Agile and Lean Supply Chain: Research Trends (2017-2021)[1]

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Çevik ve Yalın Tedarik Zinciri: Araştırma Eğilimleri (2017-2021)	Agile and Lean Supply Chain: Research Trends (2017-2021)

Özet

Günümüzde endüstriyel sektörlere etkileri nedeniyle çeviklik ve yalınlık terimlerine literatürde sıklıkla karşılaşılmaktadır. Bunlar işletmelerin strateji oluşturmalarına ve rekabet avantajı elde etmelerine yardımcı olan iki temel paradigmadır. Bu çalışma, son yıllarda çevik ve yalın tedarik zinciri (TZ) paradigmalarına yönelik yeni araştırma konularını ve ana araştırma eğilimlerini ve bu iki paradigmanın birbiriyle ilişkisini keşfetmeyi amaçlamaktadır. Çalışmada, kelime eş-oluşum analizi tekniği kullanılmıştır. Web of Science veri tabanından elde edilen 526 yayından oluşan veri seti analiz edilmiştir. Bulgular, 2018 yılından bu yana TZ stratejisi, yeşil TZ, TZ çevikliği gibi bir dizi konunun araştırma trendleri arasında yer aldığını göstermektedir. Bunun yanı sıra, TZ tasarımı, iş birliği, soğuk TZ, yalın ve çevik TZ, ve TZ risk yönetimi son zamanlarda ortaya çıkan yeni konulardır. En yaygın araştırma alanları; çevik TZ'deki çevresel riskler, yalın TZ'yi çevik TZ ile birleştirme, leagile TZ stratejileri, TZ risk yönetimi ve TZ entegrasyonunda çeviklik şeklindedir.

Abstract

Today, the two terms - agility and leanness are frequently encountered in the literature due to their effects on industrial sectors. They are the two basic paradigms of the businesses that help them to build strategies and to gain a competitive advantage. This study aimed to explore the emerging research topics and the main research trends within agile and lean supply chain (SC) paradigms in recent years and to explore the interrelationships between them. A word co-occurrence analysis technique was adopted in this study. A data set of 526 publications, obtained from the Web of Science database, had been analyzed. The findings show that many topics such as SC strategy, green SC, and SC agility are present since 2018. Besides, the topics such as SC design, collaboration, cold SC, lean and agile SC, and SC risk management were emerging topics. The most common research areas revealed are; environmental risks in the agile SC, combining lean SC with agile SC, leagile SC strategies, SC risk management, and agility in SC integration.

Anahtar Kelimeler: Kelime eş-Oluşum Analizi, Çevik Tedarik Zinciri, Yalın Tedarik Zinciri, Tedarik Zinciri Stratejisi

Keywords: Word Co-occurrence Analysis, Agile Supply Chain, Lean Supply Chain, Supply Chain Strategy

Makale türü: Araştırma

Paper type: Research

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1. Introduction

Over the years, more attention is paid to scholars in the analysis of frequently used keywords in scientific research related to their fields, authors, journals, or universities to which the authors are affiliated (Osareh, 1996; Steinman et al., 2006; Ellegaard & Wallin, 2015; Merigó & Yang, 2017; Rejeb et al., 2020). Bibliometrics and scientometrics are frequently used mapping and clustering techniques for this purpose (Sedighi, 2016). Science mapping started with prior studies such as bibliographic coupling between scientific papers (Kessler, 1963), co-citation in the scientific literature (Mall, 1973), and document connection based on references (Marshakova, 1973). Since then, a variety of different analysis methods have been developed, such as journal citation analysis (Jobber & Simpson, 1988; Osareh, 1996; Harzing & Van der Wal, 2008; Hou, Yang & Chen, 2018), co-citation analysis (Kraus et al., 2012; Wang et al., 2016), bibliometric analysis (Ellegaard & Wallin, 2015; Merigó & Yang, 2017; Rejeb et al., 2020) and co-occurrence analysis (Lis, 2018; Ali & Gölgeci, 2019; Lis, Sudolska & Tomanek, 2020). Based on the co-occurrence analysis of words (or co-word analysis), the research themes of any scientific field or domain, as well as the relations among them are determined. However, such studies based on co-word analyses allow us to identify the dynamics of science, not including any definition of research themes.

The combinations of "agility" and "leanness" are significant paradigms of competitiveness in the business world. Therefore, business and management literature is reporting increased concerns about the agile and lean paradigm in the scope of the supply chain (SC). GarciaBuendia, MoyanoFuentes & Maqueira (2021a) conducted a study via bibliographic coupling analysis to systematically identify the key intellectual developments of the highly cited publications on lean supply chain management (LSCM). According to the findings, lean-agile SC and performance assessment were two main research areas of highly cited literature. Similarly, GarciaBuendia et al. (2021b) also examined twenty-two years of publications (1996-2018) to identify main issues and future trends on LSCM through co-word networks in a longitudinal overview. On the other hand, Zekhnini et al. (2021) presented a road map model integrating lean and green SCs into digital Supply Chain Management (SCM) to achieve sustainable and viable performance. However, Centobelli et al. (2020) provided a review of 90 articles on the agile SC through co-citation analysis and reported that the agile SC literature mainly addresses digitization in the SC, but the technology does not adequately enable the deployment of the agile SC. Besides, OliveiraDias et al. (2021) presented thematic evolution research of information technologies (IT) in the context of lean SCs and agile SCs. They performed a science mapping analysis (using co-word networks) on published papers between 1996 and 2019. The findings revealed three thematic research areas: the role of IT in SC performance, the effects of IT on agile strategy, and the emerging IT for lean strategy. A literature review was conducted by Raji, Rossi & Strozzi (2021) on the state of the art of lean-agile SC through systematic network analysis. Their study revealed many research directions and emerging themes in the lean-agile field. Despite all these studies, an agile SC is still emerging and has rather unclear boundaries, possibly concerning a lean SC. Moreover, since agility and leanness are attractive strategies for managers in the field of SC, as well as an attractive research interest for scholars, the present study uses a co-occurrence analysis to characterize the interrelations between agile and lean SCs. Thus, the present paper aims to explore the trends of research in which agile and lean paradigms are within the scope of the SC. The research questions are as follows: (RQ1) How does "agile SC" and "lean SC" are interrelated? (RQ2) Which topics related to the studies on "agile and lean SC" has received the most attention in recent years?

The organization of the study is as follows: First, the literature related to agility in the SC, and agile versus lean SC was reviewed. Then, the methodology and data collection process of the study was presented. Next, scientometrics of data and clusters of high-frequency keywords on agile and lean SC was revealed. Finally, the study ended with a discussion and conclusion.

2. Literature Review

2.1. Agility in Supply Chain

Agility is defined as a paradigm that complied with organizational structures, logistics processes, information systems, and especially with mentality (Christopher, 2000). Flexibility is one of the key characteristics of an agile organization, as the origins of agility lie in flexible manufacturing systems (Gosling, Purvis & Naim, 2010). Accordingly, agility needs higher levels of shared information as well as connectivity between the firms and their suppliers (Koupaei, Mohammadi & Naderi, 2016). However, connectivity implies the exchange of information on both inventory and demand levels including multiple, collaborative relationships across all levels of the organization.

Agility is also advocated as a commercial paradigm (Mehralian, Zarenezhad & Ghatari, 2015; Centobelli et al., 2020). However, are there any formulae for agility creation? Various companies experienced different sets of changes and then required different degrees of agile practices with the combination of business strategies to achieve agility. On the other hand, agility is a concept of a business strategy that is the enterprise's ability to manage an unpredictable business environment (Qi, Zhao & Sheu et al., 2011). Firms should have capabilities for giving appropriate responses to changes for being competitive in business environments. Hence, the concept of agility is considered to be a firm's capability to deal with an ever-changing and unpredictable business environment (Baramichai, Zimmers & Marangos, 2007; Mehralian et al., 2015). Besides, the continuously changing requirements of customers in line with unpredictable environments force manufacturers to improve SC capabilities. Therefore, several firms emphasize flexibility and agility (Yusuf et al., 2004). Based on a survey administered by Power, Sohal & Rahman (2001) with 962 Australian manufacturing organizations identified critical factors for more and less agile organizations to manage SCs. One lesson is that agile organizations must be more customer-focused. Accordingly, the involvement of suppliers is crucial to ensure customer satisfaction. Another lesson is that less agile organizations are more internally focused on productivity rather than promoting customer satisfaction. Tseng and Lin (2011) developed a conceptual model for an agile SC. According to this model, collaborative relationships, process integration, information integration, and customer/market sensitivity are the pillars of agility. They are significant to conduct agile capabilities consisting of four principles defined as follows (Mehralian et al., 2015):

- Responsiveness: To identify and then reactively or proactively respond to the changes.

- Competency: To reach the aims effectively and efficiently.

- Flexibility: To process different activities with the same potentiality.

- Quickness: To perform an activity as soon as possible.

To survive in the twenty-first-century economy, firms should learn how to manage the instant challenges in business environments. The agile capabilities have made businesses more sensitive to giving appropriate replies to the changes in today's dynamic business environments (Mehralian et al., 2015; Buyens & Vandenbroucke, 2017). The need for the agility of businesses is usually associated with SCs for reasons such as shortened life cycles, highly volatile markets, demand uncertainty, and unreliability in supply. Similarly, industries that move slower in traditional SCs face similar challenges in terms of speed, flexibility, increased product variety, and customization requirements. Consequently, the need for agile enterprises is becoming more common day by day to adapt to the changing nature of business requirements.

2.2. Lean in Supply Chain

The term "lean" refers to a set of activities or solutions developed to eliminate waste and reduce non-value-added operations. The word "lean" was first used as a commentary on Japan's new mass production system, the Toyota Production System, which produces a lot of waste. "Waste" is defined as anything that essentially interferes with the smooth production flow of products, such as overproduction, holdings, handling, overruns, inventory, movement or defects, or the unused creativity of employees (Wee & Wu, 2009). According to Moyano-Fuentes et al. (2019), lean SC is aimed to meet the individual needs of customers to reduce cost and waste efficiently as well as effectively. Besides, lean SC is directly connected by upstream and downstream information flows of products, services, and finances that work together (Qi et al., 2017). Lean SC emphasized mostly minimizing waste and maximizing value during streamlines while reducing overall costs, and enhancing product quality. Lean SC also adopted various management techniques or practices such as Just-in-Time (JIT), Kanban, Six Sigma (Ardalan & Diaz, 2012; Garcia-Buendia et al., 2021c), and manufacturing techniques such as pull flow, and set-up time reduction (Moyano-Fuentes et al., 2019).

Since lean is applicable in many supply chains, Arif-Uz-Zaman and Ahsan (2014) investigated the effects of lean tools on SC performance. According to the findings, lean tools improved supply chain performance by minimizing waste and reducing overall costs from the supply chain. On the other hand, Jasti and Kodali (2015) conducted a critical review of 30 existing lean SC frameworks proposed between 1997-2012 in the SC literature. The study identified eight pillars of the frameworks such as information technology management, supplier management, logistics management, elimination of waste, JIT production, customer relation management, top management commitment, and continuous improvement. Lean thinking or subsequently lean SC could improve efficiency and increase flexibility at all levels of supply chains.

2.3. Agile vs. Lean in Supply Chain

Improving the firms' performance as well as their SC performance has attracted the interest of much research over the past two decades (Hassani, Bitan & Ştefănescu, 2020). Hassani et al. (2020) revealed some of the critical issues to improve SC performance, and "lean and agile" was one of these issues besides the waste elimination, cost reduction, improved collaboration and coordination in the SC, JIT concept, value creation, flexibility, efficiency, and resilience. Naylor et al. (1999) provided a gap between lean and agile SCs. While agility uses market knowledge to explore opportunities in an unsteady marketplace, lean creates a value stream to eliminate waste within the SCs. Besides, Christopher (2000) draws another distinction between the philosophies of leanness and agility. Whereas agility works best in less predictable environments where demand is volatile and the requirements are high, leanness works best in more predictable environments including high volume and low variety. A study by Qrunfleh and Tarafdar (2013) examined the interrelationships among lean SC strategy, agile SC strategy, and responsiveness of the SC. The findings show that SC agile practices play a distinct role in SC strategy as well as SC responsiveness. Also, an agile SC strategy significantly contributes to building a responsive SC, whereas a lean SC strategy does not.

SC agility or agile SC includes concepts such as market sensitivity, responsiveness, quality, speed, and flexibility, whereas lean in SC or lean SC includes concepts such as reduced cost, improved quality, faster delivery, and flexibility. A lean SC means less of everything such as half the human effort, half the manufacturing space, and half the investment in tools. On the other hand, lean is a philosophy of management that boosts customer value by eliminating waste and creating continuous improvement. By applying lean practices, techniques, and principles to a single company (lean implementation), managers can boost a value stream for waste elimination. Therefore, the lean strategy emphasizes

balanced production planning and cost reduction, whereas the agile strategy focuses on rapid response and reconfiguration (Qi, Zhao & Sheu et al., 2011).

When we consider "SC agility" or "SC leanness", it is about the entire SC of a large organization, not a single organization. Also, there is no readymade method conducted by researchers or practitioners for evaluating agile and lean SCs (Christopher & Towill, 2001; Jain & Benyoucef, 2008). Moreover, the ability to manage agile or lean SCs has developed more slowly than foreseen, since the technology for managing them is still being developed (Carvalho & CruzMachado, 2011; MoyanoFuentes, BruqueCámara & MaqueiraMarín, 2019).

3. Methodology

This study followed word co-occurrence analysis and network analysis methods to develop empirical knowledge by reviewing documents. Therefore, the study used documents as a data source, and a kind of Social Network Analysis (SNA) technique was used to extract the connections among relationships (nodes) in these documents. SNA is systematically analyzing and mapping collaborations among social entities -e.g. individuals, organizations, and groups, taking into account the exchange of resources (Costa & Putnik, 2014). Ting and Tsang (2014) identified the three main stages of SNA: (1) describing the datasets of the network; (2) identifying the relationships and the existing flows of information between the datasets; (3) analyzing the network structure of the dataset via the measurement of the degree of centrality.

A word co-occurrence analysis was used as an SNA technique to explore the interactions between publications based on agile and lean SCs. Courtial (1994) identified word co-occurrence analysis as follows: (1) Calculates links between words and then orders links according to their strength; (2) Choosing words having significant links (n-1), as n indicates the cluster size. (3) Calculates centrality and density weights for each cluster – as the mean value of the internal links is density, and the sum of values of the external links is centrality.

To identify the related publications on agile and lean SC, the data was collected through keyword searching of the WoS database. Using keywords is seen as an effective way to find articles on a certain topic (Cronin et al., 2008; Ramdhani et al., 2014). However, keywords were rather rough primary information to produce a deep insight into the SCM field. Therefore, this study only provided a general classification of keywords, taking into account existing relationships between agile and lean SC via co-word analysis.

The search was carried out on 1 June 2022 using the keywords 'lean and agile SC' (as a topic). The advanced query was as follows: ('lean supply chain') AND ('agile supply chain') AND (agil*) AND (lean*). The query was used to search for the titles/abstracts/keywords of documents. The search was limited using some inclusion criteria: publication years (2017–2021 period), and document type (journal articles, review articles, book chapters, or early access). To improve the quality of the study titles, abstracts, and keywords of the publications reviewed. As a result, a total of 526 publications were obtained. Thus, this study was conducted by focusing on grey literature means that the publications retrievable outside of academic databases are not included.

Most of the publications (80%) were written in English, including Spanish, German, and Portuguese. Nearly half of all publications (46,1%) were published between 2020 and 2021. 71% of them were research articles (Table 1).

Table 1. Descriptive Statistics of Publications (n=526)

| Publication Year	f	%	Publication Type*	f	%
2017	85	16.2	Research Articles	411	71
2018	100	19	Proceedings Papers	82	14.2
2019	99	18.8	Review Articles	38	6.6
2020	106	20.2	Early Access	32	5.5
2021	136	25.9	Book Chapters	16	2.8
Total	526	100	Total	579	100

f: frequency of publications, %: percentage of publications.
* A publication evaluated in more than one category.

All data for each publication was recorded in a single worksheet of MS Excel 2016, and then the VOSviewer software was used to cluster and summarize the data, as well as to extract the co-occurrence relationships between keywords. VOSviewer is a software developed to create, visualize and explore co-occurrence maps (Van Eck & Waltman, 2011). The mapping of most concurrent keywords in the titles, keywords, and abstracts was presented via VOSviewer.

4. Results

In this section, the main findings of the research are presented. Figure 1 presents the annual distribution of the studies for 2017-2021.
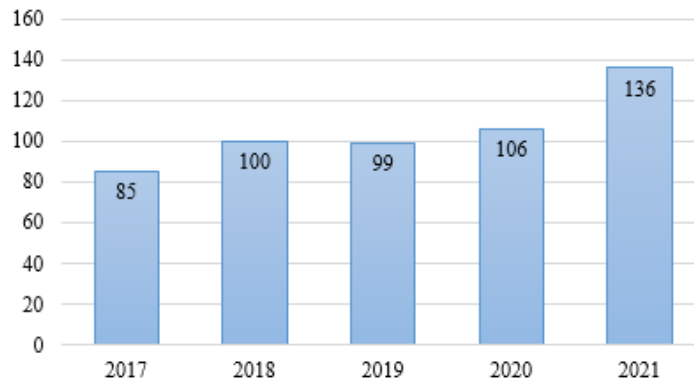
Figure 1. Frequency of Annual Publications in Search of the Agile and Lean SC

The findings revealed that scholars' attention to "agile and lean SC" has dramatically increased. However, the frequency of annual publications is almost regular intervals from 2017 to 2020. The most relevant WoS research areas in the studies on agile and lean SCs during the 2017-2021 period were presented in Table 2.

Table 2. Most Relevant WoS Research Areas (n=526)

Research Areas*	f	%
Business Economics	233	44.3
Engineering	177	33.7
Operations Research Management Science	79	15.0
Computer Science	70	13.3
Environmental Sciences Ecology	33	6.3
Science Technology	32	6.1

* A publication evaluated in more than one category.

Most of the publications (78%) were conducted in the field of Business Economics (44.3%) and the field of Engineering (33.7%). The agile and lean SC has not only been addressed by the disciplines such as Business Economics and Engineering, but also by the research areas such as Operations Research Management, Computer Science, Environmental Sciences, and Ecology. Accordingly, the most productive organizations in the studies on agile and lean SCs during the period 2017–2022 were presented in Table 3.

Table 3. Most Productive Universities (n=526)

Scholars' Affiliations / Country*	f**
Islamic Azad University / Iran	14
League of European Research Universities (Leru)***	12
Amity University Noida / India	11
Indian Institutes of Technology System / India	11
National Institute of Technology / India	10
University of Tehran /Iran	9
Birla Institute of Technology And Science–Pilani /India	8
California State University /USA	8
Universidade Federal de Santa Catarina /Brazil	8
UDICE, French Research Universities /France	7
University of Quebec / Canada	6
Cranfield University / UK	6
Polytechnic University of Milan / Italy	6
Vilnius Gediminas Technical University / Lithuania	6

* The countries that have at least one author.
**Those with more than five publications were presented.
***A network of twenty-three leading European universities

Based on the scholars' affiliations in the publications, the most productive organization was Islamic Azad University in Iran. Additionally, scholars from Indian universities had taken an increasing amount of interest in agile and lean SCs. The scholars from the League of European Research Universities (LERU), including a total of 23 leading European universities, also recorded significant interest in the agile and lean SC. As a result, 751 scholars from various countries contributed to the studies on agile and lean SCs. The most productive countries were also presented in Table 4.

Table 4. Most Productive Countries on Agile and Lean SCs (n=526)

Countries*	f**	%	Countries	f	%
India	85	11.3	Spain	24	3.2
USA	75	10.0	Australia	22	2.9
England	71	9.5	Canada	21	2.8
Iran	46	6.1	Brazil	19	2.5
China	34	4.5	Pakistan	15	2
Italy	33	4.4	Malaysia	13	1.7
Germany	25	3.3	Poland	11	1.5
France	24	3.2	Others***	233	31
			Total	751	100

* The countries according to the scholars' affiliations of the publication.
** f: frequency of scholars. Those with more than 10 scholars per country were presented.
*** South Africa, Sweden, Taiwan, Turkey, Indonesia, Netherlands, Portugal, Saudi Arabia, Austria, Lithuania, New Zealand, Switzerland, Morocco, Romania, South Korea, etc.

Based on the scholars' affiliations in the publications, the most productive country was India in the studies on agile and lean SCs from 2017 to 2021. The other productive countries were USA and England respectively. On the other hand, a limited number of studies on the topics of agile and lean SC were conducted in several business journals. However, the journals that published at least fifteen studies on the issues of agile and lean SCs are presented in Table 5.

Table 5. Most Productive Journals on Agile and Lean SCs (2017-2021)

Top Journals*	Abbr**	f***
International Journal of Production Research	IJPR	18
Production Planning Control	PPC	17
Benchmarking: An International Journal	B-IJ	16
Supply Chain Management: An International Journal	SCM-IJ	15
Sustainability	-	15

* The journals that have at least fifteen publications were presented.
** Abbr: Abbreviation.
*** f: frequency of publications.

Based on the frequency of published papers, the most productive journals on agile and lean SC were the IJPR, PPC, and B-IJ, respectively.

4.1. Thematic Research Areas on Agile and Lean Supply Chain

We have calculated five clusters aligned with the analysis of the co-occurrence of high-frequency keywords related to research on agile and lean SCs. The network of clusters given in Figure 2 is roughly displayed according to their rank to show the obtained nodes. Thus, the clusters labeled with the five following thematic research areas: 1) environmental risks in agile SC, 2) combining lean and agile SCs, 3) lean and agile SC strategies in SCM, 4) SC risk management, and 5) agility in SC integration.
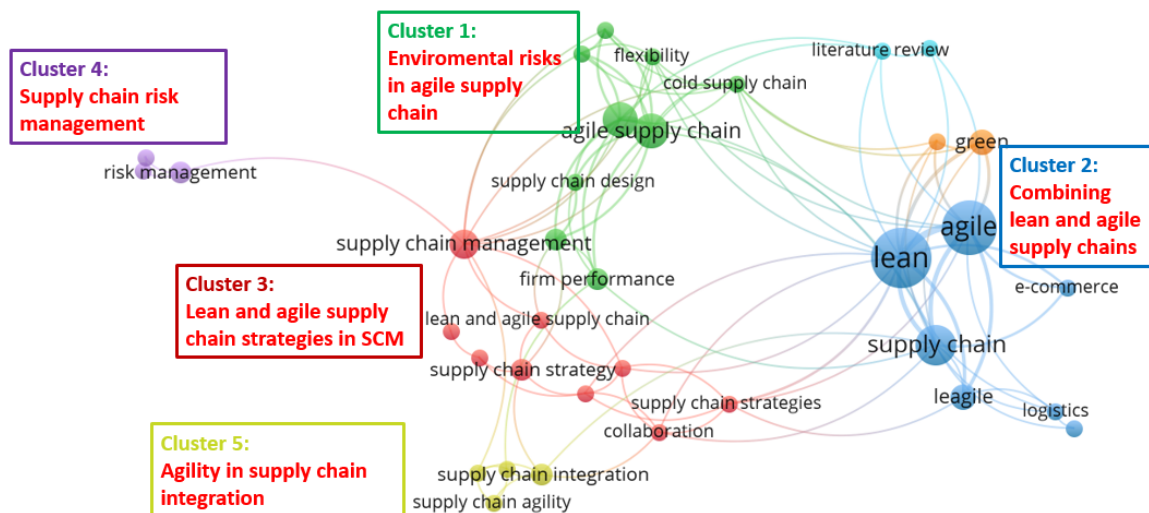

Figure 2. Clusters of high-frequency keywords in the studies on Agile and Lean SC
Source: Based on data retrieved from the WoS database on 1 June 2022, and analyzed with the use of the VOSviewer.

Cluster 1 (marked in green bubbles in Figure 2) comprises the six most frequently used keywords: agile SC, SC design, cold SC, flexibility, and firm performance. The clustering shown in Figure 3 also provides an overview of "agile SC", and its related keywords including "SC management" and "green SC". Besides, clustering shown in Figure 4 provides an overview of "firm performance", and its related keywords including "leagile SC", and "dynamic capabilities".
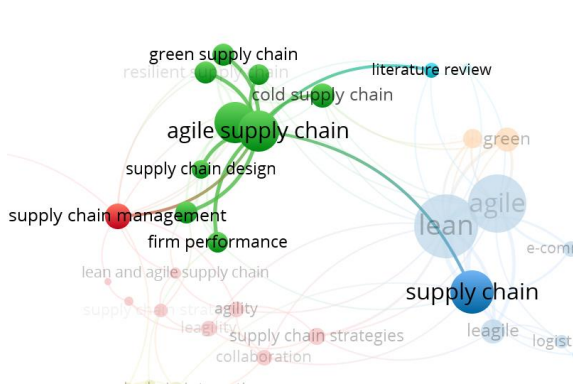
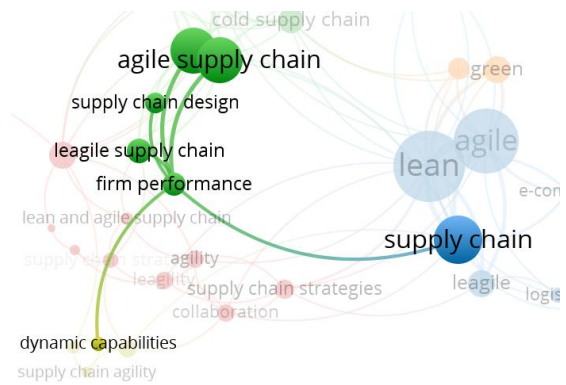**Figure 3.** The Links from Agile Supply Chain

Figure 4. The Links from Firm Performance

Cluster 2 (marked in blue bubbles in Figure 2) comprises the six most frequently used keywords: lean, agile, SC, leagile, e-commerce, and logistics. The clustering shown in Figure 5 also provides an overview of the "agile" paradigm, and its related keywords such as "SC strategies", "cold SC", and "green". Similarly, clustering shown in Figure 6 provides an overview of the "lean" paradigm, and its related keywords such as "cold SC", "SC strategies", "agility", "collaboration", and "green".
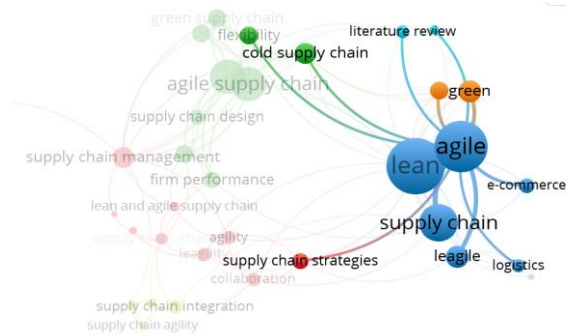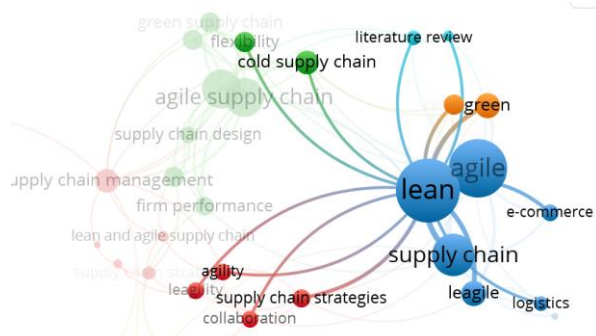

Figure 5. The Links from Agile

Figure 6. The Links from Lean

Cluster 3 (marked in red bubbles in Figure 2) comprises the six most frequently used keywords: SCM, lean and agile SC, SC strategy, SC strategies, and collaboration. Clustering shown in Figure 7 also provides an overview of "SCM", and its related keywords such as "agile SC", "green SC", "cold SC", "lean and agile SC", "agility", "risk management", and "lean manufacturing". The clustering shown in Figure 8 provides an overview of "SC strategies", and its related keywords such as "agility", "leagile", and "collaboration".

Cluster 4 (marked in violet bubbles in Figure 2) comprises one most frequently used keywords for risk management.

Cluster 5 (marked in yellow bubbles in Figure 2) comprises the two most frequently used keywords: SC integration, and SC agility.
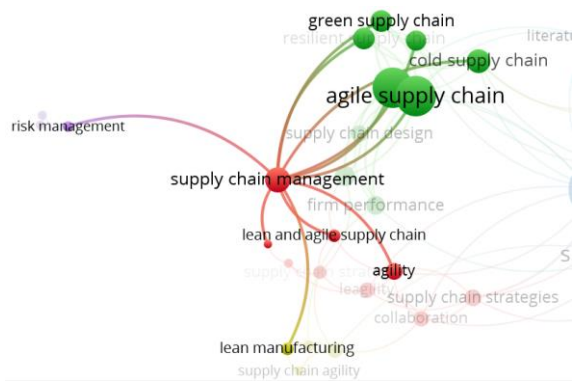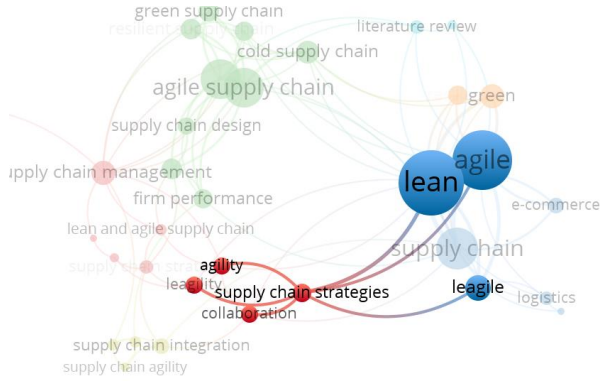
Figure 7. The Links from SCM

Figure 8. The Links from Supply Chain Strategies

4.2. The period on Agile and Lean Supply Chain

Strategic periods on agile and lean SC are presented in Figure 7. Findings during the period of 2017-2021 show that the research hotspots had mainly changed from 2018 to 2020 (see Figure 9).
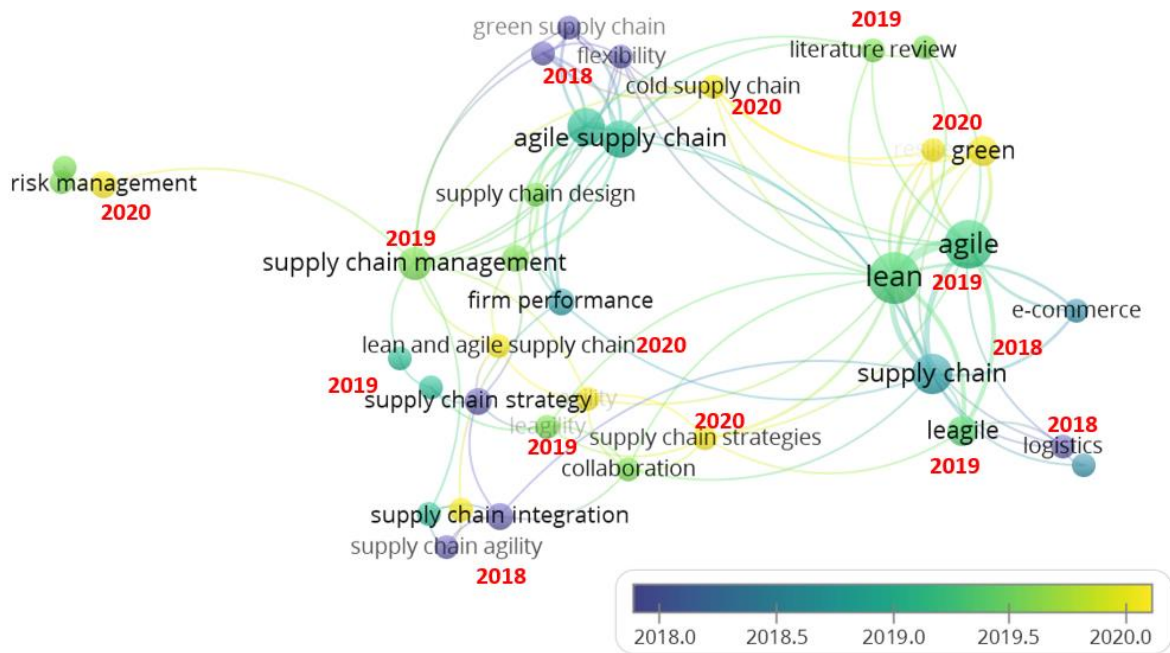

Figure 9. Research Trends from 2018 to 2020 (n=526)
Source: Based on data retrieved from the WoS database on 1 June 2022, and analyzed with the use of the VOSviewer.

First, keywords such as "SC strategy", "SC integration", "green SC", "flexibility" and "logistics" were most frequent in the first half of 2018. Then, the keywords such as "lean", "agile", "agile SC", and "leagile" were frequently seen in the first half of 2019. Next, in the second half of 2019, the keywords "SCM", "SC design", and "collaboration" were most frequent. Finally, "green", "cold SC", "lean and agile SC", "SC strategies", and "risk management" were the most common keywords of 2020.

5. Discussions

5.1. Interpreting Clusters

Cluster 1: Environmental risks in the agile supply chain

After the Covid 19 pandemic, the critical importance of SCM was revealed (Craighead, Ketchen & Darby, 2020). Hence, there is an urgent need for more resilient SC designs to deal with economic, social, and global effects (Reitsma et al., 2021). For example, a green SC is a kind of design that integrates environmental considerations into the SC. The concept of green SCM has gained increasing attention within both academia and industry for years (Sarkis et al., 2011; Tseng et al., 2019; Badi & Murtagh, 2019). Badi and Murtagh (2019) analyzed the existing literature on green SCM in the construction industry and described primary SCM activities combined with green such as purchasing, design, manufacturing, logistics, and operation. The concept of green SCM is extremely broad, however, there is no clear definition available to describe it (Tseng et al., 2019).

Some connections among keywords from Cluster 1 (green), Cluster 2 (blue), and Cluster 3 (red) can be seen in Figure 2. These connections are "SC" and "SCM". SCM has existed as long as people have been producing and trading goods. Quite simply, it is a chain of individuals or organizations that transform business resources into products and consumer services. However, this transformation process is not simple to manage, but in many cases, it involves many organizations from many countries as well as many productions and many distribution points around the world (Ahn et al., 2012). SCM aims to realize this transformation process efficiently and to deliver what the consumer wants to the end user (Christopher & Holweg, 2011). SCM came to the fore in the 1990s, when it was initially seen as an approach to gaining efficiency in ever-shrinking markets. Accordingly, this time has been the adoption of lean thinking, emphasizing efficiency and low price, while eliminating Muda (meaning waste in Japanese), which is mainly derived from JIT production by Toyota (Mistry, 2005; Taghipour, Hoang & Cao, 2020). Leagile (hybrid approach) attributed "lean" and "agile" strategies that are distinct but can be merged in many ways with SC strategies. For example, leagile aims to meet customer demands at a low cost (Goldsby, Griffis & Roath, 2006). Lean and agile strategies may also influence firm performance (Srinivasan et al., 2020), and a firm's overall performance can be affected by agility due to its flexible nature (Umam et al., 2019). By using lean and agile strategies, dynamic capabilities imply the ability to sense market opportunities, technological changes, and supplier uncertainty, which may influence firm performance – at the operational or financial level (Srinivasan et al., 2020). Integration of lean and agile SC strategies (hybrid SC, or a new blended SC) positively affects mass customization, and postponement with a true combination of information sharing as well as information and communication technologies (Adel, 2020).

Cluster 2: Combining lean and agile supply chains

E-commerce is one of the booming sectors with the development of new business models (B2C, B2B, etc.). E-commerce has completely changed the style and functioning of the SC. When these two concepts are combined with logistics, some issues arise such as increasing efficiency, reducing costs, and improving the service quality. However, due to the worsening global environmental problems nowadays, the green supply chain is an emerging trend of SCM including the concepts of e-commerce and logistics (Bin & Jun, 2009; Guo et al., 2020). As a logistics driven by background, e-commerce required heavy advertising to attract large customers, as well as high investment in hardware and software (Yu et al., 2016). In recent years, the booming growth of e-commerce, especially logistics has become one of the bottlenecks of businesses which leads to the rise of complexity in SCs (Mangiaracina et al., 2015; Yu et al., 2016). An effective combination of lean and agile SC strategies could be a solution to these problems.

Cluster 3: Lean and agile supply chain strategies in SCM

The sustainability of SC strategies such as agility, leagile, leagillity cannot be established without collaboration and integration with internal stakeholders, employees, customers, and suppliers (Alzoubi et al., 2020). Collaboration provides advantages to the SC when considering environmental uncertainties (Betts & Tadisina, 2009). SC collaboration has three dimensions (supplier collaboration, internal collaboration, and customer collaboration) (Alzoubi et al., 2020). Some other connections with SCM were found in Figure 3. Some of them were risk management and lean manufacturing. SC risk management (Pournader, Kach & Talluri, 2020) pays attention to risks such as environmental risks, industrial risks, organizational risks, risks in material flow, information flow, and financial flow. A lean and agile SC can be merged in a variety of ways to deal with these risks. Since, lean manufacturing is an urgent tool to improve sustainability (Martínez-Jurado & Moyano-Fuentes, 2014), and to improve efficient and effective SCM (Agus & Hajinoor, 2012; Chen, Cheng & Huang, 2013).

Cluster 4: Supply chain risk management

To manage SC risks, companies need to follow a path respectively; identification of risks, assessment, and evaluation of risks, selection of risk strategies, implementation of risk strategies, and estimation of unforeseen risks (Manuj & Mentzer, 2008). Tang & Musa (2011) reviewed the literature of 1995-2009 through a co-citation analysis to investigate research trends relevant to SC risk management. Findings show that there were severe consequences after SC disruptions, such as loss of profit and market share. The findings also show that SC risk management required the integration of knowledge from multiple disciplinary. On the other hand, Pournader et al. (2020) reviewed the literature from 2001-2019 on SC risk management through a co-citation analysis to explore recent research trends. The study thematically labeled the publications as matured, developing, or emerging based on the frequency as well as the timeline of the publications. The emerging themes were identified as sustainable as well as behavioral SC risk management, and the need for methodologies and theoretical frameworks.

Cluster 5: Agility in supply chain integration

SC integration aims to achieve efficient and effective information flow between a firm and its SC partners to provide value to customers at high speed, and low cost (Zhao et al., 2008; Flynn et al., 2010). Khan & Wisner (2019) investigated the relationship between agility and SC integration. According to the findings, SC integration had a worthless impact on SC agility. However, Shukor et al. (2020) examined the same relationship and revealed that the firm's SC integrations have a significant impact on SC agility. Besides, the study by Abdelilah et al. (2021) argued that the combination of lean manufacturing with the practices of SC integration resulted in SC agility, which is positively related to the operational performance of firms.

5.2. Emerging Bibliometric-based Debates in Supply Chain

To this end, we would like to draw attention to similar studies in prior literature to emphasize the importance of the state-of-the-art review of SC (Kim et al., 2011; Costa & Putnik, 2014). There are various studies mostly aimed to reveal new emergent paradigms based on social networks. Kim et a. (2011) conducted a social network-based analysis of the structure of SC networks and draw attention to the material flow of SC firms. Besides, Majiwala and Kant (2022) presented a bibliometric analysis to examine the interrelationships between Industry 4.0 and SCM. The documents were retrieved from the Scopus database from 2011 to 2022. The findings identified China and India as the most productive countries. The most productive top three journals are IJPR, Sustainability, and PPC. The study also conducted keywords co-occurrence analysis to reveal thematic research areas based on clusters. One of these clusters includes the keywords such as lean production, quality management, and agile

manufacturing. Moreover, Pournader et al. (2020) utilized both bibliometric analysis as well as co-citation analysis using keywords to extract the most relevant SCM articles from Scopus published between 2001 and 2019. The study categorized the main research themes within ten clusters. The findings indicate that more emphasis was put on SC risk management. Teng et al. (2019) reviewed the literature on green SC from Scopus and ISI WoS databases from 1998 to 2017. The study found a declining trend in the research about drivers or barriers analysis of green SCM, whereas a growing trend in applications of optimization models for decision-making to improve the environmental performance of green SCM. Other findings of the study show that the concept of green SCM gained attention from the beginning of the 20th century, however, this study finds a sharp growth of publications on green SCM after 2010.

There are also several papers presenting insights to develop a deep understanding of lean and agile SC. Garcia-Buendia et al. (2021c) conducted a study to present the bibliometric analysis of the lean SCM literature to gain knowledge about the research characteristics of the field. The study examined 715 papers published in the WoS database over the period 1996-2020. The study presented five research focus on the lean SCM having items such as basic concepts, implementation and performance, agile, sustainability, and Six Sigma. In their study, Özdağoğlu et al. (2022) focused on lean production and analyzed 1941 research articles on WoS published between 1988-2021. The findings show that the most cited studies on lean production are about the issues connected with the supply chain, environment, waste reduction, and new product development processes. The most productive countries on lean production are the USA, England, and India, and the most productive journals are IJPR, PPC, and the International Journal of Operations Production Management. On the other hand, Centobelli et al. (2020) provided a systematic review of ninety articles published in thirty-nine different journals on agile SC. According to word co-occurrence analysis, the keywords such as management, performance, agility, integration, capabilities, SC agility, model, flexibility, and SCM are the most frequently mentioned keywords in the agile SC literature. According to the thematic results of the study, research areas such as factors affecting agile SC, barriers in developing agile SC, suppliers selection under agile SC, the impact of SC agility on business performance, and agile SC performance measurement are emerging issues.

6. Conclusion

Previous studies have identified some SC strategies such as lean, agile, and hybrid modes as leagile (Naylor et al., 1999; Yusuf et al., 2004; Mistry, 2005; Goldsby et al., 2006; Carvalho & Cruz-Machado, 2011; Qrunfleh & Tarafdar, 2013). While a lean SC focuses the streamlines on the whole SC, an agile SC focuses on the reconfiguration of an SC in responding to demands in a quick, flexible manner in uncertain as well as dynamic environments (Naylor et al., 1999). In this respect, two research questions guided this study. The first question aimed to find the interrelationships between "agile SC" and "lean SC". The study provided a word co-occurrence map for the relationships between lean and agile SC concepts. To develop an understanding of these concepts, the study identified the thematic areas where "leanness" and "agility" overlap and where they divergence in terms of SCs. The most common research areas revealed in this study are as follows, but are not limited to:

- Environmental risks in the agile SC (considering cold SC, SC design, flexibility, and firm performance),
- Combining lean SC with agile SC (considering e-commerce, logistics, and green SC),
- Lean and agile (or leagile) SC strategies (considering collaboration),
- SC risk management (considering agile strategy),
- Agility in SC integration.

Our second research question aimed to reveal research trends related to the studies on "agile and lean SCs" that have received the most attention in recent years. The study revealed that there is a growing interest in the topics related to agile and lean SCs from 2018 to 2020. A number of the countries such as India, the USA, and England dominate scientific research regarding agile and lean SC. The journals such as the IJPR, PPC, and B-IJ are the top three productive journals on the issues regarding agile and lean SCs.

This study will be useful for business managers and practitioners to create strategies through the right combination of lean and agile SCs. Additionally, it will be useful for academic scholars who are seeking technologies, systems, tools, methodologies, and business processes to enhance agile and lean SCs, since there is a huge potential for future research. However, there were some limitations of the study. First, the study only reviewed the publications that come out in a search from the WoS database. The future work should include other database sources (Scopus, Google Scholar, etc.) Then, this paper was solely based on the grey literature from the point of view of academics while failing to incorporate the views of practitioners or managers. Future work should include more efforts to meet the research needs on agile and lean SCs.

Compliance with Ethical Standards

Conflicts of Interest

The author states that there is no conflict of interest for herself and third parties in the article.

Ethical Approval

The author states that there is no need for an ethics committee report in the article.

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