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AGILITY AND LEAN IN THE SUPPLY CHAIN IN MANUFACTURING SMEs: A REVIEW OF THE LITERATURE

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Agility and Lean in the Supply Chain in Manufacturing SMEs: A Review of the Literature

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Abstract

In a competitive world with constant changes, it is crucial that manufacturing companies look for new strategies to apply in their supply chain in order to generate a competitive advantage and be sustainable over time. The application of the agile methodology together with lean in the supply chain, seek to provide a solution to this problem. The purpose of this study is to perform a systematic review of the last 5 years on agility and lean in the supply chain in manufacturing SMEs. Also, to analyze and identify the main factors to increase agility along with the application of lean methodology. Consequently, it was important to review a considerable number of articles and authors specialized in these topics, as well as to be updated of the changes that are due to the course of time. Therefore, through the PRISMA method, 122 articles were obtained from the Scopus database, between the years 2017 and 2021, for subsequent analysis and to achieve the objective of the research. With this study, it is sought that manufacturing companies around the world begin to investigate more about this strategy and seek its application, to become highly competitive companies.

Keywords

Lean, Agility, Supply chain, SMEs, Manufacture

1. Introduction

Currently, manufacturing companies worldwide are in a very competitive landscape with respect to other companies, so the need arises for the integration of methodologies in the supply chain, in order to achieve a competitive advantage, satisfying customer demand in an efficient and effective way (Lee 2021). Consequently, supply chain management practices have to opt for adapting to the requirements of the business environment, with the aim of obtaining greater profitability (Tarei et al. 2021). The application of Lean methodology in the supply chain, is optimal for business environments that are stable, controllable and predictable, on the other hand, agile methodology is required for the company to be able to adapt in an environment with unpredictable changes in the market (Zhang and Cao 2018). These two methodologies have been extended towards the need for a company's supply chain to apply it together (Rajesh 2021). Achieving cost optimization, elimination of waste, facilitation in product customization and a sharing of information throughout the supply chain (Song et al. 2021). The purpose is to focus this joint implementation, in SME manufacturing companies, where it can be applied and evidenced in a clearer way the results in the supply chain. Being a great guide, for many manufacturing companies of any size going forward, and that can opt for this strategy. Therefore, the systematic literature review to be carried out will consist of 122 articles in the last 5 years, covering the topics of agility, lean, supply chain and manufacturing SMEs. Given the problems raised above, the following research

question is established: Is it possible to integrate the application of agile and lean methodology in the supply chain of manufacturing SMEs?

The theoretical foundation of the main concepts obtained in the different articles reviewed will be shown in the next section. In the second section, the methodology used is presented, and in the third section, the results obtained. The fourth section presents the discussion of all the articles studied, showing more clearly both the benefits of integration and the disadvantages. Finally, the fifth section concludes with the conclusions.

1.1 Agility and lean in the supply chain

The constant change in technology coupled with well-informed customers when purchasing and demanding products, have forced manufacturing companies to encourage to improve their processes, their intern logistic and offer added value to the customer (Machuca 2021). First, we will start by defining what Agile is and what Lean is within the context of the Supply Chain. Then, we will talk about manufacturing SMEs, the sector on which we will focus our review. The concept of agility in the manufacturing companies has been reframed in response to the constant change in global competitiveness. According to Liu et al. 2017, it is characterized by cooperation and synergy, a strategic vision, responsive and customer-valued creation. This new disruptive concept will help these companies to improve the competition level and modernization. Also, agility should be introduced in the above-mentioned companies. Agility, as a concept, tries to focus on adaptation in a context of constant change and high competition among companies in the sector. A company is agile when it is able to meet the changing needs of both customers and suppliers, accommodating and generating strategies to defend itself against a competition that is constantly innovating and providing highly profitable services. On the other hand, it is said that the scope of the agility concept has varied from a simple discussion on flexibility to a strategic operational concept that encompasses and can understand and manage, efficiently, all aspects of an organization (Kim 2020). This would lead to a major change in the traditional manufacturing system and ultimately impact changes in production so that manufacturing SMEs will respond quickly to high customer demand with significant quality.

Secondly, there is the concept of lean manufacturing, which comes from the traditional mass production approach. Bai et al. 2020, coined the term lean manufacturing to be “efficient” with your resources. Companies which apply lean methodology will use their maximum capacity without compromising the quality of their products (Fadaki et al. 2020). According to Goker et al. 2020, the implementation of lean strategies makes the manufacturing organization capable of continuously and systematically eliminating waste resulting from inefficient processes, including defective products, overproduction, transportation, inventory, and over processing. It is said that the development of lean application in a supply chain results in increased flexibility, cost reduction, higher turnover, less lead time and defect prevention (Carvalho et al. 2017). Finally, the research will focus on manufacturing SMEs, companies that are growing (in quantity) at an inordinate rate. It is said that SMEs are more prone to variations in the economy; therefore, they would not have surplus resources to invest in innovation. In addition, these companies are characterized by their dependence on their larger customers. However, the growing presence of SMEs makes it of utmost importance to better understand the issues related to Lean implementation in SMEs (Ansari et al. 2019). SMEs today have very diverse problems such as limited and slow innovation and design, low management and administrative capacity, inequitable competition from the informal sector, high production and financing costs, poor quality systems and, finally, resistance to change (Alsaleh 2017). Having mentioned these concepts, our objective is to make known how the application of lean manufacturing in an agile supply chain is, which would mean focusing on implementing dynamic strategies to obtain a quick response (agile) with a minimum cost (lean).

1.2 Objective

Synthesize and select important information from the reviewed academic articles to determine if it is possible to integrate lean and agile methodology in the supply chain of a manufacturing SME.

2. Methods

The methodology describes the set of methods and techniques selected to carry out the research process. It includes the how? and with what? the research will be carried out. In this stage, it will detail how the research work will be carried out. First, the plan for information processing will be defined. The purpose of this section is to describe the research design and the data collection and analysis procedures (Mishra et al. 2018). In order to achieve a structured literature review in a correct way, the keywords to be used, the search for related scientific articles and the analysis of these will be defined. On the other hand, we proceed with the search in the Scopus database and its respective analysis.

Figure 1 below shows the steps to be followed, the objective of the search, the methods that were implemented, the tools that were used and, finally, the use of software for a better visualization and interpretation of results.

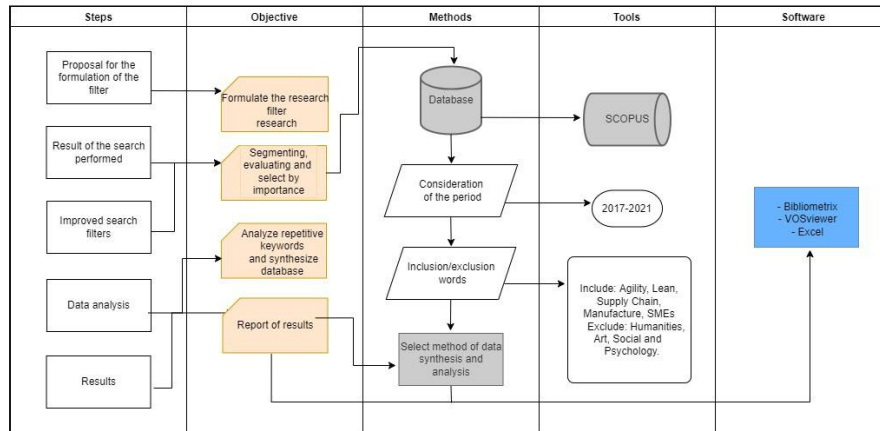


Figure 1. Steps, objectives, methods, tools and software/programs

3. Data Collection

In order to provide a better structured description of the articles finally selected, the PRISMA method was used. This method provides greater credibility at the time of the search and results in articles of great contribution to this study. Regarding the article collection methodology, the Scopus database was used because this platform provides tools capable of segmenting the articles related to the research topic. The period considered in the bibliometric review was from 2017 to 2021, only articles containing the keywords "Agile," "Lean", "Supply Chain", "Manufacture" and "SMEs" were selected. As a result, 191 academic articles were found, of which 122 articles were finally selected. It should be noted that the academic articles finally selected were filtered by final version, in academic journals, written in the English language and excluded from journals that focus on these topics in psychology, arts, social sciences and humanities. Therefore, the results were reviewed one by one to ensure that they were unique, and that the topic covered contributed to answering the research question.

4. Results and Discussion

At the end of the delimitation of the articles finally selected, they were exported from the Scopus database for statistical analysis using bibliometrix and Excel software. The purpose of this analysis is to show the existing trends with respect to the research topic. Therefore, it covers authors with the highest number of publications, journals, countries and the number of publications per year, from 2017 to 2021.

Country Scientific Production

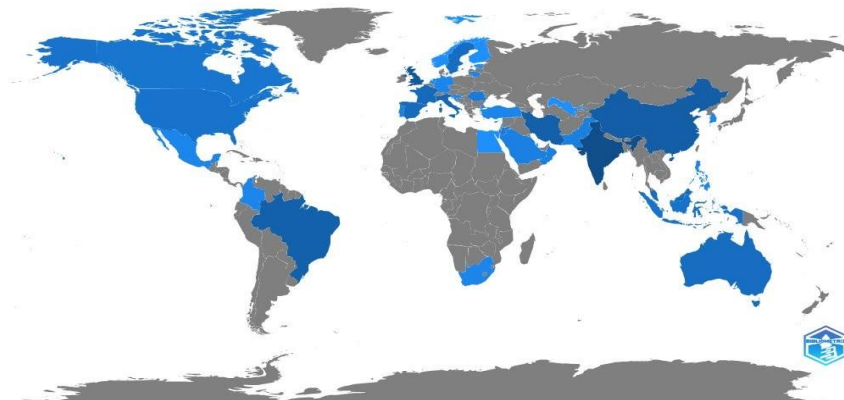


Figure 2. Graph of article production by country (elaborated in bibliometrix)

According to Figure 2, the map shows, with a darker shade of blue, the countries where most scientific production has been carried out in relation to the research topic. Among them, the country with the highest contribution is India with a frequency of 101 times among the 122 selected articles. It is followed by the UK and China, which are countries with a great industrial progress within their companies, with values of 43 and 32, respectively.

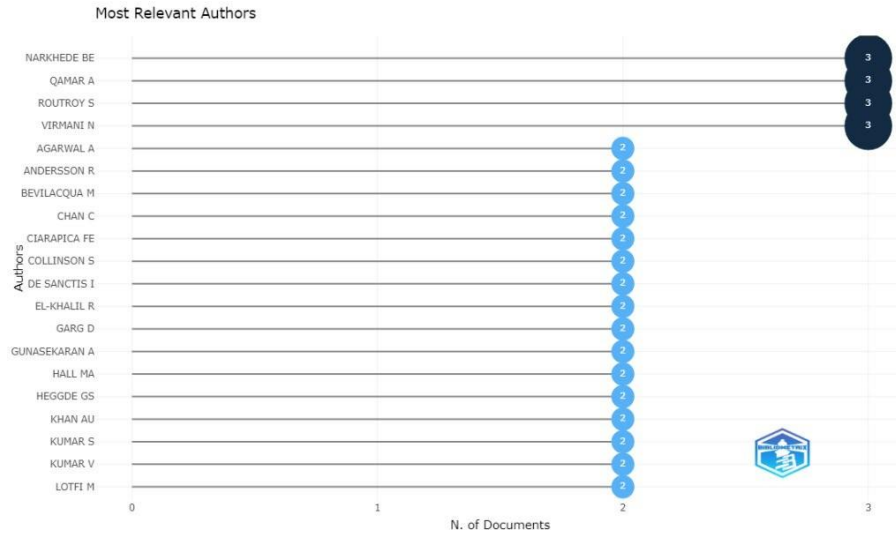


Figure 3. Graph of number of articles per author (elaborated in bibliometrix)

Figure 3 shows that the author with the highest relevance and number of published articles among the 122 selected is Narkhede, with 3 academic articles. He is followed by Qamar, Routroy and Virmani with 3 articles also, respectively.

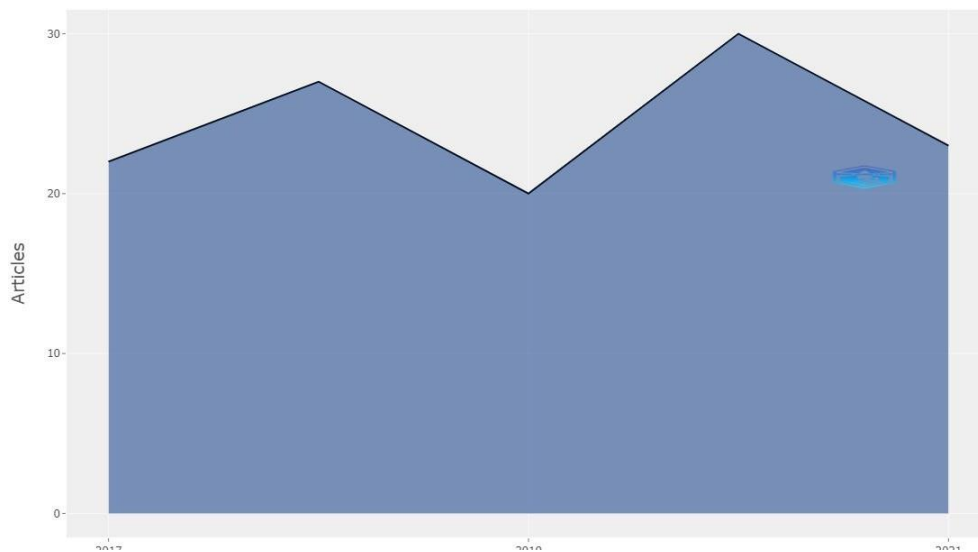


Figure 4. Articles published by year (elaborated in bibliometrix)

Figure 4 shows that there is a relatively growing and constant trend towards the interest in conducting research on the application of lean and agility in the supply chain of manufacturing SMEs, which demonstrates that this research will encourage and provide the scientific community with new results on the combination of these two methodologies.

Finally, with respect to the statistical analysis, it can be seen that the journal with the highest number of articles in the articles studied for this systematic review is Benchmarking. Benchmarking is one of the most prestigious journals since it belongs to quartile 1, likewise, the other journals mostly belong to this quartile. Therefore, this shows that most of the academic articles are of great prestige and scientific contribution, contributing to the high impact and credibility of this research.

4.1 Bibliometric Analysis

VOS viewer software was used for the bibliometric analysis of this research. Both programs (VOS viewer and Bbliometrix) have tools for information analysis and visualization, allowing to identify the evolution of the indicators. As mentioned above, articles were selected in their final state published in academic journals and in the English language. This resulted in 122 articles, with more than 350 authors and more than 750 keywords. Keywords with at least 7 occurrences were used, enabling the formation of clusters. Cluster analysis enables us to find groups, so that the objects within these groups are similar (or related) to each other and are different (or unrelated) to the objects in the other groups. The criteria, as mentioned above, in the formation of the clusters were keywords with at least 7 occurrences which resulted in 18 more repeated keywords illustrated in Figure 5. From this network illustrated in the figure above, it was possible to identify 4 clusters, the first (red color) formed by 6 keywords of which the most representative was "Flexibility", the second (green color) cluster was formed by 5 keywords and "Lean manufacturing" was the most prominent; on the other hand, the third cluster (blue color) was formed by only 4 keywords, in which "agility" stood out and, finally, the last cluster (purple color) was formed by 3 keywords in which we saw that decision making was the most outstanding.

The search we applied in the Scopus repository to extract the articles that were used to perform the bibliometric analysis will be shown below. (Table 1)

Table 1. Application of enhanced applied search

Search term	Applied search	Search results (Number of items)
Agility AND Lean AND Supply chain AND manufacturing AND SMES	lean AND smes AND agile AND supply chain AND manufacturing AND leagile PUBYEAR > 2016 AND PUBYEAR < 2022 AND (LIMIT-TO (SRCTYPE,"j")) AND (LIMIT-TO (PUBSTAGE,"final")) AND (LIMIT-TO(LANGUAGE,"English"))	191

We finally selected 122 articles from the 191 results of our filter, as we excluded from our search those that dealt with the humanities, social sciences, and, primarily, we chose the most cited ones. The VOS Viewer Software gave us keywords such as: Supply chain management, Agility, Lean production, Sustainability, among others that will be mentioned throughout the document. (Figure 5)

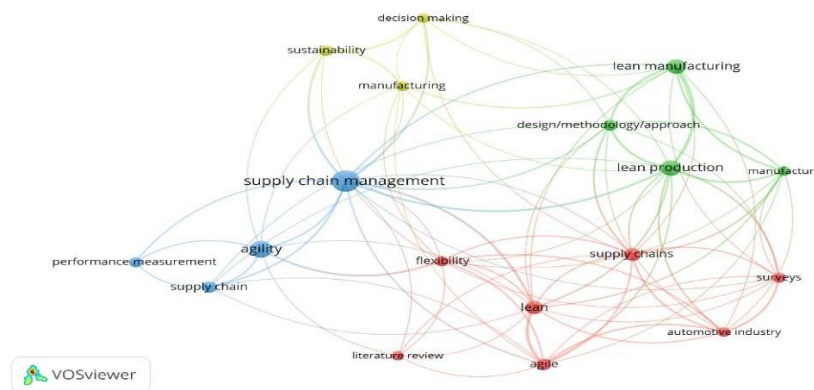


Figure 5. Keyword match (elaborated with VOS Viewer)

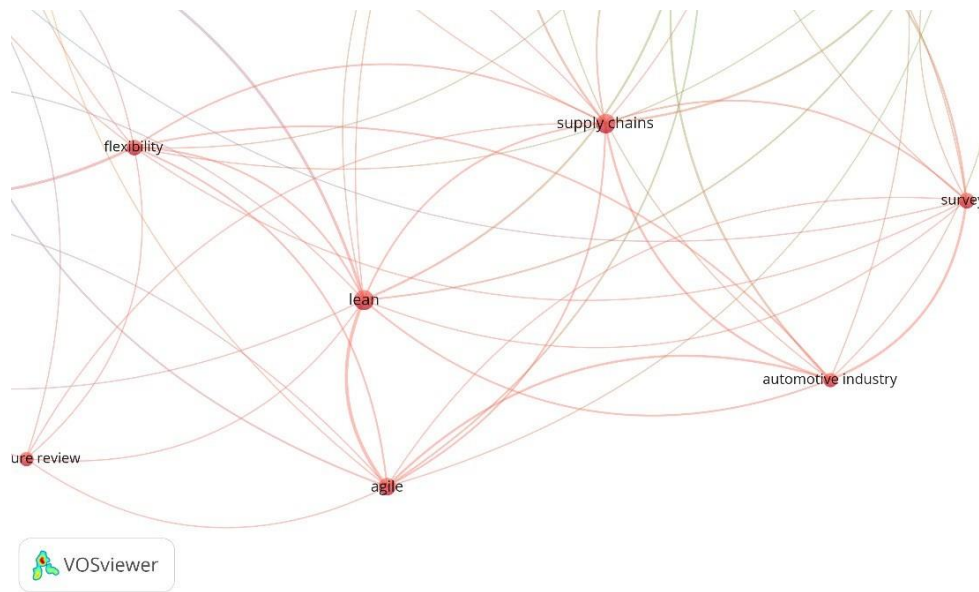


Figure 6. Cluster focus related to Flexibility

In this first figure we can visualize cluster 1, which consists of the relationship between flexibility, (Figure 6) lean production, supply chains, agile and the automotive industry. Flexibility, as mentioned at the beginning of the research, would be an essential and fundamental characteristic within an agile supply chain.

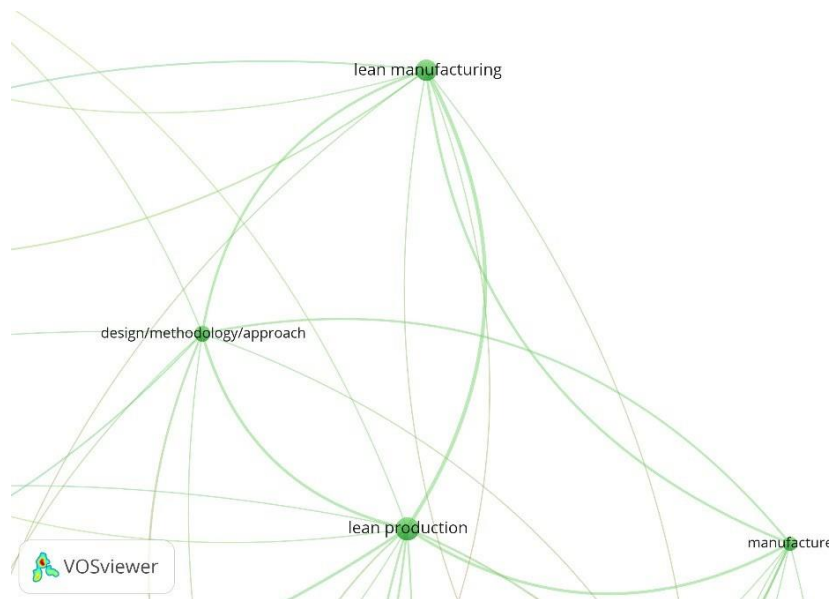


Figure 7. Cluster focus related to lean manufacturing

Cluster 2 shows a very close relationship between lean manufacturing, (Figure 7) lean production, manufacturing and design, methodology and scope of the analyzed items. Nowadays, our clients ask for new products in less time than in the past. This product should be less expensive, and we have to guarantee that it will be a quality product. In conclusion, the companies must adapt to this context considering the cost and the delivery time (Jafarian et al. 2020).

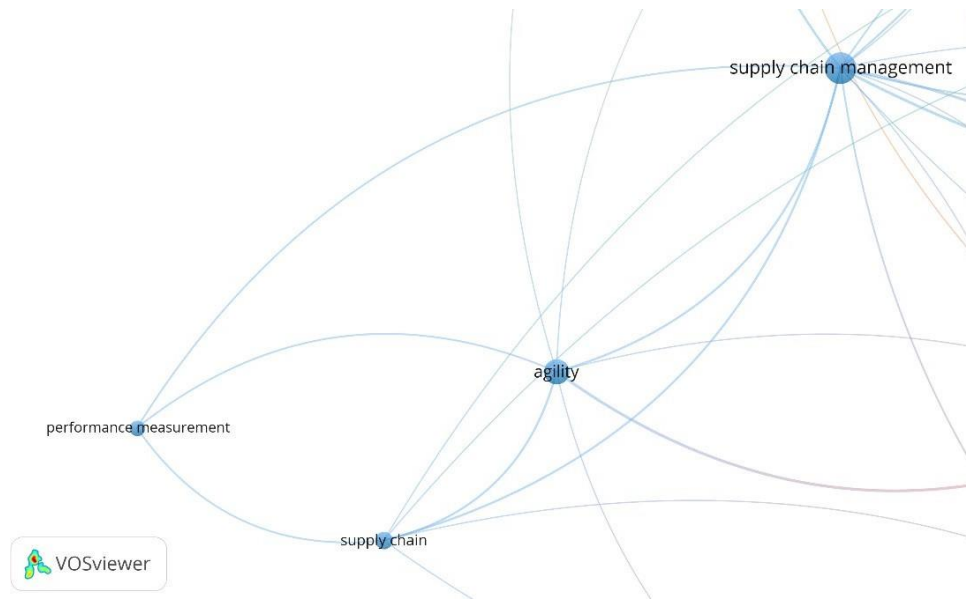


Figure 8. Cluster focus related to agility

On the other hand, in cluster 3 there is a relationship between agility, (Figure 8) performance measurement, supply chain and supply chain management, being agility the main point of relationship between the other points, we can conclude that agility is directly related to performance improvement in the supply chain. Queiroz and Fosso (2019) affirm that the concept of Agility should guarantee the company a high-quality product and will enable the company to be more competitive in their market. Finally, agility will grant the company the speed to respond to any adversity that may arise.

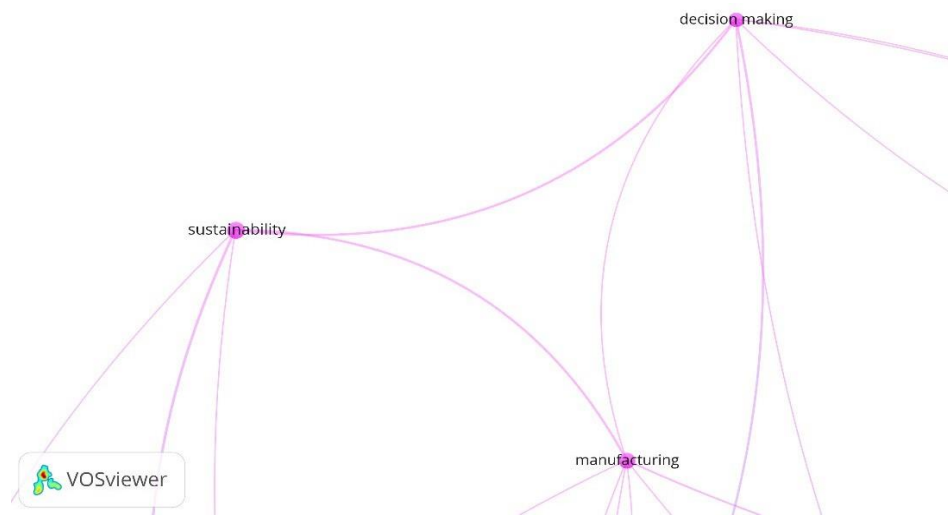


Figure 9. Cluster focus related to decision making

Finally, in cluster 4 there is a relationship between decision making, (Figure 9) manufacturing and sustainability. According to Cho et al. 2021, the functions of an employee in the company where they work, should not be based on rigidity but on flexibility, and that at the time of making decisions these are based on autonomy. Consequently, an employee would have the ability to perform other functions other than those that correspond to it, contributing to the continuous improvement and flexibility of a company, satisfying the constant requirements of the market. Finally, for organizations to achieve sustainability over time, they must opt for distributive leadership among their workers.

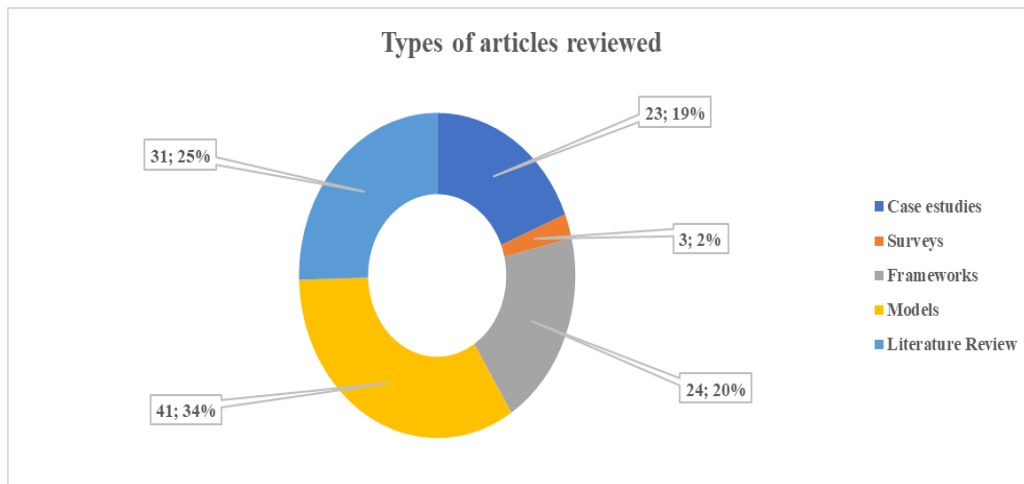


Figure 10. Types of articles reviewed

The previous figure presents the number of articles by typology. (Figure 10) It can be seen that our search yielded 41 methodology models, followed by 23 case studies, 31 literature reviews and 24 frameworks, which gives us a balance between the different types of research analyzed in our article. This provided us with a more accurate analysis when it came to our discussion and, subsequently, conclusions.

4.2 Pillars of Agility and Lean

From the systematic review of the scientific articles, each of them presents an approach that has similarities and differences with others regarding the application of Lean and Agile methodologies in each of the manufacturing SMEs. Consequently, lean and agile dimensions can be established, where manufacturing SMEs should improve to achieve improvements in their supply chain, implementing both methodologies together (Bai et al. 2020; De Sanctis et al. 2018). Therefore, the pillars to be considered for Lean and Agile, would-be Human Capital, Technology, Management Control and Planning in Manufacturing (Han et al. 2020; Ivanavov 2021).

4.2.1 Human Capital Pillar

Having highly qualified personnel is crucial to be able to jointly apply agile and lean methodologies in the supply chain of a manufacturing company, and to obtain improvements in its processes (Cho et al. 2021; Fadaki et al. 2020; Liu et al. 2017). Among the main technical skills required are academic background, innovation and creation skills, and mastery of technological tools (Zhang and Cao, 2018; Chan et al. 2021; Tarei et al. 2021). Likewise, with respect to soft skills, the ones that stand out most are motivation, proactivity, adaptability to change, teamwork and being able to communicate your ideas in an assertive manner (Liu et al. 2017; Machuca et al. 2021; Rajesh 2020).

4.2.2 Technology Pillar

Currently, the implementation of high-tech systems in each of the supply chain processes, such as Big Data, generates a number of benefits (Gu et al. 2021; Tiedemann 2020; Kim 2020; Zhang and Cao 2018). As is the case, improving production, increasing delivery speed, better inventory management and reducing the time it takes to modify a product according to customer needs and expectations (Golpira 2020; Delic and Evers 2020). Consequently, if technology goes hand in hand with lean and agile methodology, it is very likely that the supply chain of a manufacturing company will be able to bring them together on a large scale (Bittencourt et al. 2017; De Sanctis et al. 2018). A merger of these methodologies will result in extraordinary improvements in solving its problems, meeting its supply chain objectives and satisfying its customers (Alsaleh. 2017; Delic and Evers 2020 Ivanov 2021; Zangiacomini et al. 2020).

4.2.3 Management Control Pillar

Management control in a company, regardless of whether it is a manufacturing company or not, is very important, since all tasks must be aligned and synchronized to achieve the objectives set in a satisfactory manner. When all supply chain partners are synchronized, key decisions can be made for the benefit of the company. Agile supply chains would be successful because all partners seek to form an internal alliance by connecting and communicating their decisions.

Finally, it is mentioned that they seek to create knowledge, as these partners develop a better conception and response to the competitive environment, because, by working together, they are more prepared and skilled in each internal process. The exchange and assimilation of knowledge between supply chain partners enables the long-term competitiveness of the supply chain as a whole (Machuca et al. 2021).

4.2.4 Manufacturing Planning Pillar

One of the advantages of agile supply chains, apart from the flexibility and high responsiveness to customers, is the reduction of costs and risks for companies. (Table 2) To mitigate the risk of problems or inconveniences and rather improve the reliability of the whole agile supply chain, the so-called decision-makers should pay more attention to the design and construction of the supply chain at the same time and, at the same time, do not neglect and take into account the planning and sourcing strategies (Chiang and Huang 2021).

Table 2. Main drivers that increase the level of agility and lean manufacturing

Search term	Description	References
Adaptability	This concept is defined or refers to the ability to adapt in an industry in which changes are made almost constantly, being able to make adjustments depending on the needs that may arise. Finally, it was found that adaptability has a significant positive effect in relation to forming a competitive advantage in a supply chain.	(Machuca et al. 2021; Afalla-Luque et al. 2018);
Sustainability	Sustainable manufacturing is defined as a method of designing, producing and delivering end products that have the least negative impact on both society and the environment, and are economically viable for the producer, consumer and society. The primary objective of a manufacturing company is to produce and deliver products to satisfy consumer demand.	(Sangwan et al. 2018; Liu et al. 2017; Zangiacomini et al. 2020; Yang et al. 2019)
Resilience	Resilience in the context of SCM is or refers to the ability of supply chains to cope with disruptions or unexpected situations. In other words, the agile approach goes hand in hand with resilience by directly influencing supply chain performance and competitiveness. Without understanding the level of resilience of the system under analysis, it would be very difficult to assess the supply chain's response and reaction to complications.	(Rajesh 2021; Ivanov 2021; Han et al. 2020; Altay et al. 2018; Brusset and Teller 2017)
Flexibility	It refers to the adaptability capacity of the supply chain in each of the processes involved, with the objective of delivering the product or service required by the customer.	(Barata 2021; Delic and Eyes 2021; Golpira et al. 2020; Hong et al. 2019; Tiedeman 2020; Venkatesh et al. 2017; Yang et al. 2019)
Technology	Having state-of-the-art technological tools and systems allows all supply chain processes to be connected and information to be shared in real time throughout the system.	(Alsaleh 2017; Atadeniz et al. 2021; Brusset and Teller 2017; Carvalho et al. 2017; Chávez et al. 2017; Fadaki et al. 2020)
Quality	Develop improvements in product control, supplier control, design changes and final product evaluation to satisfy customers.	(Ansari et al. 2019; Bittencourt et al. 2021; Chiang and Huang 2021; Goker 2020)

6. Conclusions

This research article concludes that the application of the agile methodology in the supply chain is currently little recognized as a new model for better supply chain management, compared to the lean methodology, which has been well recognized worldwide. Although, the agile model made its appearance in the industry 20 years ago, it is not 10

years ago that it was noticed in the research and case studies conducted, until, as of 2019, its growth was exponential. That is why, an integration of agile and lean methodology, today, would demonstrate a high degree of innovation, bringing together the main pillars of each. Therefore, in order to make this possible, it is advisable to start with the application in manufacturing SMEs and then move on to large companies. The results will be evidenced by the application of the main characteristics of each methodology. For example, companies that are already applying lean manufacturing will become more agile by implementing flexibility, technology and adaptability. This will allow the manufacturing SME to stand out in the market and generate a competitive advantage over its rivals. Finally, this article can be a guide for future research on case studies that seek to apply agility, not leaving aside the application of lean, comparing operational results and advantages in its supply chain.

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