Wu *et al.* (2015); Wu *et al.* (2018)
		(c) Cooperation	Al-Shboul *et al.* (2017); Claycomb *et al.* (1999); Eltantawy *et al.* (2015); Hong *et al.* (2012); Hongpiriyakul *et al.* (2013); Jajja *et al.* (2016); Kaynak (2002); Mathur *et al.* (2018); Vázquez *et al.* (2016); Wong *et al.* (2018)

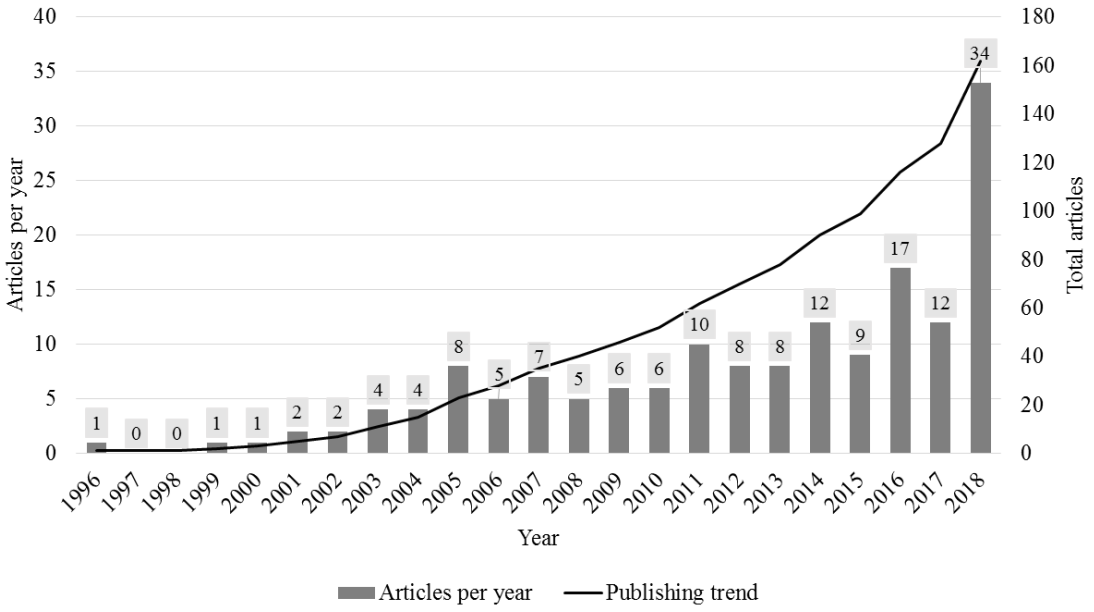
Source: Prepared by the authors

4. Descriptive analysis and research lines

4.1. Descriptive analysis

First, a chronological perspective is presented to analyze the evolution of the number of papers by year of publication. Figure 5 is a graph of both the absolute and cumulative frequency of the number of studies published annually in the considered time horizon.

Figure 5. Evolution of LSCM and performance literature

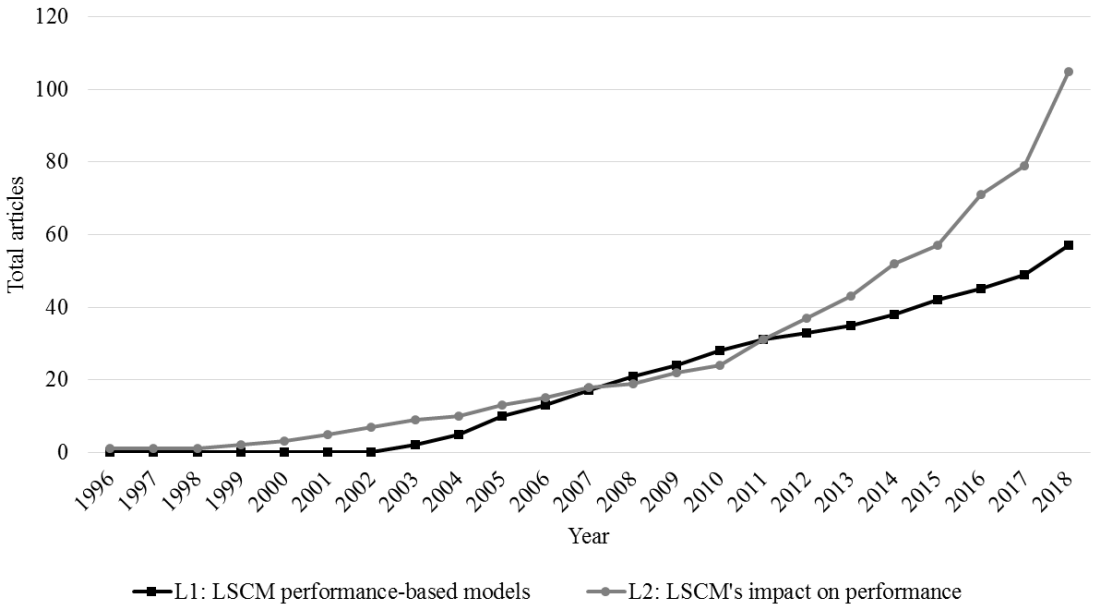


Source: Prepared by the authors

As can be observed, interest related to the research question begins around 1996, when Lamming (1996) extended the implementation of lean management to the SC. The evolution of the publications follows an irregular trend throughout the considered period, with the volume of papers on the studied subject gradually increasing. In absolute terms, 2018 has had the highest number of publications to date, with a total of 34 papers.

The chronological evolution of the studies by proposed research lines is given in Figure 6.

Figure 6. Evolution of research lines

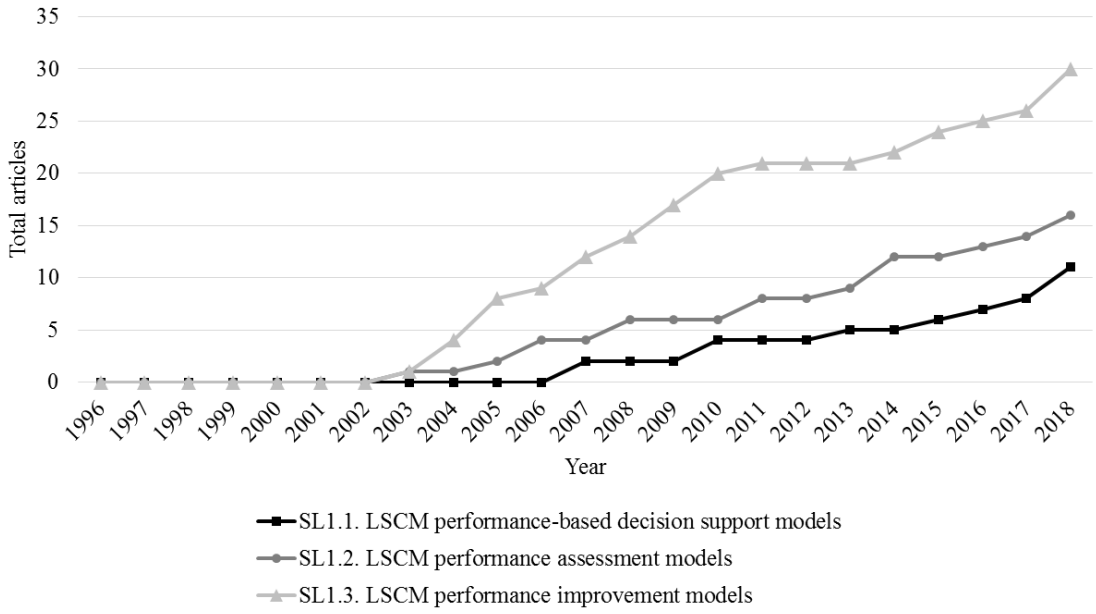


Source: Prepared by the authors

First, a greater number of studies have analyzed the research line on LSCM's impact on performance (L2) than studies that investigate LSCM performance-based models (L1). Specifically, L2 represents 64.8% of all the papers. The two research lines evolve toward growth in a similar way, although the difference between the publication of papers studying LSCM's impact on performance and the line of LSCM performance-based models can be observed to widen from 2014 on.

For a more detailed analysis, the chronological evolution of the papers included in the two main research lines is given in Figure 7, divided by subline.

Figure 7. Evolution of research sublines related to LSCM performance-based models

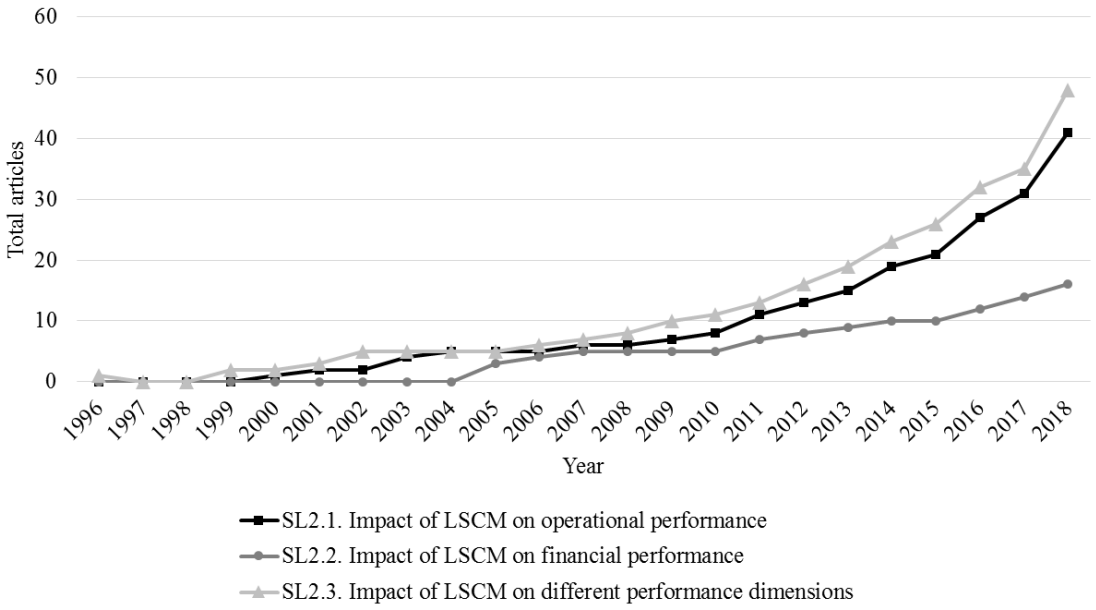


Source: Prepared by the authors

The largest number of articles, 30 (52.6%), can be seen to focus on models that improve or optimize LSCM performance. This subline (SL1.3) begins in 2003 when publications start to increase progressively. Despite a slight halt being observed in the growth of the number of studies between 2010 and 2014, in recent years there has been an upward trend. On the other hand, the sublines on decision support models (SL1.1) and performance evaluation models (SL1.2) have evolved steadily, with totals of 11 and 16 papers, respectively. A significant difference in the evolution of publications of the three research sublines can be observed to the benefit of the subline 1.3 from the outset.

As regards L2 on LSCM's impact on performance (see Figure 8), the trend among the different sublines is quite similar. Since research was first published in 1996, approximately 50.5% of studies have examined the impact on different performance dimensions (SL2.3). In this sense, the difference with the other two sublines (SL2.1 and SL2.2) can be seen to have been growing from 2009 onwards.

Figure 8. Evolution of research sublines on the impact of LSCM on performance



Source: Prepared by the authors

The authors have analyzed different kinds of performance in L1 and L2. The papers have focused on operational performance (77), financial performance (16), operational and financial performance (45), operational and environmental performance (8), financial and environmental performance (1), environmental and social performance (1), operational, financial and environmental performance (6), operational, environmental and social performance (3), financial, environmental and social performance (4), and operational, financial, environmental and social performance (1). Appendix A includes Table A1, which sets out all this information by paper and performance dimension.

The studies have also been classified according to the methodology used (Figure 9), and also by the different groups of papers that can be established within each subline (see Table 3).

Figure 9. Classification by methodology used

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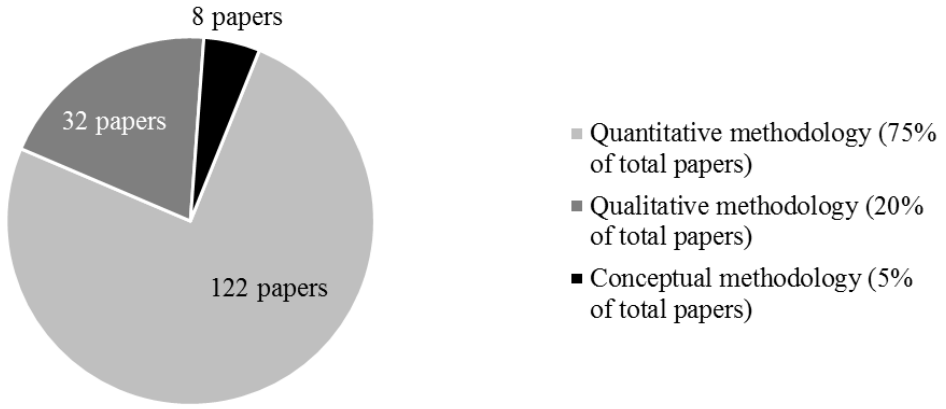

Source: Prepared by the authors

Most of the studies, approximately 75% of the total, have used quantitative methods. The techniques applied in these studies that stand out include simulation, fuzzy logic, and mathematical models. Meanwhile, almost 20% of the papers used a qualitative methodology, predominantly the case study technique. So, more than 95% are empirical studies.

Concerning the volume of papers published by research line, subline, and group, Table 3 shows the comparative importance of each category in absolute and relative terms.

Table 3. Volume of papers by research line, subline, and group

Research lines, sublines, and groups of papers	**Papers**	**% of total**
L1. LSCM performance-based models	57	35.2
SL1.1. LSCM performance-based decision support models	*11*	*6.8*
(a) Context	1	0.6
(b) Strategies	7	4.3
(c) Cooperation	3	1.9
SL1.2. LSCM performance assessment models	*16*	*9.9*
(a) Context	7	4.3
(b) Strategies	8	4.9

(c) Cooperation	1	0.6
SL1.3. LSCM performance improvement models	*30*	*18.5*
(a) Context	13	8.0
(b) Strategies	4	2.5
(c) Cooperation	13	8.0
L2. LSCM's impact on performance	105	64.8
SL2.1. Impact of LSCM on operational performance	*41*	*25.3*
(a) Context	18	11.1
(b) Strategies	12	7.4
(c) Cooperation	11	6.8
SL2.2. Impact of LSCM on financial performance	*16*	*9.9*
(a) Context	5	3.1
(b) Cooperation	11	6.8
SL2.3. Impact of LSCM on different performance dimensions	*48*	*29.6*
(a) Context	24	14.8
(b) Strategies	14	8.6
(c) Cooperation	10	6.2
Total	**162**	**100**

Source: Prepared by the authors

There are a greater number of papers that study LSCM's impact on performance than LSCM performance-based models. The most important subline in L1 focuses on models that improve performance (SL1.3). For L2, the subline that includes studies on the impact of the LSCM on different performance dimensions (SL2.3) is particularly noteworthy.

Finally, regarding the journals in which the studies in this field have been published, it is worth highlighting the importance of the International Journal of Production Economics, with almost 10.5% of all papers. Table 4 gives a distribution of the journals with most published studies on LSCM performance.

Table 4. Most prolific journals on LSCM performance

Journal	**Papers**	**% of total**

International Journal of Production Economics	17	10.49
International Journal of Production Research	10	6.17
Journal of Manufacturing Technology Management	7	4.32
International Journal of Productivity and Performance Management	6	3.70
International Journal of Supply Chain Management	6	3.70
Journal of Cleaner Production	6	3.70
Supply Chain Management	6	3.70
Benchmarking	4	2.47
Industrial Management and Data Systems	4	2.47
International Journal of Operations and Production Management	4	2.47
Journal of Operations Management	4	2.47
Production Planning and Control	4	2.47
Advanced Materials Research	3	1.85
International Journal of Advanced Manufacturing Technology	3	1.85
Journal of Industrial Engineering and Management	3	1.85
Others (67)	75	46.30
Total	**162**	**100**

Source: Prepared by the authors

4.2. Research lines

The following sections describe and analyze the content of the sublines included among the identified research lines. L1 sublines are examined first according to the purpose of the models considered. Subsequently, L2 sublines are analyzed according to the nature of LSCM performance.

L1. LSCM performance-based models

SL1.1. LSCM performance-based decision support models. Part of the literature has proposed different LSCM performance-based models or tools to support strategic decision-making when considering the implementation of specific approaches or the

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selection of the most beneficial strategy to achieve better performance variables. This research subline can be divided into three different groups: (a) Models that consider the role of the context, (b) Models that take into account the comparison or combination of LSCM with other strategies, and (c) Models that focus on the adoption of cooperation practices between SC members.

When proposing their decision support models, some authors focus on the influence of the context, e.g., the characteristics of the environment or the industry in which the SC develops its activity. Regarding contextual aspects such as the industry, Polat *et al.* (2007) present a simulation-based decision support system that takes into consideration the construction project's working conditions.

Other authors propose their decision support models with studies of the LSCM strategy compared or combined with other strategies. There is one article that develops an integrated cost model and compares it to an outsourcing strategy focusing on strategic considerations (Swenseth & Olson 2016). Some works present decision support models focused on LSCM combined with agile strategy (Drake *et al.* 2013; Okongwu *et al.* 2010; Kazmane 2018), mainly centered on operational performance. Meanwhile, some other studies focus on a comparison between lean and green strategies when developing their models (e.g., Fahimnia *et al.* 2015; Wang & Ye 2018). For example, Carvalho *et al.* (2017) propose a mathematical model to select the set of lean and green practices that managers should deploy to improve the eco-efficiency of companies and supply chains.

Focusing on cooperation between SC members, some articles present decision support models for the development of cooperative environments among SC members. These articles propose models centered on inventory management in an SC network (Beheshti *et al.* 2010), models to make decisions about whether VMI (Vendor Managed

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Inventory) alliances should be formed when the cost and benefits are unevenly distributed (Yao *et al.* 2007) and models focused on information sharing between SC agents (Rossini & Portioli 2018).

SL1.2. LSCM performance assessment models. Some articles propose evaluation tools to assess LSCM performance. This literature can be classified into three different groups: (a) Models that evaluate LSCM performance according to contextual characteristics, (b) Models that assess performance while taking LSCM and other strategies into account, and (c) Models that consider cooperation practices within the SC.

Focusing on the context, some authors propose assessment models for Small and Medium Enterprises (SMEs) (Behrouzi & Wong 2011; Behrouzi & Wong 2013). Marlow & Casaca (2003) focus on the service sector, suggesting a set of port performance indicators that measure lean port performance. In the manufacturing sector, Galankashi *et al.* 2018 develop a framework to assess leanness in the automotive industry from an operational perspective. Further work has considered the specific characteristics of demand (Gonçalves *et al.* 2005; Kojima *et al.* 2008) and production (Arif-Uz-Zaman & Nazmul Ahsan 2014).

There are authors who propose their assessment tools considering the combination of LSCM with other strategies. Carvalho *et al.* (2011) develop a conceptual model with lean, agile, resilient, and green practices, and supply chain attributes to evaluate their effect on SC performance. Regarding lean and agile strategies, some authors present a model to analyze the effects of lean and agile SC strategies on flexibility and responsiveness in the SC (Orjuela Castro & Adarme Jaimes 2017). Agarwal *et al.* (2006) propose a framework to explore the relationship between lead time, cost, quality, and

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service level with an analysis of lean, agile, and leagile supply chains. Other articles focus on LSCM in combination with sustainable strategies when evaluating performance (e.g., Kainuma & Tawara 2006; Thanki & Thakkar 2016). In this sense, some authors propose Balanced Scorecard (BSC) frameworks to assess lean and green SC performance (Duarte & Cruz-Machado 2014; Thanki & Thakkar 2018), while others have preferred the Sustainable-VSM tool (Brown *et al.* 2014).

Focusing on cooperation practices, Faria (2008) introduces a new analytical tool for JIT supply chains and demonstrates how to assess a number of relevant performance measurements regarding production costs and quality of service.

SL1.3. LSCM performance improvement models. There is another research line that develops models to improve LSCM performance. Three different groups can be identified in this line: (a) Models that consider contextual factors to improve LSCM performance, (b) Models that improve performance through the adoption of LSCM and other strategies, and (c) Models that take into account cooperation practices in the SC.

As regards the context, some authors develop their models in the maintenance, repair and, overhaul (MRO) environment (Mathaisel 2005), warehousing (Wang *et al*. 2004), and in very specific areas such as hospitals and refugee camps (Savino *et al.* 2015) and global SCs (Kreng & Wang 2005). Other authors have addressed the manufacturing industry, focusing on operational performance (Huang & Liu 2005) and operational and financial issues (Wang *et al.* 2018). Amirjabbari & Bhuiyan (2014) present the development of two models seeking the optimal level of safety stock and its optimal location across the manufacturing SC. Regarding the construction industry, Kong *et al.* (2018) incorporate both economic and environmental performance into their model to

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minimize resource waste and environmental emission penalties. Some articles propose models to achieve overall optimization in the electronics industry, either using JIT purchasing focused on operational issues (Singh & Chand 2009; Singh 2009) or adopting JIT practices and processes to improve operational and financial performance (Mistry 2005a; Singh & Chand 2010). Wangphanich *et al.* (2010) focus their attention on demand variability with the development of a simulation approach for quantifying and reducing the bullwhip effect.

There are authors who present improvement models that consider lean in combination with other strategies such as agile to reduce rework and operating cost and improve cash flow and customer interaction (Banerjee & Mukhopadhyay 2016), green to improve environmental, energy, and economic performance (Zainuddin *et al.* 2018), green and Six Sigma to improve sustainability (Cherrafi *et al.* 2017), and Six Sigma to enhance operational performance (Hill *et al.* 2018).

Regarding collaboration between SC agents, some authors present models to improve LSCM operational performance based on the perspective of collaboration (Parveen & Rao 2009; Tuli & Shankar 2015). The cooperation approach between the supplier and the buyer is also considered in the delivery policy (Kim & Ha 2003, Nie *et al.* 2006) and it is demonstrated that the result can be beneficial to both parties. Lastly, some authors propose cooperation-based integrated inventory models (Banerjee *et al.* 2007; Chen & Sarker 2010; Ouyang *et al.* 2007; Pan & Yang 2008; Yang & Pan 2004) mainly focused on operational performance. Some authors consider the kanban mechanism to improve operational performance in the integrated SC (Jain *et al*. 2011; Wang & Sarker 2004). Jong & Wee (2008) develop an optimal model for an integrated production inventory system assuming a long-term cooperation relationship between the

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supplier and the buyer. In this sense, Cao *et al.* (2007) focus on minimizing SC costs in cooperation policy.

L2. LSCM's impact on performance

SL2.1. Impact of LSCM on operational performance. Some of the studies that analyze the effect of LSCM on performance only take its operational nature into consideration. We have also classified the articles into three groups in this subline according to the core aspect addressed in each article: (a) The role of the context in the impact of LSCM on operational performance, (b) The relationship between LSCM and other managerial initiatives and its effect on operational performance, and (c) The influence of cooperation and integration between SC agents on operational performance.

In the first group, the role of both the SC's specific sector or industry and the influence of the environment have been investigated. Among the studies that analyze the influence of the environment, there are articles that focus on demand variability and its influence on efficiency and responsiveness (Bortolotti *et al.* 2013; Griffiths *et al.* 2000). The importance of the contextual aspect is also highlighted by Kisperska-Moron & de Haan (2011), who analyze the effect of a context of transition from a planned economy to a market economy. Jayaram *et al.* (2014) find a direct positive influence of LSCM on operational performance in developing countries.

From the perspective of the specific characteristics of the industry to which the SC belongs, the impact of LSCM on performance is diverse. In the manufacturing sector, Tortorella *et al.* (2017) investigate the influence of context in the positive link between an improvement in SC operational performance and LSCM practices. More recently,

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Tortorella *et al.* (2018) study the LSCM practices that efficiently improve manufacturing firms' operational performance. Other articles deal with manufacturing firms, focusing on performance elements such as delivery time (Avelar-Sosa *et al.* 2018), productivity (Al-Tit 2016), efficiency and delivery (Danese *et al.* 2012), and flow, flexibility and quality (Taj & Morosan 2011). In addition, Apte & Goh (2004) illustrate how the lean principles used in manufacturing can be successfully applied to information-intensive services with some minor modifications, arguing that minimizing cycle time plays the same role as reducing inventory. Different industries considered in the evaluation of LSCM on operational performance have been the automotive industry (Marodin *et al.* 2016; Wee & Wu 2009), the construction industry (Arbulu *et al.* 2003), the process industries (Panwar *et al.* 2017), the food industry (Ding *et al.* 2014), and the healthcare industry (Habidin *et al.* 2014; Matt *et al.* 2018).

With regard to the second group, a range of studies can be found that focus on the relationship between LSCM and other SC approaches and its impact on operational performance. Wu (2003) conducts a comparative study to identify performance differences between lean and non-lean suppliers and shows that lean suppliers have significant competitive advantages. Focusing on different SC strategies, some authors have examined the impact of lean and agile strategies on operational performance (Ahmed & Huma 2018; Qamar *et al.* 2018; Zelbst *et al.* 2010; Zhang & Qi 2013). Some articles deal with the lean, agile, and resilient approaches (Lotfi & Saghiri 2018), while others analyze the influence of lean, agile, and hybrid supply chain strategies on responsiveness (Osman *et al.* 2015; Rana *et al.* 2016a). Responsiveness has also been investigated by other authors, first to verify the significance of the lean, agile, strategic supplier partnership and postponement supply chain strategies (Rajagopal *et al.* 2016) and then to evaluate the impact of these supply chain strategies (Sundram *et al.* 2018).

Ruiz-Benítez *et al.* (2018) analyze the relationships between lean and resilient SC practices and their impact on supply chain performance. Lastly, Kumar *et al.* (2012) analyze the kanban system designed and implemented to achieve Six Sigma customer service excellence.

In the third group, cooperation and integration between SC agents are studied as further factors that can influence LSCM performance. Some authors focus on an upstream SC perspective (Alshahrani *et al.* 2018; Avittathur & Swamidass 2007; Karakadılar & Hicks 2015), although most address this issue from a full SC perspective (e.g., Dong *et al.* 2001; Furlan *et al.* 2011; Marodin *et al.* 2017). Pozzi *et al.* (2017) confirm that sharing lean thinking with the other SC stages instead of adopting an individualistic behavior improves global performance. Some articles focus on cooperation in transportation management and logistics (Prajogo *et al.* 2016; Rana *et al.* 2016) and others on information sharing along the SC using information technology (Kusmantini *et al.* 2018; Zelbst *et al.* 2014).

SL2.2. Impact of LSCM on financial performance. The literature review has allowed us to identify a group of studies that analyzes LSCM's impact on financial performance. A subdivision has been made into two groups in this subline according to the main issue addressed in the articles: (a) The role of context in LSCM's influence on financial performance, and (b) The influence of the degree of SC cooperation/integration on financial performance.

Different studies exist in the first group, focused on the context in which the lean supply chain (LSC) operates. Some authors study characteristics of the environment such as complexity and dynamism (Azadegan *et al.* 2013), uncertainty (Qi *et al.* 2011), and

industry-specific inventory characteristics and economies of scale (Hofer *et al.* 2012). As regards the sector or industry, Fawcett *et al.* (2016) analyze the relationship between the degree of LSCM implementation and financial performance in the motor carrier industry. Polat & Arditi (2005) focus on the peculiarities of the construction industry, comparing JIT and JIC (just-in-case) materials management strategies. In the traditional materials management system, also referred to as the "just-in-case" (JIC) system, materials, and parts are pushed from one process to the next, regardless of whether they are needed by the next process.

The second group includes articles that analyze the relationship between the degree of cooperation and integration between LSC members and financial performance. Some authors analyze the impact of long-term relationships with suppliers and customers on financial performance (Abbas *et al.* 2018; Pasquire *et al.* 2011), the financial dependence of the focal firm (Elking *et al.* 2017), and the effect of information sharing (Abuhilal *et al.* 2006). From a more general point of view, Qi *et al.* (2017) analyze the effects of the relationships between operations and supply chain strategies on integration and financial performance. Al-Shboul *et al.* (2018) examine the best SCM practices for improved market and financial performance, i.e., supplier collaboration, flexibility with partners, internet use, customer focus, lean production, internal integration, and quality management. Regarding JIT practices, there are articles that have focused on cooperation approaches and JIT production (Keane & Feinberg 2007), JIT supply (Mistry 2005b), JIT selling (Green Jr. & Inman 2005), and Total JIT strategy (Green Jr. *et al.* 2014; Nozari & Mojdehi 2016).

Garcia-Buendia, N., Moyano-Fuentes, J. and 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*, Vol. 32, pp. 405–423, doi: https://doi.org/10.1016/j.cirpj.2021.01.016.

SL2.3. Impact of LSCM on different performance dimensions. This research subline includes articles that have studied LSCM's impact on various performance dimensions. This group includes very different types of performance, not only operational or financial, but also environmental, social, and market performance. For their analysis, these studies have been classified into three groups according to the main aspect researched: (a) The role of context in LSCM's impact on performance; (b) A comparative analysis of LSCM and other supply chain strategies and their impact on performance; and (c) The importance of cooperation between SC members for LSCM performance.

The first group of studies comprises a large number of articles that examine the role that the context plays in LSCM's impact on performance. Some have considered the specific characteristics of the sector or industry in which the organizations and supply chains carry out their activity. Some authors have focused on the impact of LSCM on both operational and financial performance, analyzing this relationship on manufacturing SCs (Bevilacqua *et al.* 2017; Cook & Rogowski 1996), spare parts SCs (Chen *et al.* 2013), the footwear industry (Taylor 2009), the block rubber industry (Promngurn *et al.* 2014), the latex industry (Ponpakdee *et al.* 2014), the wholesale/retail sector (Daine *et al.* 2011), the healthcare sector (Adebanjo *et al.* 2016; Dobrzykowski *et al.* 2016; Nikolaeva 2018), the service-based industry (Shah & Naghi Ganji 2017), the food industry (Manzouri 2012), the logistics industry (Zhang *et al.* 2016), and warehousing (Abushaikha *et al.* 2018). Another industry considered is construction, with the study of the potential danger of indiscriminately applying lean thinking in highly complex and uncertain environments such as construction projects (Fearne & Fowler 2006). This disproportionate application of lean is also studied by Chen *et al.* (2010), who analyze the benefits and pitfalls associated with LSCM and show that applying lean "to the max" can diminish the ability of the organization to compete in certain circumstances, such as in an economic crisis.

Garcia-Buendia, N., Moyano-Fuentes, J. and 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*, Vol. 32, pp. 405–423, doi: https://doi.org/10.1016/j.cirpj.2021.01.016.

Other authors focus on operational and environmental performance, examining road hauler firms (Salhieh *et al.* 2018), and a maintenance organization (Ball & Lunt 2018).

Considering the firms' characteristics and their specific environments, there are authors who focus on operational and financial performance in SMEs (Koh *et al.* 2007; Lau & Wang 2014). Some articles analyze the impact of LSCM on operational and environmental performance, studying a closed-loop supply chain setting (Genc & De Giovanni 2018), and an emerging economy (Jakhar *et al.* 2018). Pearce *et al.* (2018) investigate the determining factors that drive sustainable performance (economic, environmental, and social) through the application of lean methods in an SC characterized by climatic and biophysical dynamism. The analysis by Mefford (2011) is interesting as it studies the effects of lean practices on consumers, employees, and financial risk in global supply chains from an ethical point of view that includes environmental impact, bribes, and anti-competitive practices, among others.

The second group includes a set of studies that focus on the relationships between LSCM and various supply chain strategies and the impact of these relationships on performance (e.g., Mishra *et al.* 2018). Some authors study the impact of the lean and agile supply chain strategies on operational and financial performance (e.g., Chan & Burns 2002; Ghobakhloo & Azar 2018; Mohammed *et al.* 2008; Morash 2001; Qi *et al.* 2009). Qrunfleh & Tarafdar (2013) focus on lean and agile supply chain strategies, responsiveness, and financial and market performance. The same authors subsequently focus on the role of information systems on efficiency (lean) and flexibility (agile) and their impact on firm performance and SC performance (Qrunfleh & Tarafdar 2014). Other articles investigate the effect of LSCM and sustainable strategies on performance. There are authors who study the impact of lean and green practices on operational and

Garcia-Buendia, N., Moyano-Fuentes, J. and 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*, Vol. 32, pp. 405–423, doi: https://doi.org/10.1016/j.cirpj.2021.01.016.

environmental performance (Inman & Green 2018; Kurdve *et al.* 2015), while others also include financial performance (Thanki *et al.* 2016). In addition, some authors address the social perspective of the impact of LSCM (Azevedo *et al.* 2012; Wu *et al.* 2015; Wu *et al.* 2018).

The last group consists of articles that analyze the role of cooperation between LSC members and its impact on performance. Most of the authors focus on the impact on operational and financial performance. Some study integration and cooperation between companies and their customers and suppliers (Eltantawy *et al.* 2015; Hongpiriyakul *et al.* 2013; Mathur *et al.* 2018), and the role of information sharing (Al-Shboul *et al.* 2017). Jajja *et al.* (2016) highlight the importance of alignment between a buying firm's supply chain strategy and the ability of its suppliers to execute correspondingly. For example, Vázquez *et al.* (2016) argue that a lack of financial cooperation in the SC damages supply chains' operational efficiency and puts their overall stability at risk. Some articles focus on the impact on the operational and financial performance of specific LSCM cooperation practices based on JIT, such as Total JIT system (Claycomb *et al.* 1999), and JIT-purchasing (Kaynak 2002). Finally, from a sustainability point of view, there are authors who analyze the impact of lean practices on a firm's environmental performance excellence and its extension to its suppliers (Hong *et al.* 2012). On a similar topic, Wong *et al.* (2018) test the effects of customer sustainable development, supported by internal and supplier sustainable development, on cost-reduction, environmental, and financial supply chain performance.

Considering a joint vision of papers belonging to the different groups of papers in our classification, Table 5 shows the number of papers on LSCM based on their focus

Garcia-Buendia, N., Moyano-Fuentes, J. and 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*, Vol. 32, pp. 405–423, doi: https://doi.org/10.1016/j.cirpj.2021.01.016.

and arranged according to the identified content groups in our literature classification, i.e., context, SC strategies, and cooperation.

Table 5. Summary of LSCM and performance relationship classification

Line/Group	Context	SC strategies	Cooperation
L1. LSCM performance-based models	- Sectors or industries addressed: manufacturing (3), automotive (1), construction (2), services (1), electronics (4), maintenance and repair (1), warehousing (1), healthcare (1). - Characteristics of the firm or SC: SMEs (2), demand variability (3), production issues (1), global SC (1).	- LSCM and different SC strategies: outsourcing (1), agile (6), green (9), resilient and green (1), Six Sigma (1), Six Sigma and green (1).	- Cooperation practices: focus on inventory management (8), internal and external value chain (8), comparison between non-cooperation and cooperation policy (1).
L2. LSCM's impact on performance	- Sectors or industries addressed: manufacturing (8), automotive (2), construction (3), motor carrier (1), spare parts (1), footwear (1), block rubber (1), latex (1), process (1), food (3), wholesale/retail (1), healthcare (5), information-intensive services (1), logistics (1), warehousing (1), road hauler firms (1), maintenance and repair (1). - Aspects of the environment: economy transition (1), economic crisis (1), developing country (2). - Characteristics of the firm or SC: SMEs (2), demand variability (2), environmental uncertainty (3), global SC (1), closed-loop SC (1), economies of scale (1).	- LSCM and different SC strategies: non-lean (2), agile (15), resilient (1), agile and resilient (1), Six Sigma (1), green (6).	- Cooperation practices: spreading of lean thinking (1), information sharing (4), cooperation with financial focus (2), JIT practices cooperation (9), cooperative transportation (2), cooperation from an upstream perspective (6), cooperation from both upstream and downstream perspectives (5), SC integration (3).

Source: Prepared by the authors

5. Gaps and future research directions

Garcia-Buendia, N., Moyano-Fuentes, J. and 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*, Vol. 32, pp. 405–423, doi: https://doi.org/10.1016/j.cirpj.2021.01.016.

Both the study of the state-of-the-art and the proposed classification have identified certain gaps in the literature that it would be interesting to address. In addition, some aspects have been observed into which the literature has not gone in sufficient depth. Some future research themes are therefore suggested with the objective of covering these gaps and further examining the aspects that have not been addressed in the literature. Table 6 shows the main gaps identified and the suggested research directions to address these gaps. The first column includes the research lines analyzed previously, while the second contains the identified gaps in these research lines. Finally, the last column comprises the actions for future research that could be addressed.

Table 6. Gaps and future directions in LSCM and performance relationships

Research line	**Main gaps**	**Future research**
L1. LSCM performance-based models	Deep consideration of contextual factors and specific characteristics of the SC	• Design and development of models for cross-country SCs considering factors related to logistics development in each country and cultural issues • Development of generalizable models applicable to different industry sectors and organizations
	Consideration of LM implementation at the internal level and along the SC	• Development of models that take into account internal lean implementation as the initial step for subsequent LSCM implementation
	Focus on the relationships between LSCM and some SC strategies	• Proposal of models that add resilient or six sigma practices to LSCM to achieve better performance • Development of tools to empirically assess the combination of lean, agile, resilient, Six Sigma, and green SC strategies
	Reliability and validity of some performance-based models	• Establishment of quantitative and qualitative performance metrics and KPIs that reflect all the assessment areas of the SC • Verification and validation of the proposed frameworks in a real environment • Design and development of models jointly by researchers and practitioners

L2. LSCM's impact on performance	Focus on the service sector	• Exploration of the extension of LM to the SC in the service sector, e.g., hospitality, education, banking, public administration, etc., and its impact on performance
	Emphasis on the study of LSCM and performance in the context of SMEs	• Study of LSCM and performance relationships in SMEs to assist managers and practitioners in the implementation process
	Exploration of the influence of uncertainty derived from economic cycles or epidemics (COVID-19 outbreak) on LSCM performance	• Study of the effects of supply uncertainty on LSCM - performance relationship
	More analyses of LSCM's impact on the three sustainability dimensions (economic, social, and environmental)	• Deeper understanding of the influence of LSCM on sustainability performance
	Studies which evaluate the effects of LSCM and other SC strategies on performance	• Assessment of the impact of combining the lean and the six sigma or resilient SC on performance
	Assessment of the influence of information technologies (IT) on the LSCM and performance relationship	• Examination of the impact of the implementation of emerging IT along the LSC • Investigation of IT's mediator or moderator role in the LSCM - performance relationship • Analysis of the joint effect of Industry 4.0 and LSCM on business performance
	Studies of LSCs with particular customer-supplier relationship	• Study of the impact on performance of LSCs characterized by lack of trust or relative power between their members • Research on the supply chains with an extensive number of agents or with a very limited one • Examination of organizations located very high upstream or very low downstream
	Focus on the relationship between LSCM and risk management	• Analysis of the role of risk management in LSCs where the lack of visibility and control of information shared with the members is key and its influence on performance

Source: Prepared by the authors

To sum up, some general research directions can be suggested for the development of performance-based models (L1) and the study of LSCM's impact on performance (L2).

Garcia-Buendia, N., Moyano-Fuentes, J. and 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*, Vol. 32, pp. 405–423, doi: https://doi.org/10.1016/j.cirpj.2021.01.016.

Regarding the context and the SC characteristics, the principal gaps are related to unexplored contextual factors. The exploration of LSCM and performance relationship according to the country where the LSC develops its activity (cross-country SCs), the current implementation stage (internal level and along the SC), and firm size (SMEs) are contextual issues that can be addressed by future research. Concerning the industry, there are many differences between the manufacturing sector and the service industry that may hinder the successful implementation of LSCM (Cherrafi *et al*. 2016), so further studies should take these differences into consideration when studying the relationships between LSCM and organizational and SC performance. A deeper focus on the service sector is required since our study has shown a clear focus on the manufacturing industry in the research literature that addresses this issue. The need to reinforce research and explore novel ideas in the lean service context has been also supported by Danese *et al*. (2018). Additionally, the significance of environmental uncertainty (see Chen & Paulraj 2004) in LSCM and performance relationships has increased recently. The COVID-19 global outbreak is changing the outlook around the world, so many SCs are facing the uncertainty and complexity of their environment in new circumstances. Empirical studies should be carried out to address the role of uncertainty and, mainly, supply uncertainty in LSCM performance to help managers and practitioners to better understand the new challenges and opportunities provided by LSCM.

Regarding the combination pattern of LSCM and other SC strategies, most of the studies on LSCM and performance have focused on LSCM and agile or green approaches (see Table 5). There is a lack of studies dealing with the impact of the joint implementation of LSCM and Six Sigma or resilience strategies on performance. This work shows that the few studies that have addressed these combinations and their impact on performance have focused on operational performance (see Table A1), so further

research should pay attention to the social and environmental performance dimensions. From a broad perspective, many papers analyze the outcomes of LSCM from a technical perspective (operational-financial performance), while few studies examine social outcomes (working environment and impact on society) and LSCM sustainability (see Table A1). The previous literature has also identified a focus of scientific research on operational performance when analyzing lean outcomes (e.g. Danese *et al*. 2018). This confirms a lack of studies analyzing the social and environmental outcomes of LSCM. Future research in this field should cover this gap by digging deeper into the social and environmental outcomes of LSCM. Some authors have recently demonstrated the importance that the scientific research gives to certain human-related factors in the successful implementation of LSCM (Garcia-Buendia *et al*. 2020), so it may become important to analyze the different dimensions of sustainability performance.

Finally, the mediator/moderator role of IT in the LSCM - performance relationship needs to be investigated, given the relevance of the digital transformation that many SCs are undergoing in order to form part of the so-called Industry 4.0. In this sense, Nuñez-Merino *et al*. (2020) have previously proposed the study of the impact of Cloud Computing, Big-Data, IoT, and AI on LSCM performance at both the operational and financial levels. The role of information and digital technologies in LSCM sustainable performance is also an interesting avenue for future research.

6. Conclusions

The aim of this paper has been to identify, evaluate, and analyze the literature about LSCM and performance relationships. The analysis has allowed us to deduce the lack, to date, of a literature review that brings together all the research on the impact of adopting

and implementing an LSCM strategy on performance. The literature reviews of this issue have paid no attention to the interrelationships between LSCM and performance, so this paper fills this gap in the literature.

This study provides a guide that can facilitate the work of academics and practitioners. For researchers seeking to delve into this topic, our analysis is helpful for exploring and identifying the issues addressed in the interrelationships between LSCM and performance. Regarding managers and practitioners, existing performance-based models can be compared to analyze the effectiveness of LSCM. It will also be possible for managers to determine which performance dimensions are influenced by certain aspects of the context. Similarly, this work can be useful for facilitating the choice of supply chain strategies that, combined with lean, will achieve the best performance.

Finally, there are some limitations to this study due to the SLR approach taken. On the one hand, only articles in press and papers published in English that satisfied our quality and content criteria (e.g. the use of the databases or keywords considered) were included, thus some lean-related documents may have been omitted (publication bias). The selection of traditional organizational performance keywords that do not include any sustainability-related terms could be considered a minor limitation, given that our SLR considers a wide search period when sustainability concepts were not fully established. On the other hand, the literature classification is based on subjective processes, i.e., the researchers' own criteria. Nevertheless, these limitations are inherent to the SRL methodology, since appropriate restrictions need to be specified for the review to be feasible.

Appendix A. Supplementary data

Garcia-Buendia, N., Moyano-Fuentes, J. and 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*, Vol. 32, pp. 405–423, doi: https://doi.org/10.1016/j.cirpj.2021.01.016.

Table A1. Summary of the LSCM performance dimensions addressed by the literature

P	Abbas et al. (2018)	Abuhilal et al. (2006)	Abushaikha et al. (2018)	Adebanjo et al. (2016)	Agarwal et al. (2006)	Ahmed & Huma (2018)	Al-Shboul et al. (2017)	Al-Shboul et al. (2018)	Al-Tit (2016)	Alshahrani et al. (2018)	Amirjabbari & Bhuiyan	Apte & Goh (2004)	Arbulu et al. (2003)	Arif-Uz-Zaman & Nazmul	Avelar-Sosa et al. (2018)	Avittathur & Swamidass	Azadegan et al. (2013)	Azevedo et al. (2012)	Ball & Lunt (2018)	Banerjee & Mukhopadhyay	Banerjee et al. (2007)	Beheshti (2010)	Behrouzi & Wong (2011)	Behrouzi & Wong (2013)	Bevilacqua et al. (2017)	Bortolotti et al. (2013)	Brown et al. (2014)	Cao et al. (2007)	Carvalho et al. (2011)	Carvalho et al. (2017)	Chan & Burns (2002)	Chen & Sarker (2010)	Chen et al. (2013)	Chen et al. (2010)	Cherrafi et al. (2017)	Claycomb et al. (1999)	Cook & Rogowski (1996)	Daine et al. (2011)	Danese et al. (2012)	Ding et al. (2014)	Dobrzykowski et al. (2016)
OP			●	●	●	●	●		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●	●	●	●	●	●
FP	●	●	●	●			●	●						●			●			●					●		●	●	●	●		●	●		●		●	●			●
EP																		●	●								●	●	●						●				●		
SP																		●									●								●						
P	Dong et al. (2001)	Drake et al. (2013)	Duarte & Cruz-Machado	Elking et al. (2017)	Eltantawy et al. (2015)	Fahimnia et al. (2015)	Faria (2008)	Fawcett et al. (2016)	Fearne & Fowler (2006)	Furlan et al. (2011)	Galankashi et al. (2018)	Genc & De Giovanni	Ghobakhloo & Azar (2018)	Gonçalves et al. (2005)	Green Jr & Inman (2005)	Green Jr et al. (2014)	Griffiths et al. (2000)	Habidin et al. (2014)	Hill et al. (2018)	Hofer et al. (2012)	Hong et al. (2012)	Hongpiriyakul et al. (2013)	Huang & Liu (2005)	Inman & Green (2018)	Jain et al. (2011)	Jajja et al. (2016)	Jakhar et al. (2018)	Jayaram et al. (2014)	Jong & Wee (2008)	Kainuma & Tawara (2006)	Karakadilar & Hicks (2015)	Kaynak (2002)	Kazmane (2018)	Keane & Feinberg (2007)	Kim & Ha (2003)	Kisperska-Moron & de	Koh et al. (2007)	Kojima et al. (2008)	Kong et al. (2018)	Kreng & Wang (2005)	Kumar et al. (2012)
OP	●	●	●		●	●	●		●	●	●	●	●	●			●	●	●			●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
FP			●	●	●			●	●				●	●	●	●				●	●	●				●			●	●		●		●			●				
EP			●			●						●									●			●			●		●						●				●		
SP			●																		●																				

P	Kurdve et al. (2015)	Kusmantini, et al. (2018)	Lau & Wang, 2014	Lotfi & Saghiri (2018)	Manzouri (2012)	Marlow & Casaca (2003)	Marodin et al. (2016)	Marodin et al. (2017)	Mathaisel (2005)	Mathur et al. (2018)	Matt et al. (2018)	Mefford (2011)	Mishra et al. (2018)	Mistry (2005a)	Mistry (2005b)	Mohammed et al. (2008)	Morash (2001)	Nie et al. (2006)	Nikolaeva (2018)	Nozari & Mojdehi (2016)	Okongwu et al. (2010)	Orjuela Castro & Adarme	Osman et al. (2015)	Ouyang et al. (2007)	Pan & Yang (2008)	Panwar et al. (2017)	Parveen & Rao (2009)	Pasquire et al. (2011)	Pearce et al. (2018)	Polat & Arditi (2005)	Polat et al. (2007)	Ponpakdee et al. (2014)	Pozzi et al. (2017)	Prajogo, Oke, & Olhager	Promngurn et al. (2014)	Qamar et al. (2018)	Qi et al. (2009)	Qi et al. (2017)	Qi et al. (2011)	Qrunfleh & Tarafdar (2013)	Qrunfleh & Tarafdar (2014)
OP	●	●	●	●	●	●	●	●	●	●	●		●	●		●	●	●	●		●	●	●	●	●	●	●		●		●	●	●	●	●	●			●	●
FP			●		●	●				●		●	●	●	●	●	●		●	●								●		●		●			●	●	●	●	●	●
EP	●											●																	●												
SP												●																	●												
P	Rajagopal et al. (2016)	Rana et al. (2016)	Rana et al. (2016a)	Rossini & Portioli (2018)	Ruiz-Benítez et al. (2018)	Salhieh et al. (2018)	Savino et al. (2015)	Shah & Naghi Ganji (2017)	Singh (2009)	Singh & Chand (2009)	Singh & Chand (2010)	Sundram et al. (2018)	Swenseth & Olson, 2016	Taj & Morosan (2011)	Taylor (2009)	Thanki & Thakkar (2016)	Thanki & Thakkar (2018)	Thanki et al. (2016)	Tortorella et al. (2018)	Tortorella et al. (2017)	Tuli & Shankar (2015)	Vázquez et al. (2016)	Wang & Sarker (2004)	Wang & Ye (2018)	Wang et al. (2004)	Wang et al. (2018)	Wangphanich et al. (2010)	Wee & Wu (2009)	Wong et al. (2018)	Wu (2003)	Wu et al. (2015)	Wu et al. (2018)	Yang & Pan (2004)	Yao et al. (2007)	Zainuddin et al. (2018)	Zelbst et al. (2014)	Zelbst et al. (2010)	Zhang & Qi (2013)	Zhang et al. (2016)	**T**	
OP	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●	●	●	**140**	
FP							●	●			●		●		●		●	●				●				●			●	●	●	●			●				●	**72**	
EP						●										●	●	●					●						●		●	●			●					**26**	
SP																															●	●								**9**	

P – Performance; **OP** – Operational Performance; **FP** – Financial Performance; **EP** – Environmental Performance; **SP** – Social Performance; **T** – Total papers

Source: Prepared by the authors

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