

# TRENDS IN THE SCIENTIFIC LITERATURE ON THE LEAGILE SUPPLY CHAIN: BIBLIOMETRIC AND CITATION CONTEXT ANALYSES

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## Article history

Received: August 27<sup>th</sup>, 2023

Received in revised form: October 4<sup>th</sup>, 2023 | Accepted: October 12<sup>th</sup>, 2023

Available online: December 4<sup>th</sup>, 2023

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## Abstract

*Leagile is a hybrid of conventional lean and agile approaches intended to eliminate specific constraints and capacity limitations and enable agility in highly competitive business environments. Interest in incorporating lean and agile into the supply chain has grown in recent years, as shown by the growing number of scientific publications on this topic. This topic has garnered significant interest across a wide range of academic disciplines; however, a comprehensive study of the literature in this field has not yet been conducted. Therefore, the present study aims to provide a state-of-the-art summary of leagile supply chain issues that concern researchers. To do so, we use a bibliometric method, combined with citation context analysis, to evaluate data extracted from Scopus peer-reviewed articles published between 1999 and March 2023. Data analytic techniques, including citation analysis, co-citation analysis, and co-word (co-occurrence) analysis, are used. Using rigorous bibliometric and visualization tools, the results show the current status of the research problem, its impact, and suggestions for future work to address research gaps, such as a problem in an area of research that has been answered incompletely or insufficiently. The findings suggest that researchers in unexplored research areas in the ASEAN region include green supply chain strategies, supply chain risk management influenced by lean and agile strategies, and comparative analyses among ASEAN countries. These areas offer promising avenues for future research, contributing to regional competitiveness and performance enhancement.*

**Keywords:** Bibliometric; Leagile; Scopus; Supply chain; Systematic review.

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DOI: [http://doi.org/10.37569/DalatUniversity.13.4S.1222\(2023\)](http://doi.org/10.37569/DalatUniversity.13.4S.1222(2023))

Article type: (peer-reviewed) Full-length research article

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## 1. INTRODUCTION

A supply chain is defined as a collection of companies, including suppliers of raw materials, manufacturers, distributors, and other resources, that directly or indirectly move goods or services from producers to consumers. The term, “supply chain management,” can describe the entire manufacturing process of an organization, including purchasing and supply management within dyadic relationships between firms, the total chain, and the total company network (Harland, 1997). Manufacturing plays an important part in a supply chain. The supply chain management field is still young compared with manufacturing. Indeed, the industrial revolution originated in the manufacturing industry. The manufacturing industry began very early, and there has since been a marked advance in the fundamentals of philosophy and tools. In response to a lack of financial resources post-war, the Toyota production system came into being at the Toyota plant. The purpose of this system is to boost production using as few resources as possible. Thus, one tool or method that has been applied to many industries is “lean manufacturing,” which means “doing more with less and less” (Martin & Towill, 2000). Along with cutting waste to minimize costs, lean manufacturing maximizes value by getting “the right things to the right places at the right time and in the right amount” (Browning, 2000). Lean will not bring flexibility to supply chains, organizational structures, information systems, logistics processes, and especially not to the thinking of management (Naylor et al., 1999). Lean is not able to respond to changing and volatile markets. Adaptability makes manufacturers more resilient to uncertainty; therefore, manufacturing has tended toward adjustment in response to prevailing market circumstances. Mason-Jones et al. (2000) argued that businesses need both lean to optimize business operations and agile as the next step since they cannot be “too lean” (Pham & Thomas, 2011) or being too inflexible will negatively affect their performance (Metternich et al., 2013). The combination of lean and agile for sustainable growth in the supply chain was first demonstrated by Naylor et al. (1999). One year later, Mason-Jones et al. (2000) named this combination “leagile supply chain” (LSC).

Even if its principles are widely known, lean is not easy to apply, and further research is required to eliminate the difficulties (Secchi & Camuffo, 2019). Because of the need to simultaneously deploy leagile, managers may fail to apply these paradigms properly (Rahimi & Alemtabriz, 2022). Thus, there is a need to categorize and explain various historical aspects of the scientific development of this topic and to identify significant problems that have not been studied.

LSC-related studies are very diverse. As observed, there is much research related to LSC; however, to the best of our knowledge, an investigation of this body of literature has not been performed. Therefore, the LSC literature was reviewed for scientific developments, and suggestions are made for further research to fill gaps in scientific research cooperation.

## 2. METHODOLOGY

This study uses a bibliometric method. Existing research on a given topic is identified using the output of the annual archive of scholarly articles through

bibliographic analysis (Agrawal et al., 2022; Al-Khoury et al., 2022; Mukherjee et al., 2022). The authors then find the degree of influence (impact of articles in the relevant profile), the issue being researched, and cooperation in research. Journals and scholars from a variety of disciplines have published many high-impact articles that use bibliometric techniques to study the evolutionary nuances of different fields and capture new trends (Mukherjee et al., 2022).

To consolidate our findings, we additionally conducted a citation context analysis of clusters identified in our co-occurrence analysis of keywords. We especially focused on reading recently published articles to further interpret research patterns. This mixed-methods analysis helped us identify results more accurately and provide specific suggestions to fill research gaps.

### 2.1. Dataset

To construct the dataset for this bibliometric study, secondary data were collected from the Scopus database, which is one of two relatively reliable data sources at present, along with the Web of Science database. We also chose Scopus because it is large and accounts for more than 60% of the Web of Science database (Zhao & Strotmann, 2015).

### 2.2. Search terms

The primary title search keyword was “leagile.” We also combined the words “lean” and “agile” to find papers that do not use the term “leagile.” The exact query is shown in Table 1. The query referenced literature reviews by Seuring and Gold (2012) and Francis et al. (2014) on supply chain management. They excluded books and studies published as book chapters to ensure high reliability of the output results.

**Table 1. Search terms**

Date of extraction:	11:16 a.m. 22/3/2023 (GMT + 7)
Query:	[TITLE (leagile) OR TITLE (lean AND agile) AND TITLE (supply AND chain)]
Inclusion criterion:	English peer-reviewed article or conference paper

### 2.3. Methods table

It was necessary to develop a protocol. Search results that met the inclusion criterion and were extracted for analysis included bibliographical information, abstracts, keywords, citation information, and references. We used various complementary software tools and data presentation methods (Table 2).

**Table 2. Tools and methods of data representation**

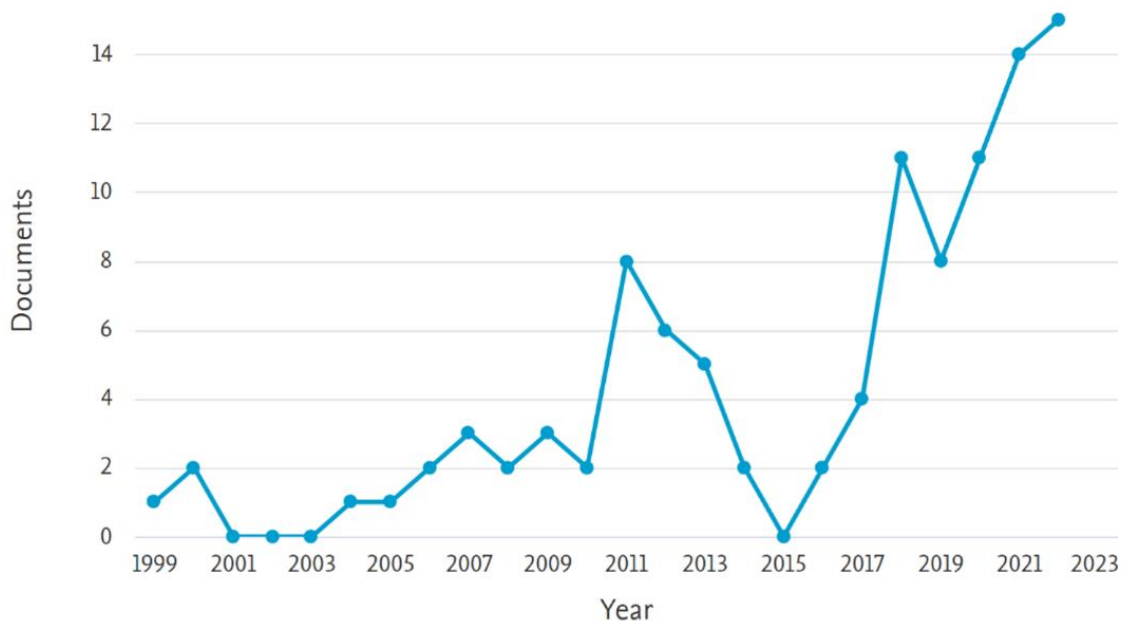
Research topic	Representation	Software/Website
Publications by year, country, and subject area	Line, bar, and pie charts	Scopus built-in analysis tools

**Table 2. Tools and methods of data representation (cont.)**

Research topic	Representation	Software/Website
Co-authorship countries	Node clusters	VOSviewer
Co-citation	Node clusters and evidence from citation context analysis	VOSviewer, + Scite.ai
Research patterns	Node clusters and content analysis	VOSviewer

### 3. RESULTS AND DISCUSSION

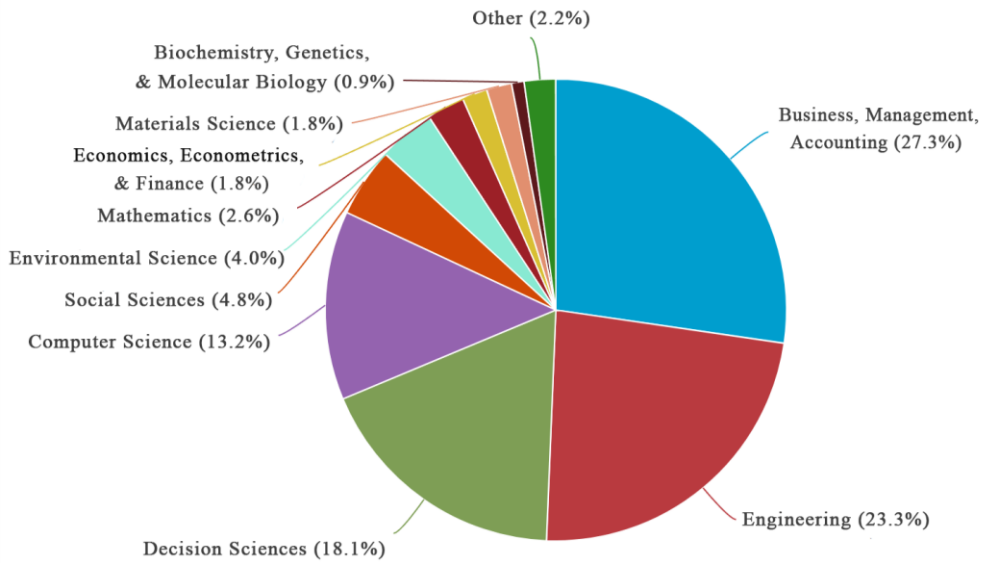
The search returned 103 documents (Figure 1). The idea of combining lean and agile in the supply chain is the same as that first proposed by Naylor et al. (1999). Surprisingly, there has been a strong growth in the number of publications on this topic since 2016. In the five years from 2018 to the time of extraction in March 2023, the total number of studies obtained was 59, more than half of the total number of documents obtained.



**Figure 1. Article distribution by year of publication**

Source: Scopus.

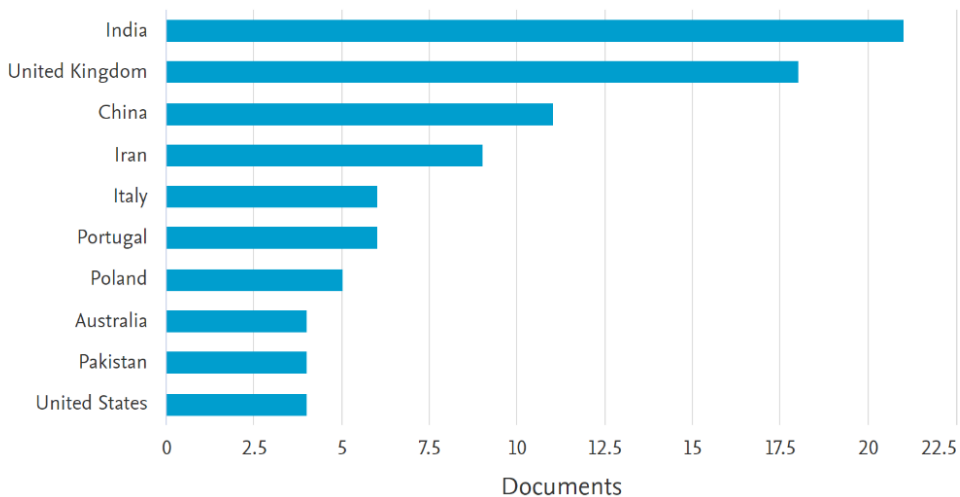
Figure 2 shows the diverse fields of research in which LSC studies have been published. Research publications in the fields of business, management, and strategy account for 27.3%, and publications in engineering journals account for 23.3%. There has been much research in the fields of decision science (18.1%) and computer science (13.2%). Other fields, such as social sciences (4.8%), environmental science (4.0%), and mathematics (2.6%), account for relatively little weight, with less than 5% for each field.



**Figure 2. Documents by subject area**

Source: Scopus.

Figure 3 shows that articles from the top four countries account for more than half of the total number of studies, led by authors from India (21) and followed by the United Kingdom (18), China (11), and Iran (9). The other top 10 countries by number of contributions are Italy (6), Portugal (6), Poland (5), Australia (4), Pakistan (4), and the United States (4).



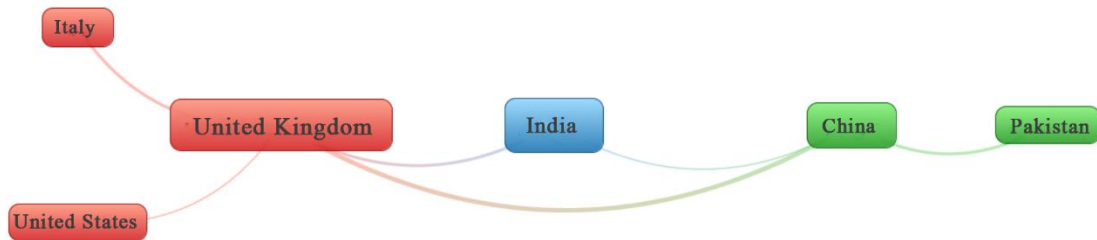
**Figure 3. Article distribution by country**

Source: Scopus.

### 3.1. Co-authorship countries

The analysis of co-authorship countries indicates collaboration between authors, organizations, and countries (Figure 4). Abdullah and Khan (2021) argue that the participation and contribution of multinational research teams in the creation of individual

scientific papers leads to a higher quantity and quality of scientific output. We believe that it is difficult to judge whether the quality is better with multinational cooperation; however, it is easy to see that the cooperation shows that scientists from different countries have a working relationship.



**Figure 4. Co-authorship countries**

Note: Author analysis using VOSviewer.

Conducting further analysis requires the use of VOSviewer software. The filter was set so that the minimum number of documents from a country is two, so that only cooperation between countries with two or more publications is recognized. We exclude the ASEAN countries and examine the resulting subject group more closely (Table 3). The results are three cluster groups: (i) Italy + UK + US, (ii) China + Pakistan, and (iii) India (Figure 4).

**Table 3. Total link strength and number of co-authored papers by country**

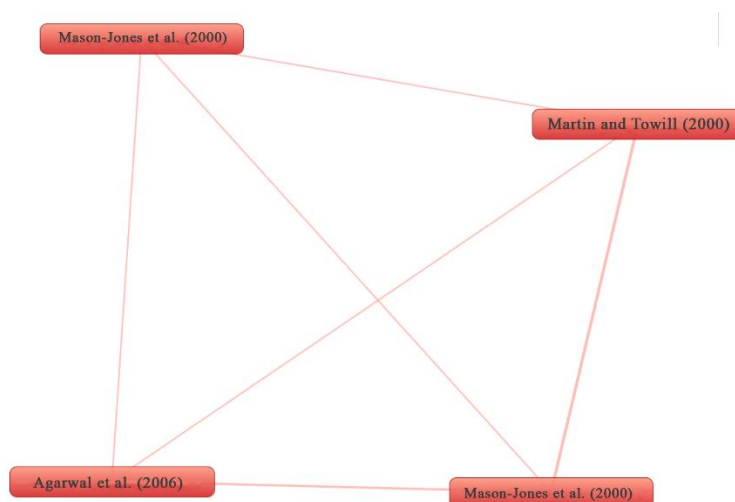
Country	Documents	Total link strength
United Kingdom	18	8
Australia	4	6
China	11	6
Czech Republic	2	6
Iran	9	6
Turkey	2	6
India	21	3
Italy	6	2
Pakistan	4	2
Finland	2	1
Poland	5	1
Indonesia	3	1
United States	4	0
Canada	3	0
Egypt	2	0
Malaysia	3	0
Thailand	1	0

International collaboration on papers by Indian authors is low, so the total link strength index is low. The lack of cooperation in researching LSC topics shows the lack of problem-solving cooperation between developed and developing countries. Notably, among the ten research projects from ASEAN countries, most are internal studies without any collaboration or connection between the countries. The exception is the research by an Indonesian author whose study is part of a doctoral dissertation on business performance in Saudi Arabia (Zimmermann et al., 2020).

### 3.2. Co-citation

Citation analysis is probably the most traditional method applied in bibliometrics as an approximate measure of scientific quality, particularly in the case of individual researchers (Ellegaard & Wallin, 2015). First, we evaluated the influence of citations on the basis of the citations/document index. A high value of the index indicates a certain degree of prestige and influence of the research. The data show that countries with a high citation/document index include the United Kingdom (178.6), the United States (103.5), Portugal (52.3), India (44.6), and Italy (41.0).

Next, we evaluated co-citation. Assessing citation trends is important because it allows us to understand the relationship between the area of interest and other branches of research. Co-citation describes two documents appearing together in the reference list of a third cited article. These two documents together form a co-citation relationship. The co-citation analysis of literature can efficiently and conveniently locate the crucial knowledge foundation in a specific field of research; that is, it can locate and identify the core classical literature. Furthermore, it can analyze and mine the relationship and development context between the documents. The academic influence of references can be quantified to a certain extent according to co-citation frequency and intermediary centrality.

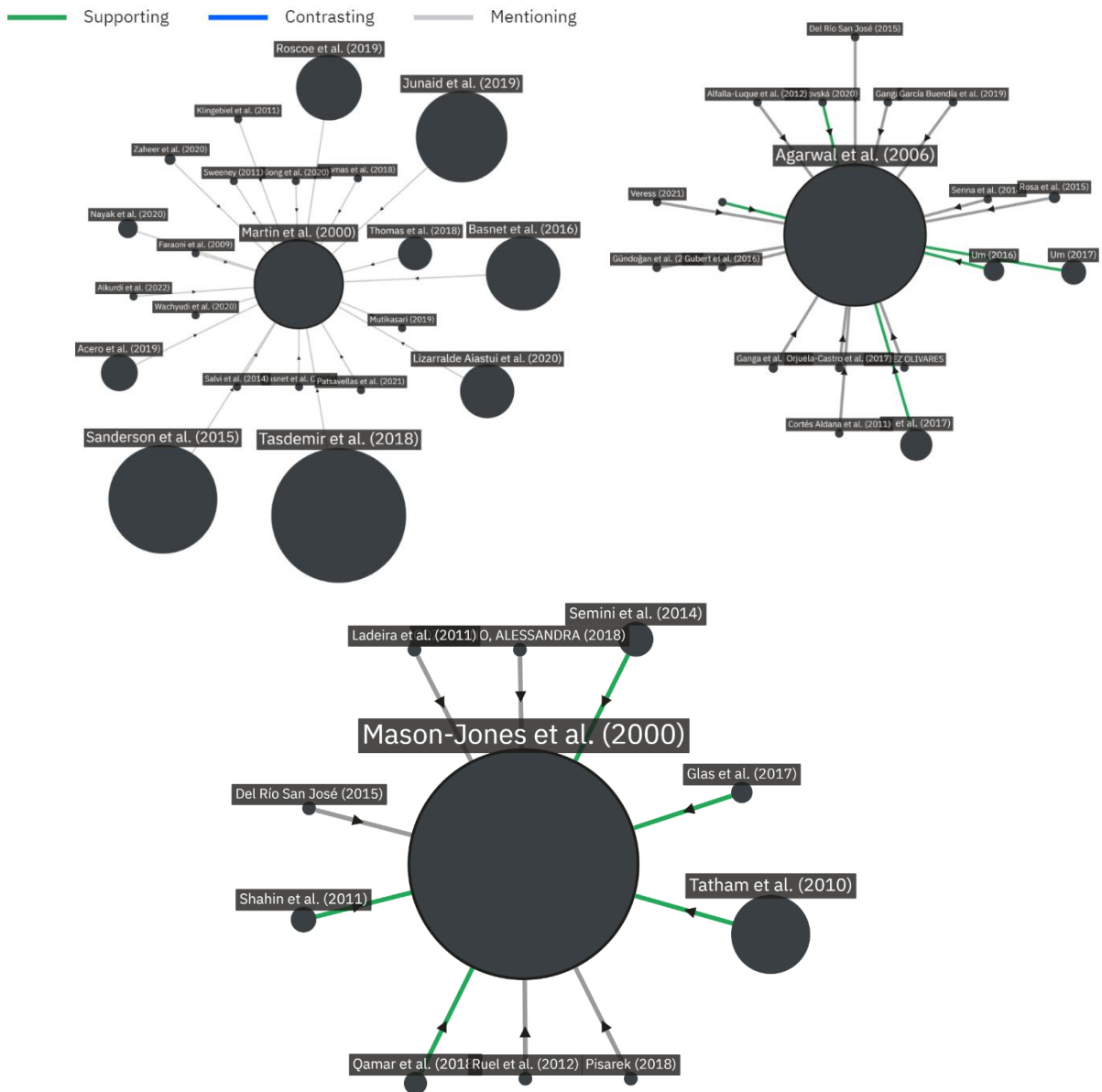


**Figure 5. Frequent co-occurrence of authors**

Note: Author analysis using VOSviewer.

The co-occurrence of authors Mason-Jones et al. (2000), Martin and Towill (2000), and Agarwal et al. (2006) is cited frequently in other research papers (Figure 5),

which is understandable because the above authors are among the founding authors. Mason-Jones et al. (2000) coined the term “leagile paradigm” and suggested that leanness and agility can be combined with the strategic use of a decoupling point. Martin and Towill (2000) encouraged the management of lean supply upstream and agile supply downstream and proposed a cyclic migration model from a traditional supply chain to a leagile operation. Agarwal et al. (2006) used lean, agile, and leagile conformity review models. From the research results, the leader was rated the highest in terms of the ability to reduce lead time, which was the criterion considered most important by the respondents. In addition, the leanness and agility indexes change, and it is recommended that enterprises consider the effects of market-winning and market-qualifying criteria.



**Figure 6. Model of how research articles cite the original articles**

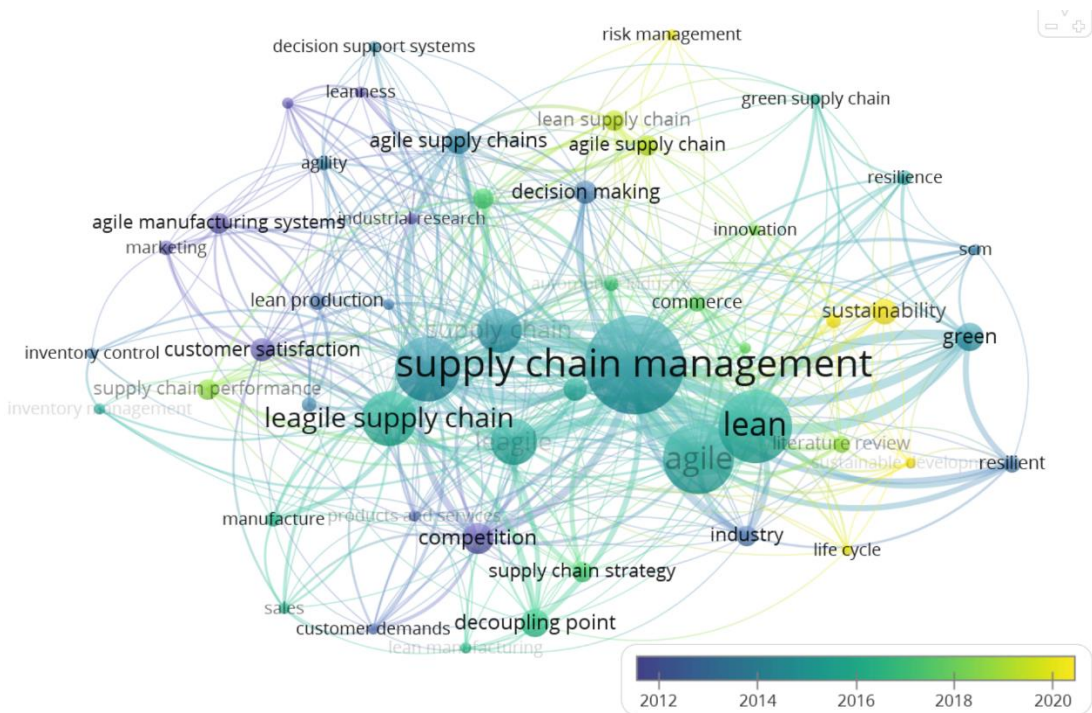
Note: Author analysis using Scite.ai.



Next, we analyzed three selected articles using Scite, an AI tool designed for citation context analysis. Scite is a platform introduced in 2012 that combines deep learning with expert analysis. Scite is now a trusted monitoring tool for COVID-19 pandemic research (Khamsi, 2020). For this research, the Scite tool allowed us to search for how anything in the three selected articles was mentioned in citation statements from datasets, protocols, assets, and research papers. We could also identify results, claims, and arguments. Figure 6 is an illustrative model of how research articles cite each of the three original articles. It can be seen that no research results contradict the three original studies. In addition, several research studies found evidence to support one or other of the two original articles: Mason-Jones et al. (2000) and Agarwal et al. (2006). (Green lines mean “support” previous results, and gray lines mean “mention” previous results without providing additional evidence.)

### 3.3. Co-occurrence keywords

A graph of keyword co-occurrence networks is shown in Figure 7. As before, the story was about solving inventory problems, meeting customer demands, achieving competitive advantage, and making comparisons. Research emerged in 2020 on the impact of lean and agile strategies on supply chain risk management and leagile for sustainable supply chains. The global supply chain of goods and services in 2022 faced major challenges from the effects of the COVID-19 pandemic and unpredictable macroeconomic fluctuations, so research focused on lean and agile to develop a more sustainable supply chain.



**Figure 7. Graph of co-occurrence relationships**

The colored areas on the graphic in Figure 7 separate keywords by year. Areas of the same color show keywords that appear together. The cyan area represents the group

of keywords that appear the most. The areas with other colors do not differ much in density. From the above statements, combined with the analysis of the most recently published articles (Figure 7), with high citations, we conclude that the main areas of LSC research are the following:

- Area 1 (cyan): The most-studied research area concerns customer demand and competition by implementing the leagile paradigm. Examples include the studies of Naylor et al. (1999) and Mason-Jones et al. (2000), which proposed the leagile paradigm. Bruce et al. (2004) presented a case study of the textile and clothing industry that demonstrated the effectiveness of leagile in achieving quick responses and reduced lead times, although the textile industry does not fit neatly into either the lean or agile paradigm.
- Area 2 (green): This area starts with the story of how LSC satisfies customers and then develops it. The case study by Kisperska-Moron and de Haan (2011) concludes that the Polish distributor is an example of an LSC and indicates that one concept (lean or agile) can be more useful than the other. Note that many studies use multiple-criteria decision-making methods to measure the weights of the lean and agile criteria.
- Area 3 (blue): A lean, agile, resilient, and environmentally friendly (“green”) paradigm in supply chain operations can lead to unintended results. This research area identifies the necessary understanding of paradigm trade-offs. Case studies include Carvalho and Cruz-Machado (2011) and Carvalho et al. (2013).
- Area 4 (light blue): This area concerns the trade-off between lean and agile inventory attributes and interrelations. Effective inventory management is a key necessity for fulfilling an order and positioning a decoupling point between customer order production and the supply chain network. Case studies include Kumar et al. (2019).
- Area 5 (purple): This is a relatively new research area that concerns the impact of lean and agile strategies on supply chain risk management and a risk management approach to evaluate lean and agile integration. Case studies include Rachid (2017).
- Area 6 (yellow): This is a relatively new research area that focuses on green innovation through lean, green, and agile supply chain practices. One such study proposes a framework of lean-agile-green supply practices (Yadav & Kumar, 2022). Another investigates the impact of lean-green-agile supply chain practices on green innovation, supply chain competitive advantage, supply chain responsiveness, and sustainable firm performance (Waqas et al., 2022).

### 3.4. Abstract analysis

Abstract analysis is a data mining technique used to support co-occurrence keyword results (Figure 8). The bright yellow areas represent repeated keywords. The closer the



and concerns about transparency and efficient resource utilization. To mitigate these challenges, a study conducted in Thailand proposes the application of leagile strategies from the business domain to enhance resource efficiency. Salleh et al. (2020) introduced a new dimension to the study, focusing on the assessment of lean, agile, resilient, and green (LARG) dimensions within their model. Their study evaluates LARG performance at selected ports in Malaysia. This research is not only relevant to port operators but also holds the potential to improve business capabilities, enhance operational efficiency, and boost competitiveness within the maritime supply chain. Ariadi et al. (2021) extend the exploration by analyzing observational data from 139 companies in Indonesia. Their findings emphasize the significant role played by leagile strategies in enhancing the financial performance of bottled water manufacturing companies. The study also introduces the concepts of strategic supplier integration (SSI) and strategic customer integration (SCI) as mediator variables, showing their stronger impact on the relationship between lean supply chain strategies and financial performance.

Together, these five papers create a cohesive narrative that underscores the importance of supply chain strategies, partnership approaches, and the adoption of leagility principles across various industries and contexts, ultimately contributing to enhanced performance and competitiveness in the ASEAN region. Based on the comparative analysis results, potential research areas in the ASEAN region that have not been extensively explored include the following:

**Green Supply Chain Strategy:** Although there have been some references to green supply chains in certain cases, specific research on green supply chain strategies and their impact on performance and the environment could be a promising area for further investigation.

**Risk Management in Supply Chains:** Examining how lean and agile strategies may influence risk management within supply chains could also be a significant research avenue. Further research could explore how these strategies apply specifically to the unique economic, cultural, and logistical characteristics of ASEAN member states.

**Comparative Analysis across ASEAN Countries:** Clarifying and understanding the differences and similarities in supply chain management among ASEAN countries through comparative analysis and contrast can be a valuable undertaking.

#### **4. CONCLUSION**

Research on LSCs has increased in the past five years. The field of study is quite diverse. Influential studies from authors in the United Kingdom, the United States, and India are among the most cited. Research cooperation exists between countries, but cooperation between developing and developed countries is still unclear.

Leagile uses a decoupling point to separate lean and agile in the basic supply chain. It is supported by researchers who advocate or justify a framework that evaluates the effects of market-winning and market-qualifying criteria on lean and agile. Researchers also consider supply chains, supply chain risk management, and leagile. Previous research has shown the effectiveness of LSC with case studies and empirical

studies that indicate the position of a decoupling point and the level of lean and agile application upstream and downstream in the supply chain. Many empirical studies have tested LSC using data mining analysis. In the context of ASEAN, it is unsurprising that most studies by authors on similar topics are empirical, reinforcing theoretical research findings. Consequently, there is a need for additional comparative analyses among ASEAN countries, as lean strategies may not consistently yield uniform outcomes. Furthermore, several unexplored research domains exist within the ASEAN region, including investigations into green supply chain strategies and the influence of lean and agile strategies on supply chain risk management. These areas offer promising prospects for further research, contributing to regional competitiveness and performance enhancement.

The contribution of this work is the construction of a knowledge repository to support the LSC literature. To the best of our knowledge, this is the first study attempting to identify bibliometric and citation context analyses related to this field. Research limitations are that we have not evaluated articles in languages other than English; this remains an area for further research.

## ACKNOWLEDGMENTS

The author would like to thank Van Lang University, Vietnam, for funding this work. We would also like to thank the reviewers for taking the time and effort to review the manuscript.

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