A review of lean, agile, resilient, and green (LARG) supply chain management in engineering, business and management areas

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C H R O N I C L E	A B S T R A C T
	Supply chain management (SCM) that is Lean, Agile, Resilient, and Green (LARG) are required for competitiveness in today's complex, high-demand market. SCM must consider LARG paradigms concurrently, a rarely investigated topic. This study provides a comprehensive review of publications that combine all four LARG principles in engineering, business, and management domains. According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach, two Scopus and Google Scholar databases were exhaustively examined. Thirty-two manuscripts were selected for a comprehensive review. The year of publication, document type, countries, authors, journals, keywords, and topics was analyzed from 2000 to 2023. Also, each paper's methodology, central topic, findings, limitations, and future recommendations were outlined. Consequently, the current systematic literature review (SLR) revealed that the proposed topic is in its infancy, with promising prospects. By emphasizing the findings of this study, managers and businesses can increase consumer satisfaction and reduce costs.

1. Introduction

In today's complex and high-demand market, having LARG supply chains (SCs) is necessary to stay competitive. The LARG metrics can measure a region's ecological, social, political, and economic well-being. Maintaining operational excellence in manufacturing is necessary to stimulate the supply chain across multiple borders with proficient techniques for acquiring resources affordably and elegantly (Sahu et al., 2022). Improving customers' overall satisfaction should be the ultimate objective of any supply chain. Customers who are pleased with their purchases are more likely to make additional ones, which helps established businesses build customer loyalty and name recognition (Sadeghi Asl et al., 2023). Also, choosing the finest supplier can improve SC performance. LARG SC underpins the new supply chain competitiveness and sustainability paradigm (Tavana, 2021). Therefore, SCM must consider LARG paradigms concurrently, a topic investigated infrequently. As a result, this study has conducted a SLR on publications that combined all four LARG paradigms. The following conditions were required to satisfy the criteria for inclusion:

1. Publications indexed in the Scopus and Google Scholar databases

2. Publication dates between 2000 and 2023

3. Written in English

4. Being a review or main article

5. Conference Proceedings

6. Book chapters

2. Research Method

A comprehensive systematic review was undertaken to assess the state of LARG SCM in the engineering, business, and management areas using the PRISMA policies (Liberati et al., 2009). Until August 2023, Scopus and Google Scholar were exhaustively searched for relevant publications. In addition, Backward & Forward Reference Searching was utilized to identify significant related papers.

The following keywords were used for the search process:
(("lean" and "agile" and "resilient" and "green") or "LARG") and ("supply chain management" or "supply chains" or "supply chain" or "SCM").

Only English articles from the two databases in engineering, business, management, and accounting were initially considered, and 65 papers were identified. Then, owing to redundancy, nine papers were instantly deleted. Five articles were eliminated using fast screening. Eleven papers were eradicated after reviewing the remaining publications' titles, abstracts, and keywords. Following a thorough review, eight studies were wiped out because they were judged insufficiently related to the objectives during the final stage. This procedure is depicted in Fig. 1, which displays 32 final products.
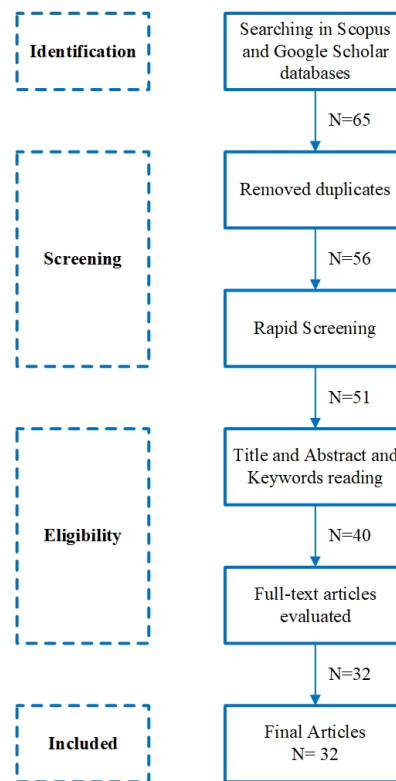

Fig. 1. Synopsis of the compiled papers

3. Results

This section contains in-depth information regarding previous research on LARG paradigms for SCM in Engineering, Business, Management, and Accounting. The 32 selected papers are analyzed based on their publication years, countries, paper types, journals, authors, keywords, and topics.

3.1 Publication year of papers

The trajectory of research initiatives conducted on the References is illustrated in Fig. 2. The investigated articles were published between 2011 and 2023, and the number of studies on this topic increased significantly after 2018. Half of the

articles, namely 16 out of 32, were published within the last three years, indicating that this article's topic has gained popularity among researchers and scientists.
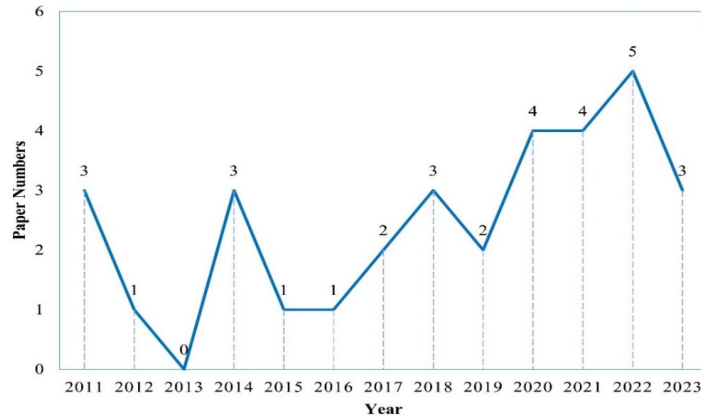

Fig. 2. Number of papers published in each year

3.2 Countries

Twenty nations conducted research in the investigated area. Portugal placed first with eight papers, India placed second with seven, and Iran placed third with six. Two papers were published by each of the following nations: the USA, Italy, The UK, Lithuania, Jordan, the Czech Republic, and Spain. Each of the ten remaining nations possessed one document. Most citations came from Portugal, India, and the UK, respectively. The distribution of papers by country is depicted in Table 1 and Fig. 3.
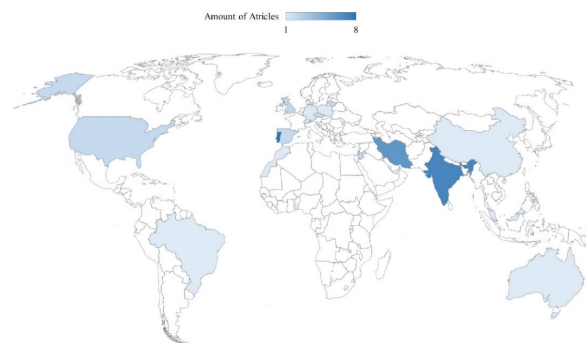

Fig. 3. The paper distribution among countries on the Earth's geography map

Table 1
Contributions of different nations as determined by the number of published papers and citations

No.	Country	Amount of articles	Citations	Total link strength
1	Portugal	8	640	0
2	India	7	225	7
3	Iran	6	58	5
4	USA	2	34	4
5	Italy	2	23	3
6	UK	2	128	3
7	Lithuania	2	22	2
8	Jordan	2	43	1
9	Czech republic	2	3	0
10	Spain	2	78	0
11	Germany	1	22	3
12	Australia	1	7	2
13	China	1	83	2
14	UAE	1	7	2
15	Qatar	1	33	1
16	Switzerland	1	1	1
17	Brazil	1	0	0
18	Malaysia	1	8	0
19	Morocco	1	9	0
20	Poland	1	0	0

Fig. 4 depicts the country network generated by the VOSviewer software. This network showed the importance and prominence of the LARG SCM subject. It demonstrates that the topic is popular among academics from multiple nations, as the number of academic relationships between countries increased between 2021 and 2023. Furthermore, recent research has belonged to Australia and the UAE in 2023.
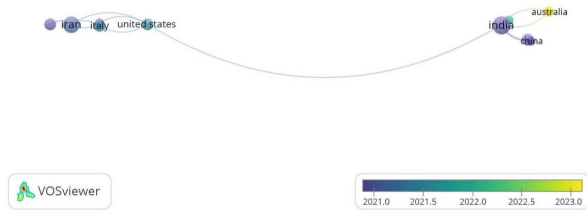

Fig. 4. The network of nations based on the VOSviewer software
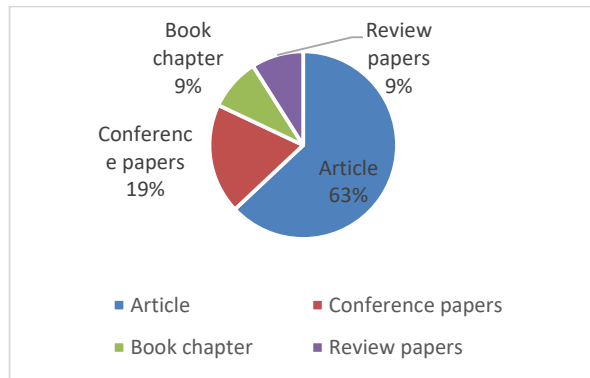

Fig. 5. Type of documents

3.3 Type of papers

According to Fig. 5, 63% of the papers were original articles. Conference papers came in second with 19%. Ultimately, the review papers and book chapters comprised about 9% of the documents.

3.4 Journals

It was observed that four publications, Journal of Business Strategy and the Environment, Benchmarking, and Cleaner Logistics and Supply Chain, each published two articles. The rest of each journal, conference, and book had one document. Table 2 illustrates the name of journals, article numbers, and citations.

Table 2
Specifications of the most notable publications

No.	Journal	Number of atricles	Citations
1	Benchmarking	2	80
2	Journal of Cleaner Production	2	77
3	Business Strategy and the Environment	2	46
4	Cleaner Logistics and Supply Chain	2	34

3.5 Authors

Eighty-three authors contributed to writing the articles. V Cruz-Machado ranked first with seven papers. R. D. Raut took second place with four papers, and H Carvalho and S. G. Azevedo tied for third with three articles each. Thirteen other authors had two papers. More details are exhibited in Table 3.

Table 3
Authors with the most amount of papers

No.	Author	Number of papers
1	V Cruz-Machado	7
2	R. D. Raut	4
3	H Carvalho	3
4	S. G. Azevedo	3
5	F. J. Abad	2
6	S Alhyari	2
7	M Batista	2
8	S Duarte	2
9	A. Grilo	2
10	P Jirask	2
11	S. K. Mangala	2
12	V Pérez-Fernandez	2
13	M Ramirez-Peña	2
14	Atul K Sahu	2
15	Anoop K Sahu	2
16	A. J. S. Sotano	2
17	T Suifan	2

3.6 Keywords

Fig. 6 illustrates keyword associations and relevance analyzed by VOSviewers software. The magnitude of the nodes was modified based on the centrality measures of betweenness. The betweenness centrality revealed the significance of the nodes' locations and their influence on the entire network. The hue of the nodes indicated how closely the keyword relates to current research. The most important keywords were green, lean, agile, resilient, SCM, green SC, resilient SC, sustainability, and automotive industry. Recent keywords such as industry 4.0, LARG, manufacturing, supplier selection, sustainable development, customer satisfaction, and competition demonstrate the current research importance. It has been revealed that the topic is the trend and has a fresh perspective.
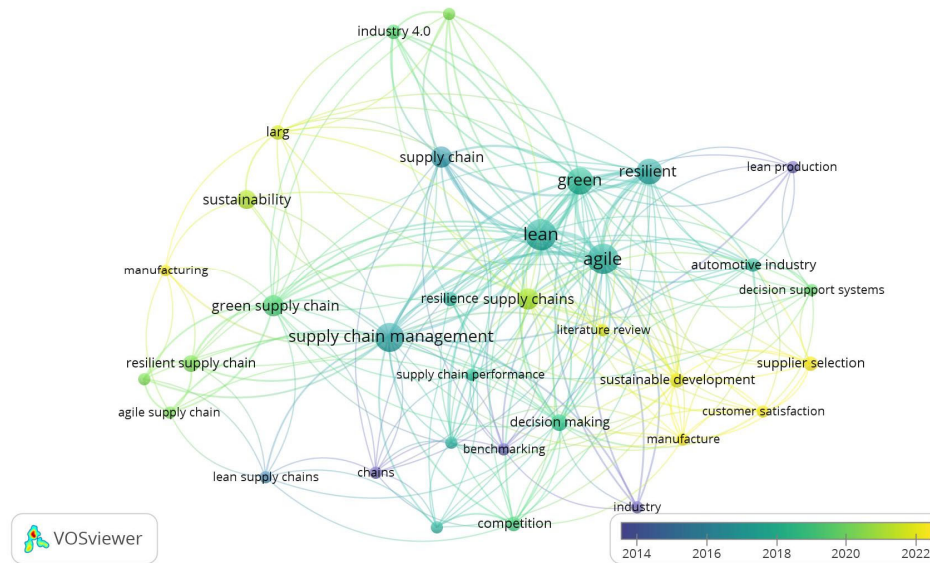

Fig. 6. Keyword relationships and relevancy based on VOSviewers software

3.7 Topics

This part provides an exhaustive context of all 32 publications. Each paper's methodology, core subject, findings, limitations, and prospective suggestions have been outlined. At the end of the part, significant information has been summarized in a table. Thus, concentrating on current results can aid researchers in identifying gaps and future directions.

For the first time, Carvalho et al. (2011) outlined the tensions between the four supply chain principles of LARG. They studied the distinctions and engagements between the LARG paradigms and the effect of paradigm practices on SC aspects. The causal relationships between paradigmatic actions and supply chain features were shown using causal diagrams. Four separate representations were fused into one comprehensive conceptual model. Results indicated that the combination of several paradigms positively affected various aspects, such as increased information frequency and integration level and decreased manufacturing lead time and transportation lead time.

Duarte and Machado (2011) sought to determine whether the LARG paradigms were employed and integrated into the SCM domain. They conducted an organized literature review on SCM. Five databases were used to examine the integration of supply-chain models. Fifteen distinct permutations of the terms "lean", "agile", "resilient", "green", and "supply chain" were discovered. Until 2011, just one article presented the LARG paradigm for SCM, and the results demonstrated that combinations of more than two paradigms were restricted.

Espadinha-Cruz et al. (2011) asserted that the latest SCM approaches, such as LARG SC, are unaffordable due to interoperability issues. They highlighted the primary interoperability challenges when implementing LARG methodologies in an industrial setting, particularly in developing and deploying an information system to streamline business operations within the automobile industry's SC activities. The (Analytical Hierarchy Process) AHP decision-theory model was employed to assess the compatibility of business partners and improve LARG SC processes by assigning ratings to pertinent data. The authors recommended that future research should prioritize large-scale validation of the model using a more substantial number of LARG practices.

Cabral et al. (2012) created an integrated LARG analytic network process (ANP) model to aid businesses in the selection of suitable techniques and key performance indicators (KPIs) for usage in supply chains (SCs). The model was assessed through an exploratory approach, employing a case study within the automotive SC of the Volkswagen Autoeuropa company. According to experts, the most exemplary attributes within each cluster were identified as 'Service level,'

'Responsiveness to urgent deliveries,' 'System for a rapid reaction in case of crises, challenges, or unexpected demands,' and Agile. Carvalho et al. (2014) stressed the relevance of LARG paradigm trade-offs. They examined how LARG SCM procedures affect SC capabilities, both positively and negatively. A case study involved four Portuguese auto SC enterprises. The findings revealed that not all organizations with the same supply chain need LARG compliance. Some businesses might be more resilient, and the lean paradigm was no exception. Capacity was sacrificed for Resilient's "strategic stock." Thus, the strategy might not be extensively adopted if they wished to lead in cost. The car firm was the only one with modest implementation, whereas the suppliers had high levels. Two separate sequences of capabilities were revealed due to variations in the application level of LARG procedures throughout supply chain echelons. The carmaker should prioritize quality, flexibility, environmental protection, cost, and delivery. The primary emphasis of the top-tier supplier hierarchy should be on emphasizing quality, with flexibility, delivery, price, and environmental protection following suit.

Rolo et al. (2014) proposed a theoretical framework that delineates implementing a strategic plan using the LARG paradigms. The authors highlighted the need to use this strategy to improve competitiveness within the framework of a worldwide automotive supply chain. Three hypotheses were devised for evaluation using an explanatory model and Key Performance Indicators (KPIs) to gauge the overall effectiveness of the supply chain. Findings were validated through the process of analyzing the data. These tasks encompassed identifying the most pertinent KPIs for evaluating the effectiveness of the LARG strategy and shifting from a traditional SC to a more expansive supply network. Also, the research findings indicated that the supply network relied on information and communication technology, enabling collaborative virtual network features to be integrated. The utilization of this format facilitated effective communication and enabled consumers to interact with geographically separated businesses. The network examination revealed no organizational management techniques that might be a foundation for developing supply network design frameworks. Consequently, a conceptual framework was constructed, wherein corporate executives were invited to provide comments regarding its validity and potential.

Jirask and Holman (2014) sought to distinguish amongst SCM ideas, focusing on LeanSCM, AgileSCM, ResilientSCM, and GreenSCM. They thoroughly evaluated various SCM techniques based on four crucial factors: management regulations, value-added, productivity, and cost appraisal. Also, the four fundamental principles enabled the definition of differences between MassSCM, LesanSCM, AgileSCM, ResilientSCM, and GreenSCM and the identification of DNA of the five SCM paradigms. In the face of declining demand, the simulation results on the MassSCM and LeanSCM models showed the need for a radical DNA shift. The simulation findings and comparison of the MassSCM and LeanSCM models revealed waste previously considered additional values in standard productivity measurement methods. The transition from MassSCM to alternative SCM models necessitated a modification in the SCM DNA for the supply chain to effectively adjust to market dynamics, meet customer demands, and remain competitive in contemporary market environments. The original step in establishing that all four sections of SCM DNA needed dramatic modifications was to justify the necessity for radical change in SCM productivity, which was dictated by market trends. Ultimately, the model allowed SCM production to be assessed by DNA alterations in the SCM paradigm.

Fazendeiro et al. (2015) developed the LARG index to evaluate global supply chains' leanness, agility, resilience, and sustainability. Enterprise 2.0 technologies and Fuzzy Logic approaches were used during the evaluation process to facilitate various assessment tasks within the LARG evaluation paradigm:Identifying an adequate set of Lean, Agile, Resilient, and Green practices.

- Identifying a suitable combination of Lean, Agile, Resilient, and Green techniques.A widely recognized definition of how each activity in the broader plan should be weighted.
- An extensively acknowledged description of how the relative importance of each action in the overarching plan should be weighted.
- Adapting the assessment policy to the specific supply chain.
- Considering the test results and acting on them.

The results revealed that utilizing Mamdani fuzzy inference systems was chosen to implement the LARG evaluation policies. This decision was based on the system's inherent clarity and ability to represent expert knowledge accurately through rules in IF-THEN statements.

Azevedo et al. (2016) developed the LARG index to assess automotive firms' and supply networks' efficiency and sustainability. A weighted index of LARG SCM principles and practices for automotive SC sustainability was proposed. Delphi computed the significance of each SC paradigm and developed a linear aggregation technique. Vehicle SC was used to show the LARG index. The firm's LARG index value revealed its leanness, agility, resilience, and greenness. The study stressed the LARG paradigms for the automotive sector's long-term profitability. It offered automobile SC functional benchmarking and LARG index business rating.

Jamali et al. (2017) offered a strategic study for LARG SCM competitive strategies in Iranian cement companies. They employed SWOT analysis, the SWARA approach, and the SPACE matrix to find the best plan. The Iranian cement industry was assessed based on four criteria: industrial appeal, environmental sustainability, competitive edge, and financial robustness. The results revealed that the aggressive tactic was the best choice. The SPACE diagram demonstrated that the

Iranian cement industry might follow an aggressive strategy because of its strong competitive position in a rapidly growing market. The two significant issues in the competitive position were avoiding complacency and implementing an anti-competition program.

Rachid (2017) proposed using a generic RMA to systematically introduce, detect, analyze, and prioritize risks in LARG operations. In order to showcase the practicality of the method, he utilized an academic case study in logistics that relied on experimental simulation. Logistics operational risks are categorized in the literature according to their physical occurrence levels within the supply chain or their connection to a specific chain partner. An analysis was conducted to determine and prioritize performance hazards based on their significance. The findings validated the conflicting correlation between Lean and Green objectives and the four LARG characteristics. The findings indicated that the ability to adapt or recover quickly may determine how risk impacts performance, regardless of whether it is related to Lean or Green practices.

Contrary to the prevailing belief, it is impossible to directly compare agility vs. resilience and Lean versus green due to system hazards. The Lean and Green aims were similar as they both emphasized the efficiency of industrial performance. Ultimately, the research developed a "LARG risk map" that determined the impact of a risk on agility and resilience, as well as its influence on Lean, Green, and Achievement goals.

Sen et al. (2018) proposed an integrated decision support framework for assessing both "greenness" and "resiliency" in the automobile sector. They introduced the concept of a resilient index to measure these factors together. The g-resilient index was used to assess SC performance. The fuzzy performance significance index and the FST-derived Degree of Similarity (DOS) were utilized to rank performance indicators. Furthermore, interpretive structural modeling (ISM) identified the relationships between g-resilient performance indicators. The results indicated that Fuzzy DOS classified SC performance measures as regretful, tolerable, or satisfactory. Finally, G-resilient behaviors were acknowledged, and the framework mitigated environmental impacts.

Rajesh (2018) examined partition line position development in robust and sustainable supply chains. The research compared supply chain goals. When supply chains went from lean to green and sustainable or agile to robust, their strategic objectives became diverse. Lead time reduction, responsiveness, cooperation, strategic partnerships, information sharing, and visibility were six of the 32 LARG paradigm supply chain concepts. Managers were told to coordinate strategies across the partition line, concentrating on a speculative and realistic network. Tactical and operational administrators were directed to maintain stocks and buffer capacity in the upstream network to the partition line. After the partition line, the downstream network might buffer demand variations by delaying operations maximum or using delayed differentiations.

Jirask (2018) assessed the effect of Industry 4.0 on SCM. He showed a case study of third-party logistics (3PL) perceptions of Industry 4.0 based on in-depth interviews with the top global 3PLs operating in the Czech Republic. The research detailed a modification to the company's supply chain system that would be required to reestablish its competitive position in the era of Industry 4.0. The results were as follows:

- In the Czech Republic, conventional SCM was more efficient than SCM 4.0 because consumers valued pricing more. Thus, innovators must embrace SCM 4.0.
- SCM 4.0 gave customers and suppliers more supply chain data to customize goods and services.
- SCM 4.0 improved process traceability and visibility but introduced data security risk.
- SCM 4.0 monitored customer behavior, changed order management, and met client needs.
- SCM 4.0 identified cost drivers and allowed real-time work and product allocation.
- Low salaries reduced SCM 4.0 ROI.
- Digitalization accepted paperless administration, automated planning, and real-time online productivity monitoring.

Suifan et al. (2019) used the entropy-Topsis technique to analyze and contrast the benefits and drawbacks of different SCM paradigms while balancing competing goals. Indeed, their purpose was to investigate and appreciate the LARG tenets' contrasts thoroughly. The problem was investigated through empirical research, which included 14 pharmaceutical enterprises from the Jordanian economy. The method's dependability was confirmed via sensitivity analysis. The empirical investigation demonstrated that rivals emphasized various characteristics, including quality, expertise, adaptability, timeliness, customer focus, innovation, and cost. The allocation of weights to competing priorities in SCM models led to distinct competitive advantages in different scenarios. Organizations that adopted a lean approach gained competitive advantages in various areas such as quality, cost, delivery, innovation, and expertise. However, the adoption of this strategy did not yield a significant impact on customer attention. In contrast, implementing an agile deployment strategy proved crucial in enabling organizations to effectively attain their competitive goals on quality, delivery, flexibility, client orientation, and expertise without any noticeable impact on cost or innovation. The green paradigm emphasized quality more than cost, flexibility, customer attention, know-how, and innovation, with less significant delivery. Implementing resilience in competitive choices revealed that several criteria were crucial. Among these criteria, quality, customer attention, know-how, and innovation were the most critical factors. Additionally, delivery and flexibility were essential criteria, while resilience had minimal influence on cost selection.

de Sousa et al. (2019) examined LARG SCM, emphasizing environmental management systems (EMS). They presented a diagnostic instrument that could assist the target company in examining and measuring the environmental sustainability of its suppliers' management practices. A SLR was carried out to identify research deficiencies in SCM. The SLR revealed a dearth of literature addressing it from a supplier management perspective. The proposed technique was evaluated on a company included in the Corporate Sustainability Index of the Brazilian Mercantile and Futures Exchange. Eleven supply chain service providers were used to evaluate the model. Consequently, the target company reviewed the supplier profiles and noted their commitment to achieving their EMS objectives. Several suppliers were unaware of their performance's influence on the focal company's Environmental Management System. The company assessed its suppliers' participation level in its environmental management plan and tested the developed model on a sample of its suppliers.

Salleh et al. (2020) proposed the LARG performance model to enhance seaports' competitiveness. Extensive literature and expert research were employed to define and evaluate seventeen LARG supply chain criteria. Using the AHP, fifteen experts evaluated the relative merit of each LARG paradigm. According to the study, operational performance had the most significant impact on the efficacy of the port's supply chain, followed by economic and environmental factors. The authors asserted that the model could assist related entities in augmenting business capabilities, operational efficiencies, and competitive advantages of seaports in the maritime supply chain.

Alqudah et al. (2020) examined the direct relationship between SCM paradigms and SC performance. The model also examined SC capability and sustainability's indirect mediating effects. They conducted a systematic investigation to demonstrate how product complexity influences these relationships in order to confirm the hypothesis. Supply Chain Operations Reference (SCOR) was employed as a significant performance indicator. The study found that supply chain efficiency degraded when product complexity (structural and operational) made it harder for supply chain members to articulate their needs and production schedules. Compared to conventional supply chain research, the criteria for mild mediation analysis presented in this article helped practitioners make more informed decisions and better understand critical facets of SC performance. Researchers could investigate the impact of LARG on SC performance using SCOR's performance metrics.

Ramirez-Pea et al. (2020) linked industry 4.0 technology to the most crucial supply chain concepts, including Lean, Agile, Resilience, and Green, to define the shipbuilding supply chain. The supply chain analysis identified the most applicable paradigms: Lean, Agile, Resilient, and Green. Twelve enabling technologies have been designated key to positioning the shipbuilding supply chain because they promote the LARG paradigms. The I4.0 performance model context established relationships between the identified enabling technologies. These connections allowed for the creation of a shipbuilding-specific conceptual model. The study found that the green supply chain paradigm incorporated the necessary social elements of the 4.0 performance industry paradigm. The core paradigm of shipbuilding was lean, with intrinsic attributes of resilience and agility. Upon establishing the fundamental elements in the conceptual model, it was logical to deduce that the shipbuilding supply chain should possess both environmentally sustainable and efficient characteristics. The outcome consisted of two distinct phases. The initial phase aims to create a viable shipbuilding supply chain that improves economic, energy, and environmental aspects by utilizing autonomous robots, additive manufacturing, cloud computing, cybersecurity, and augmented reality. In the second phase, the Functional and Social components were combined through horizontal and vertical integration, big data, blockchain, simulation, the Internet of Things, and artificial intelligence (AI). This served to strengthen the robust and agile paradigms.

Ramirez-Pea et al. (2020) combined Industry 4.0 technology with resilient lean, green, and agile SC traits to describe shipbuilding SC. Discrete event simulation revealed how each enabling technology affects the SC, what paradigms to adopt, and what processes to follow for shipbuilding supply chains in a 4.0 environment. LARG was used to analyze them since they had already identified the most influential SC paradigms. Twelve enabling technologies based on LARG concepts were developed to position the shipbuilding SC. The discrete event simulation approach needed to apply the 4.0 SC at a shipyard may be rolled out shortly.

Developing and assessing SC selection criteria eliminate inefficient SCM from the organization. Thus, Anvari (2021) looked into the application of SCM concepts like "Lean," "Agile," "Resilient," "Green," and "Sustainably Managed" to the petrochemical sector's supply chains. The conceptual model was developed after extensive theoretical research on the relationship between LARG supply chains and environmental friendliness. He sorted SCM production concepts according to their degree of integration using data from earlier studies. He used PLS, FAHP, and VIKOR to analyze the model's causal relationships. The research uncovered three primary drivers and eleven secondary elements as essential indications of a supply chain's ability to provide a competitive advantage. Reviewing the literature and conducting in-depth interviews led to the identification of the four main competitive advantage factors (cost, quality, time, and service), the five main LARG and sustainable supply chain indicators (lean, agility, resilience, green, and sustainability), and the three main SCM performance criteria (operational, economic, and environmental). The model found that businesses that combined LARGS activities with creating and refining performance indicators had a significant advantage.

Raut et al. (2021) investigated how Big Data Analytics (BDA) mediated the relationship between sustainable supply chain business performance and a variety of aspects such as lean, social, environmental, organizational, supply chain, financial, and total quality management techniques. They investigated the impact of BDA on business performance by incorporating

its significance for long-term SC and corporate performance. Seven factors that affect BDA adoption decisions were identified. A survey with a sample size of 297 responses was conducted among 37 Indian manufacturing enterprises to validate the conceptual model. The findings emphasized how difficult it is to handle LARG operations that ensure the supply chain's sustainability. Results could help plants and SC fellows to understand BDA adoption sub-factors. It was advised that future studies look into the role of AI, the circular economy, and business process discovery in mitigating supply chain risk and whether digitalization via Industry 4.0 boosts SC performance.

Sharma et al. (2021) conducted a comprehensive literature review to incorporate LARG and sustainable concepts into SCs. The research outputs, trends, and possibilities of LARGS paradigms in SCM were explored. Critical papers were identified by searching various databases. A retrospective sampling method was employed to choose a corpus of 160 scholarly publications published between 1999 and 2019. The analysis revealed the noteworthy concerns and potential avenues for future research in the context of Supply Chain Logistics and Advanced Routing and Scheduling (SC LARGS) paradigms. The study results indicated that the agile, green, and resilient paradigms were predominantly novel or in the early stages of development, except for the lean paradigm, which has been extensively investigated and has a comprehensive body of existing literature. It has been indicated that up until 2019, the LARG paradigm had been examined in only four studies. Despite the implementation of numerous analytical or statistical investigations, it was found that just 21% of the cases examined encompassed many countries. The industry-based classification placed a significant focus on the production of automobiles. Limited research has been conducted on the impact of paradigms on incoming and outbound logistics. The study also unveiled other aspects of performance, including overall performance, competitive advantages, operational performance, economic performance, social performance, and environmental performance.

Tavana et al. (2021) suggested a fuzzy-based technique for reverse SC supplier selection within a LARG strategic paradigm based on the fuzzy group best-worst method (FG-BWM) and the fuzzy combined compromise solution (FCoCoSo). A LARG approach developed critical criteria for green supplier selection and particular sub-criteria for the company's distinguishing characteristics. These Sub-criteria might be significantly adapted to the environmental, engineering, and managerial variables influencing the manager's judgments inside the company's framework. The findings were obtained by applying the concept to a real-world case study at a sizeable Iranian wood and paper production company. The firm was chosen because of its dedication to eco-friendly manufacturing and tactics. Managers might make informed judgments on reverse supply chain supplier selection by introducing triangular fuzzy numbers (TFNs) into a LARG paradigm. Other companies with comparable characteristics might use the methodology to handle environmentally friendly selection difficulties.

Sahu et al. (2022) developed a Decision Support Framework (DSF) to aid companies in choosing reliable suppliers based on the level of adherence to the LARG principle. The framework was rigorously tested in India's automobile sector. The DSF analytical methodology was utilized to assess a reliable supplier through LARG procedures. The production of DSF involved a meticulous categorization of LARG features. Manufacturing firms implemented 63 Lean, 15 Agile, 14 Resilient, and 19 Green supplier selection measures. The findings were ranked in descending order: internal communication agility, interchangeability of staff resources, production flexibility, degree of the online solution, rapidity to resource up-gradation, manageability to demand and supply change, and overstocking inventory practices. The required LARG indicators encompassed transparency in information sharing, internal communication agility, manufacturing flexibility, and the production of environmentally friendly products. Therefore, the analysis could assist in choosing the most advantageous SC LARG option. The presentation introduced LARG standards, which aim to assist manufacturing organizations in implementing sustainable supply chain practices and enhancing operational efficiency.

Due to the need for a more comprehensive understanding of how LARG techniques affect agrifood supply chains (AFSC), supply chain practitioners endeavored to enhance them. Sahu et al. (2022) examined the barriers to applying LARG and environmentally friendly characteristics in agrifood supply chains. AFCS study was founded on identifying obstacles to deploying LARG methodologies in a developing country. The paper outlined the 12 significant difficulties that policymakers and decision-makers must address for LARG approaches to be adopted. A multi-stage methodology was employed to ascertain the challenges and interconnected relationships among the LARG issues. The methodology employed the generalized interval-valued trapezoidal fuzzy numbers, the degree of similarity, and the DEMATEL algorithm. The suggested initiative assisted AFSC in implementing suitable LARG (Local Area Resilience Group) methods by utilizing a case study in the sugar industry. The main barriers and drivers for applying LARG principles were highlighted as a requirement for an improved understanding of the demands of customers and other stakeholders and a deficiency in transparency and trust. The effect group category has found two notable obstacles: the lack of auditing and monitoring in continuous supply chain activities and the necessity for competitive advantages. The cause groups considered these difficulties to be essential. The research could enhance overall productivity, reduce carbon footprints, and improve customer satisfaction. Additionally, it would aid companies in becoming more competitive and sustainable by mitigating the influence of individual bias when evaluating the factors presented to survey participants. The findings of this study have the potential to assist professionals in effectively managing significant challenges and enhancing the overall effectiveness of the AFSC.

Maryniak (2022) investigated supply chain resilience in the context of agility, leanness, and sustainability. The study sought to ascertain if the proposed building resilience models accounted for the various chains in which the tested production entities were embedded. The study included both qualitative and quantitative methods. Over seventy people were

interviewed as part of a critical literature review on the model of resilient supply chains. According to the study, green practices and supply chain resilience benefited from the use of lean technology, and lean chains were highly efficient overall. The application of both lean and resilient strategies improved ecologically friendly practices. Furthermore, hybrid networks that promoted savings were the norm in the economy. Accents consistent with the nature of economic chains should be considered in the proposed resilient chain research models. The ability of supply chains to remain competitive in the face of financial market downturns, climate change, or a shift in the balance of political or economic forces has become a litmus test. As a result, the concerns expressed about the nature of chains and resilience must be considered in a broader context.

Bottani et al. (2022) introduced the LARG framework to provide a comprehensive and efficient method for evaluating food supply chain performance. This approach combined Performance Measurement Systems (PMS), extensive research on food supply chains, and metrics that assessed the chain's lean, agile, resilient, and green capabilities. The LARG model evaluated the food supply chain based on thirteen stringent criteria, utilizing three indices, each for being lean, agile, and green, and four for being resilient. According to the literature, some viewpoints were studied more deeply than others; the lean perspective stood out since its rationale could be used in various contexts. On the other hand, the impacts of the COVID-19 pandemic have given rise to a new theoretical framework: the resilient approach. Instead, the green perspective has been researched for over a decade to meet the growing need for sustainability.Thus, using information from the literature, the authors revisited several measures to adapt them to the peculiarities of the food supply chain. However, it required modification to generate actual business administration indexes. Some metrics were vague and required industry context. They emphasized the significance of obtaining food supply chain specialists' opinions to validate the proposed indexes in future research. Determining the connection between LARG perspectives and supply chain economic performance could be a fascinating research topic. As a result, various companies in the food supply chain could utilize the framework for testing and benchmarking purposes. The findings could aid managers in selecting the optimal combination of LARG indices and developing novel concepts, approaches, and measures.

Sonar et al. (2022) offered an interpretive structural modeling (ISM) approach to create hierarchical links between supplier selection criteria in the LARGS paradigm. Twenty-two essential criteria were uncovered for choosing the best suppliers. Twelve experts contributed to ISM's analysis. According to the data, proximity to the buyer was more important than any other factor when choosing a supplier. Critical factors such as location, lead time, innovation capacity, and reaction rate were positioned at the model's base. Finding a supplier that valued supply chain efficiency and effectiveness by implementing lean management, agility, resilience, environmental sustainability, and sustainable practices was essential for achieving the best outcomes.

Divsalar et al. (2022) evaluated LARG supply chains for medical equipment using a conceptual multiple-attribute decision-making (MADM) model. Incorporating criteria, behavior, paradigm, and options, the model was comprehensive. Dependability, responsiveness, agility, SC cost, and asset management were the SCOR model and Green SCOR Criteria aspects. Many LARG SC strategies were described in the published works. The Fuzzy Delphi method was then used to choose the most promising practices to construct the practice dimension. The extended hesitant fuzzy linguistic (EHFL) VIKOR, a qualitative group decision-making approach, was used to rate the LARG performance of Iranian needle and syringe firms. The results showed customer satisfaction rose after adopting agile practices such as quick product development cycles and flexible team structures. The agile paradigm, adaptability, and the rapid introduction of new products were the most laudable features of these three. The inquiry's findings validated the vendors the Iranian Ministry of Health selected for needles and syringes.

Kamali Saraji et al. (2023) developed a complete assessment technique because LARG SCs have proven challenging to deploy, particularly in the pharmaceutical industry. They employed fuzzy spherical analysis to evaluate five Iranian pharmaceutical companies' LARG SC adoption initiatives. A review of the literature and a survey yielded 35 challenges. Lean had seven flaws, agile had nine, resilient had nine, and Green had ten. Fifteen professionals confirmed the problems. The SF-MEREC-TOPSIS approach assigned weighted hurdle performance to businesses. According to the findings, the leanest difficulty was designing for manufacturing, the biggest agile problem was integrating all industrial processes, and the biggest resilience challenge was good communication with suppliers and distributors. The most significant green barrier to LARG adoption was green packaging. A comparison study was also conducted to determine the proposed method's superiority over SF-WSM, SF-WMP, and SF-WASPAS. Companies that focus on all four LARG pillars may outperform their competitors. The findings persuaded pharmaceutical executives to utilize the LARG paradigm when developing strategies, making them more stable in a changing world. The research methods and calculations were time-consuming. Future research could rank companies using VIKOR, MABAC, and COPRAS. Additionally, the SWARA approach could also be used to evaluate intuitive difficulty.

Sadeghi Asl et al. (2023) developed GRACL SC using SLR between 2000–2019. They used Web of Science (WOS) databases with 17 publication titles and subject keywords. The introduction reviewed 1,190 WOS surveys. Two research reviews (5%) were linked to the LARG and 64% to the GSC: authors, publication year, and statistics report type. Twenty-seven groupings aggregated 122 variables. They examined agile, resilient, green, and lean supply chain synergies and divergences. The findings helped supply chain managers implement network performance-improving models. They advised corporations on product aspects to avoid issues and helped researchers identify crucial market segments and organizations.

Finally, Table 4 provides an overview of prior LARG SCM papers.

Table 4
A summary of past papers on LARG SCM

No.	Reference	Topic/Category	Method	Findings	Limitations	Suggestions for future research
1	Sadeghi Asl et al. (2023)	Food Industry (in Iran)	Systematic Literature Review (SLR) from 2000 to 2019	The review article used 39 WOS-sourced papers. Only two review articles covered the LARG, whereas 64% covered the GSC. Statistics were filtered by year, author, and category. At least 122 variables were eliminated and grouped into 27 primary groups. The study advised firms on product promotion to prevent complications and helped researchers discover major market regions and varied populations.	Papers after 2019 did not consider.	1) No CSC overview existed between 2000 and 2019. More study is needed. 2) "Food safety" affects health. No study has addressed actively developing cold chain activity, one of the distinctive concerns. 3) Exploratory component analysis created the study's conceptual model. Inconclusive literature reviews benefit from graph theory and Interpretive Structural Modeling.
2	Kamali Saraji et al. (2023)	Healthcare system (Pharmaceutical companies)	The MEREC-TOPSIS under spherical fuzzy sets	1) Design for manufacturing was the biggest challenge to adopting LARG; agility was integrating all industrial activities, resilience was effective communication with suppliers and distributors, and green was environmentally friendly packaging. 2) Based on the sensitivity analysis results, the four pillars of the LARG paradigm could potentially generate significant advantages for organizations.	Computations and application of the research methodology were time-consuming.	1) Comparing VIKOR, MABAC, and COPRAS rankings to the study's conclusions. 2) Impediments may be intuitively weighted using SWARA. 3) Future research might test the proposed approach on other fuzzy sets to see how fuzzy logic influences results.
3	Sahu et al. (2022)	Automotive sector (in India)	AHP, DEMATEL, ANP, MOORA, SAW	The study identified 63 indicators, with 15 measures for Agile, 14 for Resilient, 19 for Green, and 15 for Lean, that can be used to improve the supplier selection process in manufacturing organizations. The study established the foundation for evaluating the SC's most feasible LARG alternative. The program provided a comprehensive range of indicators to encourage operational expansion in manufacturing companies toward adopting sustainable SC practices.	1) India's emerging economy results cannot be extended to established nations. 2) Study subjects came from one crop. Diverse research is vital. 3) The framework must be statistically examined to eliminate decision-maker bias in DSF supplier selection indicator evaluation.	1) Because the framework was designed in the already intricaste automobile sector SC, it must be tested in other less established SCs. 2) It is essential to evaluate the commitment of senior management to correctly integrate this DSF into the organization's existing support infrastructure.
4	Sahu et al. (2022)	Agri-food SC (Sugar industry)	GIVTFNs, DEMATEL, the degree of similarity	The primary challenges and motivations for adopting LARG principles were the insufficient comprehension of consumer and stakeholder expectations and the absence of transparency and trust. The absence of auditing and monitoring of ongoing SCs activities and the absence of competitive advantages were identified as significant barriers within the impact group, which were influenced by difficulties within the cause group.	1) The concerns under consideration were linked to the LARG component of AFSC. For the study to apply to different industries or organizations, the selected data sets needed greater robustness. 2) The opinions of the specialists may have been based on personal perspectives and prior LARG deployment practice in AFSC.	1) Future studies should reduce individual bias in remarks analyzing respondents' factors. 2) The LARG framework could be expanded to cover safety-sensitive sectors and behaviors. 3) Studying LARG methods in other sectors' supply chains to increase efficiency, carbon footprint reduction, customer happiness, and company competitiveness and sustainability.

Table 4

A summary of past papers on LARG SCM (Continued)

No.	Reference	Topic/Category	Method	Findings	Limitations	Suggestions for future research
5	Maryniak (2022)	Resilience features for all SCs types	Quantitative and Qualitative methods, including Interviews	The compiled research model provided a firm foundation for decision-making when we assembled our resistant chains. The results were profitable because they revealed to businesses the hybrid supply network structures they had developed.	According to the author, comparable studies cannot be conducted because the development's concepts are being evaluated for the first time.	1) Investigating how chain hybrids can complement one another to create resistant chains is beneficial. 2) whether agility-related chains are more resilient than lean or green chains is still being determined. Thus, further research is necessary. 3) The content must be expanded to include pro-environmental elements.
6	Bottani et al. (2022)	Food Industry	PMS identification for LARG SC using Literature Review	The methodology considered the 13 indicators for assessing a food supply chain's LARG capabilities. These indicators are divided into three lean indexes, three agile indices, four resilience indexes, and three green indexes. The findings could assist managers in selecting the ideal combination of LARG indices and developing new concepts, approaches, and measures.	The study required considerable time and effort to identify the precise indices a genuine firm requires for effective business management. Some metrics were vague and needed further clarification when applied to a particular industry sector.	Future research should gather the opinions of specialists working in food SCs to validate the collection of indicators proposed. Determining the relationship between LARG viewpoints and SC economic performance could be an exciting future study subject.
7	Sonar et al. (2022)	Supplier Selection according to LARG paradigm (In general)	Expert Judgments, Interpretive Structural Modeling (ISM)	The findings suggested that geographical location was the most crucial consideration for supplier selection. Geographic location, lead time, innovation capacity, and reaction rate were critical criteria at the bottom of the model.	1) The specified criteria were broad. However, context-specific supplier selection criteria may provide a unique viewpoint. 2) Eight respondents provided information. The results could not be extrapolated to other industry sectors due to the short sample size.	1) Operational levels and production systems may be studied using different criteria. 2) A large sample size is needed to establish correlations using multiple MCDM approaches. 3) SEM may be used to validate the model statistically. 4) Different MCDM approaches may be used to rank different criteria.
8	Divsalar et al. (2022)	LARG supply chain performance evaluation (Medical equipment, Iranian needles and syringes companies.)	The SCOR-based model with hybrid MADM methods	The studies showed that agile methodology, timeliness, and speedy product launch boosted customer satisfaction. The agile mindset, reactivity, and fast product launch were best. The findings supported Iran's Ministry of Health's needle and syringe suppliers.	1) The institution analyzed needle and syringe makers solely in public hospital data, not private hospital data. 2) Due to the geographical dispersion of 15 needle and syringe enterprises across Iran provinces, only four prominent needle and syringe firms were studied.	1) improving LARG SC utilizing MODM or the structural equation model. 2) Assessing LARG strategies for sustainable SCs. 3) Implementing the method in different industries.

Table 4
A summary of past papers on LARG SCM (Continued)

No.	Reference	Topic/Category	Method	Findings	Limitations	Suggestions for future research
9	Sharma et al. (2021)	Literature Review for incorporating LARGS concepts into SCs	Systematic literature review (SLR)	All the agile, green, and resilient paradigms were new or emerging except lean, which has thoroughly examined the topic and existing literature. They stated that only four papers investigated the LARG paradigm until 2019, Despite various analytical or statistical investigations, just 21% covered multiple countries. Car manufacturing was the emphasis of the industry-based classification.	Only the reflection of the selected papers was analyzed in the descriptive and theoretical study.	1) How can LARGS and sustainability be included in supplier selection and logistics at different SC phases? 2) How do LARGS paradigms affect strategic, tactical, and operational levels? 3) How does Industry 4.0 affect LARGS model-SC output indicator compromise? 4) What are essential performance indicators for the LARGS paradigm selection?
10	Tavana et al. (2021)	Supplier Selection (the wood and paper manufacturing company)	Integrated FG-BWM and FCoCoSo method	The method's adaptability was enhanced by the use of triangular TFNs inside a LARG paradigm, allowing for more informed supplier selection choices by managers in reverse SCs. The authors claim the framework may be used to select problems in environmental sustainability by other firms with similar features.	The managers' capacity to select specialists to undertake pairwise comparisons is a drawback. The disadvantage can be minimized by adjusting the imprecision level based on the imprecision level assumed by the manager.	Some potential areas of investigation for the future include selecting a sustainable e-waste collection location, selecting a sustainable partner, selecting a sustainable waste disposal site, and selecting a sustainable energy plant site.
11	Anvari (2021)	Applying the LARG paradigm for SCM (in the Petrochemical industry)	PLS, FAHP, and VIKOR	Three SCM performance criteria (operational, economic, and environmental) were identified after reviewing the literature and conducting specialized interviews, besides the four main competitive advantage factors (cost, quality, time, and service).	1) The conceptual model was developed by drawing upon anecdotal and empirical evidence from the existing literature without undergoing any validation process. 2) A study on LARGS procedures and manufacturing supply chain performance is needed to evaluate the suggested model.	1) Validations must be expanded to encompass more than three practices. 2) Assessing and comparing perceptions from diverse organizations in the supply chain is critical. 3) Future researchers should use grounded theory to verify the LARGS integrated model.
12	Raut at al. (2021)	BDA implementation for sustainable SC of manufacturing firms (Indian organization performance)	The survey (questionnaire)	The research will help manufacturers understand the essential elements influencing BDA adoption in sustainable SC. Before BDA can be appropriately applied, many actors in SC will need to comprehend the nuances of sub-factors. The findings could aid policymakers in developing a BDA that works for factories.	1) Data was gathered using structured questions. 2) Because the study was done on Indian manufacturing enterprises, the conclusions cannot be applied beyond this setting.	1) New geographical regions and data samples from other developing economies could increase the data sample size. 2) Hybrid SEM-ANNs can handle non-linear relationships and improve forecasts. 3) Industry 4.0 digitalization can be tested for SC performance. 4) Investigate how AI, the circular economy, and BDA reduce supply chain risk.

Table 4
A summary of past papers on LARG SCM (Continued)

No.	Reference	Topic/Category	Method	Findings	Limitations	Suggestions for future research
13	Salleh et al. (2020)	Supply chain performance (Seaport system)	AHP	Operational performance was found to have the most significant impact on supply chain performance at the ports, followed by economic and environmental metrics. Authors claimed the concept could help linked firms boost seaports' competitive advantages, operational efficiencies, and business prowess along the marine supply chain.	1) The LARG practices listed can vary according to the industry. 2) Seaport activities are enormous, seaport operations are rigid, and maritime trade is dynamic; therefore, the seaport supply chain criteria do not encompass all practices. 3) The criteria and procedures can be tailored to the practitioner and business.	11) A variety of decision-making strategies (e.g., Symmetric Model (SM), Fuzzy Set Theories (FST), and Bayesian Belief Network (BBN)) can be utilized in tandem. 2) LARG will be tested in maritime supply chain operations at several seaports. 3) The study on modeling LARG performance in seaport SC operations would integrate the study's findings.
14	Alqudah et al. (2020)	A Moderated Mediation Model of LARG Paradigms in SC	The Supply Chain Operations Reference (SCOR) model	The study expanded research on supply chain capacity, sustainability, and performance and provided measurements for other scholars to explore these factors. Scholars could use the model to study the proposed relationships empirically.	1) The SCOR model indicators needed to be more utilized due to its vast list of 589 well-documented metrics structured at the process detail level. 2) The conceptual model was not validated.	Future studies must validate the links established from the existing model and create scales for both the SCM paradigms and performance measures.
15	Ramirez-Peña et al. (2020)	Industry 4.0 and Sustainable SCs (Shipbuilding)	The Survey and Literature review	The green SC Paradigm connected the social aspects of the performance industry 4.0 paradigm. The Lean paradigm was the most crucial framework, encompassing resilience and agility as intrinsic qualities in shipbuilding. Based on identifying essential characteristics in the conceptual model, it was logical to conclude that the Shipbuilding SC should prioritize being environmentally friendly and efficient.	------	------
16	Ramirez-Peña et al. (2020)	Supply chain 4.0 (in the shipbuilding industry)	The simulation of discrete events	The study demonstrated how each enabling technology affects the SC, what paradigms to attain, and what procedures to take using discrete event simulation to execute the shipbuilding supply chain in a 4.0 context. Twelve enabling technologies were established to position the shipbuilding SC because they leveraged the LARG paradigms.	------	The required methodology for implementing the 4.0 SC in a shipyard using discrete event simulation could be deployed soon.
17	Suifan et al. (2019)	The trade-off between SC paradigms (Pharmaceutical industry in Jordan)	Topsis and entropy method	Jordan's pharmaceutical industry's competitive priorities were 'quality,' 'know-how,' 'flexibility,' 'delivery,' 'customer focus,' 'innovation,' and lastly, 'cost.' The SCM concepts most impacted the 'quality' competitive priority.	1) Most samples were from Jordanian pharmaceutical businesses. It restricted external generalizability. 2) Upstream and downstream suppliers were inaccessible. 3) Each business gathered a few samples. Self-reporting bias was possible.	1) Multi-industrial supply networks may improve generalizability. 2) The study sample must span industries. 3) Upstream and downstream research is required to support the study's findings.

Table 4
A summary of past papers on LARG SCM (Continued)

No.	Reference	Topic/Category	Method	Findings	Limitations	Suggestions for future research
18	de Sousa et al. (2019)	Environmental Management of LARG SC (Assessing Suppliers of the Brazilian Mercantile and Futures Exchange)	Systematic literature review (SLR)	It was found that several suppliers had no idea how their actions affected the Environmental Management System of the relevant organization. By surveying a subset of its vendors, the firm calculated the extent to which its suppliers were involved in developing and implementing its environmental management plan.	Identifying the network of suppliers whose activities may influence the primary firm's Environmental Management System was challenging.	Future studies should focus on developing a methodology that educates suppliers about their supply chain environmental obligations.
19	Sen et al. (2018)	Ecosilient performance index of SC (Automotive Industry)	fuzzy DOS, Interpretive structural modeling	The results indicated that Fuzzy DOS classified SC performance measures as regretful, tolerable, or satisfactory. Finally, G-resilient behaviors were acknowledged, and the framework mitigated environmental impacts.	------	1) The separate GRI can help compare the performance of companies with similar SC structures. 2) Fuzzy decision support system can contain interval-valued fuzzy numbers set theories. 3) Investigating how the DMs' diverse decision-making attitudes influence the final decision outcome.
20	Rajesh (2018)	Sustainable–resilient supply networks (Indian electronic gadget manufacturer)	Conceptual framework, literature review	The authors emphasized 6 of the 32 supply chain principles within the LARG paradigm. These concepts include lead time reduction, responsiveness, cooperation, strategic alliances, information sharing, and visibility. Due to the significance of accurately identifying the specific location of the demarcation point within their SCs in order to comprehend the precise strategic emphasis at different levels of the supply network, it proved advantageous for managers to adopt strategies that prioritize sustainability in the upstream direction and resilience in the downstream direction.	1) Implementing a sustainable–resilient network required extensive research and expert practitioners. 2) The sudden modification in strategic objectives posed a challenge for an existing supply network. 3) Implementing a sustainable and resilient network was a considerable problem because of partition lines' fictional and changeable nature in a real-world supply network.	1) Sustainable-resilient supply networks require top-level management and technological changes. 2) Investigating contemporary organizations' supply chain operations could help adapt sustainability and resilience principles to varying supply networks. 3) Future studies might potentially examine a supply network in real-time and determine the partition line. 4) To use and expand sustainable-resilient SCs, theoretical and practical research must be balanced.
21	Jirask (2018)	The Impact of Industry 4.0 on SCM	Depth interviews with experts	1) There was inadequate client interest and demand for SCM 4.0 services. 2) Price-focused Czech customers made conventional SCM more efficient than SCM 4.0. Innovators must embrace SCM 4.0. 3) SCM 4.0 provided additional supply chain data for customization. 4) Paperless administration, automated planning, and real-time online productivity monitoring were provided by digitalization.	1) In SCM 4.0, there is a risk concern regarding data security. 2) personnel management, hiring, and corporate culture changes are not adequately considered for SCM 4.0. 3) The impact of innovation on society and firm employees is equivocal.	Future studies must determine how to create a plan for sustained progressive innovation regarding customers, vendors, and staff.

Table 4
A summary of past papers on LARG SCM (Continued)

No.	Reference	Topic/Category	Method	Findings	Limitations	Suggestions for future research
22	Jamali et al. (2017)	LARG SCM competitive strategies (Iranian Cement Industry)	SWOT Analysis, SWARA method, SPACE Matrix	The results revealed that the aggressive tactic was the best choice. The two significant issues in the competitive position were avoiding complacency and implementing an anti-competition program.	------	1. Investing in innovation to maintain and expand competitive advantage. 2. Creating chances to achieve a diverse value offer appealing to market segments.
23	Rachid (2017)	Risk Management in LARG SC Context	Risk Management Approach (RMA)	Agility and resilience were linked to system risks; therefore, they could not be directly compared. Lean and Green objectives differ in production mean performance. It showed that risk could be assessed using agility or resilience and that performance could be Lean or Green.	------	Is there a relationship between the risks of agility and resilience? Is the risk agile concerning risk resilience? Can researchers innovate by overcoming the conflict between risk and performance goals?
24	Azevedo et al. (2016)	LARG index for improving SCM (Automotive Industry)	The Delphi technique, the linear aggregated method	Regarding the particular firm, the LARG index value provided insight into the company's position in leanness, agility, resilience, and greenness. The study emphasized the significance of the four SCM paradigms (LARG) for the automobile industry's long-term viability. It enabled functional benchmarking methodologies in the automotive SC and ranking among businesses using the suggested LARG index.	1) The suggested index was primarily concerned with the automobile industry. 2) The Delphi weighting method was created in two rounds. More rounds would increase questionnaire validity. 3) The data set was too weak to extrapolate LARG's prospective commercial advantages.	1) More firms should improve the strategy's efficacy, and more members should be added to the Delphi technique panel to increase the validity of the recommended approach. 2) A more in-depth examination of the links between SCM concepts and associated practices should be conducted using various mathematical models.
25	Fazendeiro et al. (2015)	Assessing the LARG Index for SCM	Fuzzy Logic and Delphi method	The results demonstrated that Mamdani fuzzy inference systems were utilized to implement the LARG assessment policies. This choice was made because these systems include inherent clarity and the ability to effectively incorporate expert information through rules with precise semantics in IF-THEN statements.	------	------
26	Carvalho et al. (2014)	The trade-off in LARG paradigms (Portuguese automotive Industry)	Qualitative method: semi-structured interviews and the literature review	The findings revealed that not all firms with the same supply chain need higher LARG standards compliance. Some businesses might be more resilient, and the Lean paradigm was no exception.	Both the methods of LARG and the capacities of SC were limited.	Additional research is needed to examine the quantitative trade-off analysis between LARG techniques and SC capabilities, such as structural equation modeling (SEM).
27	Rolo et al. (2014)	The collaborative virtual network In LARG SC (Multinational Car Manufacturer)	Semi-Structured Interviews	No organizational management practices were discovered inside the network to create a framework for designing supply networks. As a result, they established a conceptual framework for which business executives provided feedback on its validity and opportunity.	One limitation in the case study pertained to integrating a supplier network within a particular industry. No indicators were employed to ascertain the performance of the network.	In future research, methods should be built to define the network's strategy and KPIs as a whole rather than only at an individual level.

Table 4
A summary of past papers on LARG SCM (Continued)

No.	Reference	Topic/Category	Method	Findings	Limitations	Suggestions for future research
28	Jirask and Holman (2014)	Determining the distinctions between LARG SCM concepts (Market conditions)	The Simulation approach using Witness software	The simulation findings and comparison of the MassSCM and LeanSCM models revealed waste previously considered additional values in standard productivity measurement methods. The shift from MassSCM to any other SCM model required a change in SCM DNA for the supply chain to acclimate to market dynamics, meet customer demands, and remain competitive in contemporary marketplaces.	------	------
29	Cabral et al. (2012)	Automotive Industry (The Autoeuropa VW firm in Germany)	ANP	Experts affirmed that each group's superior elements were service level, promptness in handling urgent deliveries, a rapid response system for crises, issues, or exceptional requests, and adaptability.	The main disadvantages of ANP were the extensive amount of pairwise comparisons needed and the problems with inconsistency.	1) Extending validations to include over three practices and KPIs. 2) Comparing SC viewpoints from multiple companies is essential. 3) Adding fuzzy logic to the LARG ANP model and comparing results. 4) Extending and verifying the concept in different sectors.
30	Espadinha-Cruz et al. (2011)	Evaluating LARG Practices Interoperability in SC (Automotive industry)	AHP	The primary interoperability challenges were highlighted when adapting LARG methodologies to an industrial setting, precisely when building and deploying an information system to support business operations in the automobile industry SC activities.	------	Future research should prioritize extensively validating the model by incorporating a larger sample size of LARG practices. Furthermore, academics must prioritize the development of the AHP model to the ANP, owing to the possibility of a lack of independence in specific BIPs, which is necessary for AHP.
31	Duarte and Machado (2011)	Elucidating the manufacturing paradigms in SCM	The structured literature review	Until 2011, just one article presented the LARG paradigm for SCM, and the results demonstrated that combinations of more than two paradigms were restricted.	------	1) Gaining a thorough awareness of the trade-offs across management approaches. 2) More study is needed on the integration of SC paradigms.
32	Carvalho et al. (2011)	Trade-offs explanation between LARG SC concepts	The conceptual model within causal diagrams	Enhanced collaboration between different approaches or systems was linked with a higher frequency of information sharing and greater integration, resulting in reduced manufacturing and transportation time.	The model connections were created using anecdotal evidence from a literature review, which painted an incomplete picture of the underlying SC dynamics.	More research into additional supply chain elements, paradigm practices, and the validity of the stated correlations was advised.

4. Discussion

Based on the Table 4, the subsequent findings and recommendations have been encountered:

Findings:

- The 32 selected papers in engineering, business, and management domains were analyzed based on their publication years, countries, paper types, journals, authors, keywords, and topics.
- The LARG SC paradigm was used in nine different sectors, namely: automotive, food, healthcare (pharmacy), seaport and shipbuilding, economy and stock market, petrochemicals, cement, wood and paper, and electronics industries.

- The automotive sector was the primary industry in which the LARG SC Paradigm was implemented, accounting for 33% of its overall execution. Comparable in share at 14% each, the food industry, the seaport system and shipbuilding, and the healthcare system (pharmacy) occupied the second position. The stock market and economy constituted 9% of the total, while the petrochemical, cement, wood and paper, and electronics sectors each accounted for 4%.
- The primary research methodologies employed in the articles encompass a range of ten methods, namely: Literature Review (12%), AHP and Fuzzy FAHP (10%), Interviews (10%), Delphi method (7%), ANP (5%), TOPSIS and Fuzzy TOPSIS (5%), DEMATEL (5%), SCOR (5%), Simulation (5%), and ISM (5%).
- In the Healthcare system, the design for manufacturing was the biggest challenge to adopting LARG; agility was integrating all industrial activities, resilience entailed efficient communication with suppliers and distributors, while green referred to ecologically friendly packaging.
- The four fundamental principles of the LARG paradigm have the potential to generate exceptional advantages for organizations.

Recommendations:

- Industry 4.0 digitalization can be tested for SC performance.
- Investigating how AI and the circular economy can reduce supply chain risk.
- The focus should be developing a methodology that educates suppliers about their supply chain environmental obligations.
- Various decision-making systems, like the Symmetric Model, Fuzzy Set Theories, and Bayesian Belief Networks, can be utilized together.Improving LARG SC utilizing MODM or the structural equation model (SEM).
- Individual bias in remarks analyzing respondents' factors should be reduced.
- Assessing LARG strategies for sustainable SCs and how LARG paradigms affect strategic, tactical, and operational levels.
- None of the studies have specifically examined the active development of cold chain activity, which is one of the unique problems.
- Investigating the correlation between LARG perspectives and the economic performance of the supply chain is an intriguing research opportunity within the food business.

5. Conclusions

LARG SC is required for competitiveness in today's complex, high-demand market. Combining the four principles of the LARG SC, organizations can strive for an optimized supply chain that is efficient, adaptable, and resilient to disruptions. This study conducted a systematic literature review (SLR) on publications that combined all four LARG principles in engineering, business, and management domains. According to the PRISMA approach, two databases were exhaustively examined until August 2023: Scopus and Google Scholar. Then, 32 manuscripts were selected for a comprehensive review. The content analysis analyzed the year of publication, document type, countries, authors, journals, keywords, and topics. Between 2011 and 2023, articles were published, and after 2020, the number of studies on this topic increased dramatically. Twenty nations conducted research in the investigated area. Portugal placed first with eight papers, India placed second with seven, and Iran placed third with six. Original articles constituted 63% of publications, while conference papers accounted for 19%. Review articles and book chapters each accounted for 9% of the materials. It was observed that four publications titled Journal of Business Strategy and the Environment, Benchmarking, and Cleaner Logistics and Supply Chain published two articles each.

In contrast, the remaining publications published one article. Eighty-three authors contributed to the composition of the articles. V Cruz-Machado topped the list with seven publications. R. D. Raut placed second with four papers, and H Carvalho and S. G. Azevedo tied for third place with three articles apiece. Thirteen additional authors had two publications. All Keywords and their relationships were analyzed by VOSviewer software. The most important keywords were green, lean, agile, resilient, SCM, green SC, resilient SC, sustainability, and automotive industry. Recent keywords such as Industry 4.0, LARG, manufacturing, supplier selection, sustainable development, customer satisfaction, and competition showed the current research's importance. Finally, the context of all 32 publications was explained in detail. Each paper's methodology, central topic, findings, limitations, and future recommendations were summarized in Table 4. In conclusion, the current review research reveals that the proposed topic is in its infancy, with promising prospects. Researchers can comprehend research gaps and future directions by paying attention to this SLR. In addition, managers and companies can enhance customer satisfaction, reduce costs, mitigate risks, and contribute to a more sustainable future.

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