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# The evolution of lean management research: A bibliometric review

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**Abstract---**The objective of this study is to identify and illustrate the structure of the field of research of Lean manufacturing, using a bibliometric analysis which combines an analysis of productivity and co-words. We started from a search in Wos with the theme Lean management and the data was processed with Biliometrix, allowing an analysis of indices, quantity of articles, productivity by country and by authors, as well as journals. In addition, the nodes (different themes) and cluster (trends) of the field of study were identified, highlighting the main research topics.

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## 1. Introduction

In recent decades, the powerful process of globalization, the accelerated development of technology, and the concerns over the potential negative effects these may cause (Umar *et al.*, 2020; Sharif *et al.*, 2021) have resulted in a constantly shifting economy. In turn, this has caused organizations to seek tools which will allow them to adapt to this environment (Smith and Besharov, 2019) and obtain positive results by improving the efficiency of production and processes, as well as the conditions, relations, and satisfaction of both employees and customers (Mourtzis, 2016; Hernandez-de-Menendez, Escobar Díaz and Morales-Menendez, 2020).

The tools of Lean philosophy allow companies to achieve the aforementioned objectives, seeing as they facilitate the reduction of costs, a reduction in the number of unnecessary tasks which do not add value to the process, the reduction, and elimination of waste, a reduction in inventory, and the delivery of the product in the right numbers and at the right time, whilst also improving quality (Jasti, Research and 2015, 2015; Alahyari, Gorschek and Berntsson Svensson, 2019; Alves *et al.*, 2019).

This philosophy was applied to business management under the paradigm of "Lean Management", a tool which can offer an overview of processes from the perspective of the client. This is based on removing activities which do not generate added value for the client, ensuring that production is adapted to effective demand, and eliminating warehousing or reducing it as much as possible, thereby reducing the resources needed for the management of such and the risk of product and material obsolescence. All of this generates improved cooperatively without the need for investment, allows for comparisons between periods, promotes teamwork and improves quality in the search for perfection (Florescu and Barabas, 2022).

According to Petrillo *et al.*, 2018, businesses which shy away from implementing these tools and techniques may become obsolete compared to their competition and therefore run the risk of folding. These reasons make going deeper into this field of study a necessity.

In this context, the realization of a bibliometric analysis could play an important part in research on the term Lean Management and its tools, and also in the growth and development of the scientific research and production that has taken place in recent years and that has generated the need to create indicators which analyses this concept. Due to this increased academic interest and the lack of focused reviews, we believe it is time to examine the overall picture in order to suggest suitable lines of future research. Bibliometric analysis is a methodology which enables the analysis of scientific production in order to orient the scientific community as regards the focus points and progress in a certain area of knowledge. It also analyses various elements such as collaboration between

authors, scientific activity by country or region, citations, and the impact factor of publications and journals (Vogel and Güttel, 2013; Donthu, *et al.*, 2020)

Based on the above, our work aims to study the main patterns and trends within the academic literature on lean management through the use of bibliometric tools. Essentially, we seek to answer five research questions (RQs) as follows:
*RQ1. Which is the historical evolution of the literature about lean management?*
*RQ2. Which are the main journals around which the research topic is organized?*
*RQ3. Which are the main documents that have influenced the intellectual structure of the topic?*
*RQ4. Which are the more productive authors and the top publishing countries and universities?*
*RQ5. Which is the conceptual structure of this area or research?*

The bibliometric analysis that was carried out to achieve this objective started with a search on the theme of Lean manufacturing on the Web of Science (WoS) platform. The references were exported from the database and then processed using the Bibliometrix software, which allows the realization of an analysis of indicators such as the number of articles, the authors with the biggest presence in the field, productivity by country and by journal, and the journals with the highest number of articles and greatest impact by number of citations. Furthermore, it aids the identification of nodes (different topics) and clusters (trends) in the field of study, highlighting the main research themes, their evolution and emerging trends which may provide future lines of research in the field [16].

## 2. Research Method

The chosen methodology in this work is bibliometric (Moreno-Guerrero, Gómez-García, *et al.*, 2020; Moreno-Guerrero, López-Belmonte, *et al.*, 2020). The database used for this was the WoS database, seeing as it has a high number of articles, authors and journals, and as it also complies with the condition of peer review for scientific quality (Hodge and Lacasse, 2011; Zhang, Zhang and Wang, 2022). Also, the concepts to be analyzed were established by creating a search equation with all the terms associated with the selected concept for the study (Montero-Díaz *et al.*, 2018). Therefore, the search equation (Theme ("Lean Management") was first defined for the main collections of the Science Citation Index Expanded and the Social Sciences Citation Index.

For further investigation, we downloaded the txt or BibTeX formats of complete records and references of the acquired articles. Characteristics of the publication in detailed were recorded from Web of Science, including source, country, institution, author, title, abstract, keywords, number of citations, cited literature. A total of 504 documents were obtained from the first filter and, after having removed those published in the current year, 2023, and those that were unrelated to the subject, the number of works analyzed was 468. Our study is divided into five periods of time: 1993 to 2000, 2001 to 2007, 2008 to 2014, 2015 to 2020, and from 2021. The described procedure is summarized in the six steps shown in Figure 1.

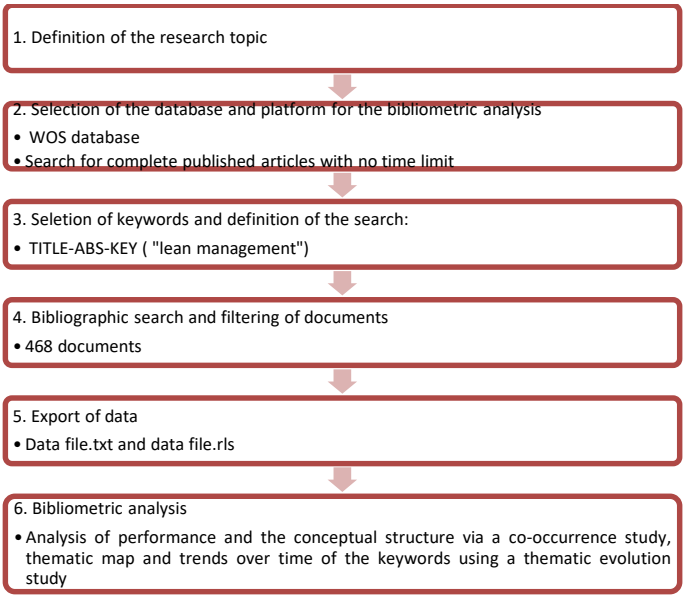


**Figure 1:** Steps for a bibliometric.
Source: (León-Castro *et al.*, 2021).

## 3. Results

*3.1. Evolution of documents per year*

Figure 2 shows the production of scientific articles published in the WoS database and associated with the theme of the Lean Management between 1993 and 2022, and the total is 468. Despite using a broad period for the study (30 years), the majority of the articles were published recently. The number of articles published per year did not exceed a dozen until 2013 and from that point onward, the number of publications within the theme slowly grew up until 2018 when there was a significant increase. The biggest amount of scientific production was in the 2018-2022 period, which accounts for 59.61% of the total number of publications, as shown on the trend line, thus demonstrating the scientific community's increased interest in this area of knowledge. In 2021 (the year with the highest production), the total number of articles rose to 68, representing about 14.53% of the total publications. To illustrate the progression in the number of articles from 1993 to 2022, a trend line was used through a linear regression model (Okumus, Koseoglu and Ma, 2018). The dependent variable refers to articles published, while the independent variable represents the years in which articles have been published. The linear model shows a proportion of variable explained of $R^2 = 0.693$. The regression parameters indicate that the trend in the number of articles per year in lean management is upward, increasing on average by 5 articles per year.

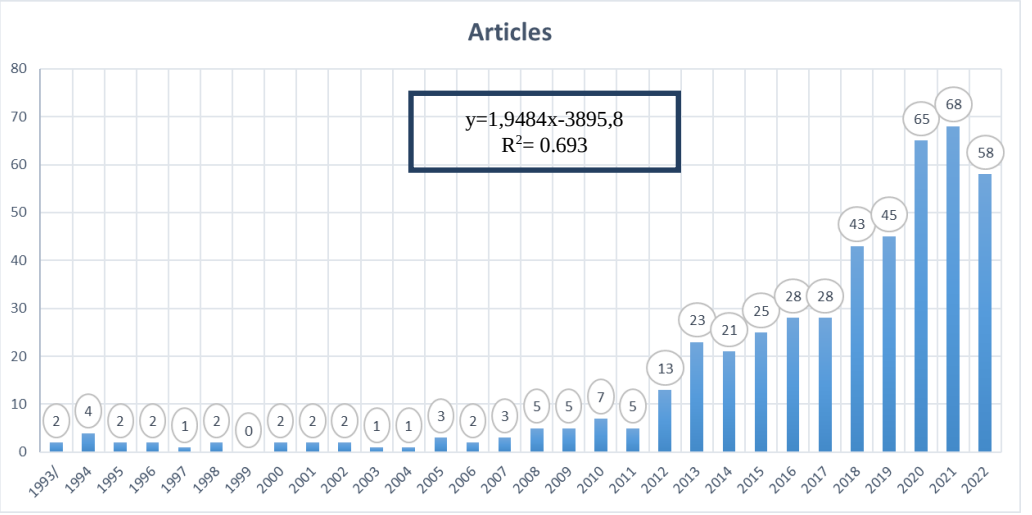


**Figure 2.** Annual scientific production of articles related to Lean Management.

*3.2. Sources*

Shown in Figure 3 is how the articles are distributed across 204 journals, with Sustainability (26 articles) being worthy of note, despite being in ninth place as regards relevance by number of citations and none of its published articles on this theme being among the 15 most relevant. It is followed by Production Planning & Control, which has 23 published works and is in fourth place in terms of number of citations. In third place with 17 articles is the International Journal of Production Research, and it has the highest number of citations in this field of study.

Journal Citation Report (JCR) measures a journal's impact in terms of the citations received for the articles it publishes (Al-Hoorie and Vitta, 2019). This index is calculated by dividing the total number of citations of a journal in a given year by the number of publications of the journal during the last two years (Garfield, 2006). Concerning JCR impact, Journal of Cleaner Production is the highest quality source among the six that publish more than ten articles. Its impact is 11,1. The second journal with the highest impact is International Journal of Production Research, with 9.2. In third, fourth, fifth, and sixth place are Production Planning and Control, Journal of Manufacturing Technology Management with an impact of more than seven for the first and four for the last two. It is observed that the journal with the greatest number of articles published is the one that has a lower impact index.

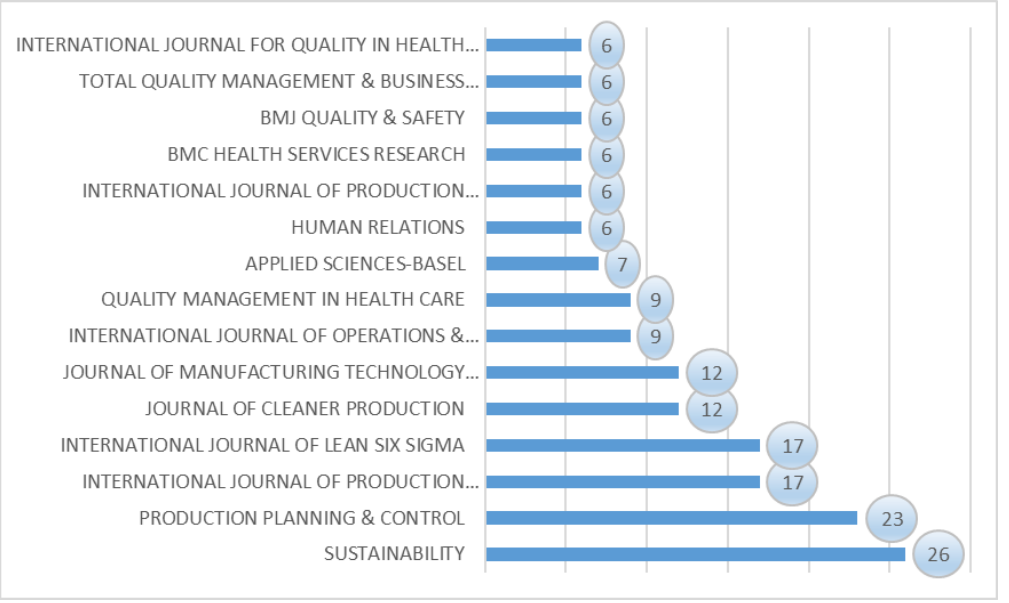


**Figure 3.** Number of publications on Lean Management, per journal.

*3.3. Documents*

The document with the greatest number of citations, "Lean, green, and the quest for superior environmental performance", was published in 2001 in "Production and Operations Management", which is ranked as the fifth journal in number of citations (321). Of the 15 most cited documents shown in Table 1, three were published in the Journal of Cleaner Production, the third most cited journal (508 citations) behind the International Journal of Production Research (663), which featured 2 of the most relevant articles with 195 citations between them (see Figure 4).

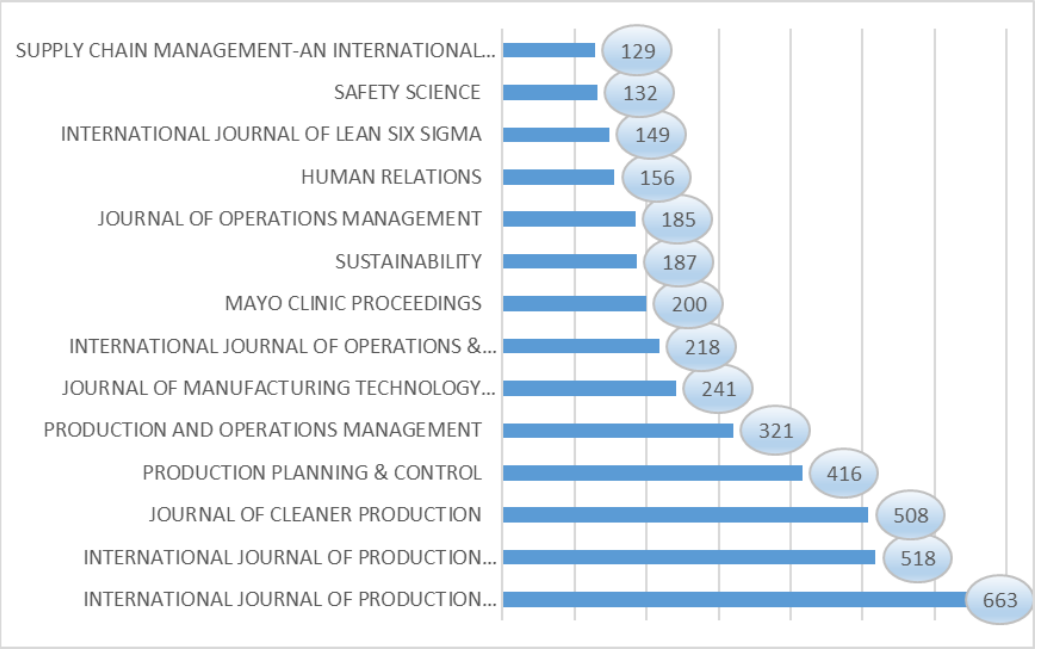


**Figure 4.** Number of citations concerning Lean Management, per journal

| **Document** | **Article** | **Local Citations** |
|---|---|---|
| (Rothenberg *et al.*, 2001) | Lean, green, and the quest for superior environmental performance. *Production and operations Management*, *10*(3), 228-243. | 321 |
| (Bortolotti, *et al.*, 2015) | Successful Lean implementation: Organizational culture and soft Lean practices. *International Journal of Production Economics*, *160*, 182-201 | 294 |
| (Toussaint and Berry, 2013) | The promise of Lean in health care. In *Mayo Clinic proceedings* (Vol. 88, No. 1, pp. 74-82). Elsevier. | 200 |
| (Fullerton, *et al.*, 2014) | Lean Manufacturing and firm performance: The incremental contribution of Lean Management accounting practices. *Journal of Operations Management*, *32*(7-8), 414-428. | 185 |
| (Hajmohammad *et al.*, 2013) | Lean Management and supply Management: their role in green practices and performance. *Journal of Cleaner Production*, *39*, 312-320. | 157 |
| (Collar *et al.*, 2012) | Lean Management in academic surgery. *Journal of the American College of Surgeons*, *214*(6), 928-936. | 117 |
| (Rosin *et al.*, 2019) | Impacts of Industry 4.0 technologies on Lean principles. *International Journal of Production Research*, *58*(6), 1644-1661 | 106 |
| (Fercoq *et al.*, no date) | Lean/Green integration focused on waste reduction techniques. *Journal of Cleaner Production*, *137*, 567-578. | 97 |

| | | |
|---|---|---|
| (Morris and Lancaster, 2006) | Translating Management ideas. *Organization studies*, *27*(2), 207-233. | 90 |
| (Gapp, Fisher and Kobayashi, 2008) | Implementing 5S within a Japanese context: an integrated Management system. *Management Decision*. | 90 |
| (Bullinger, *et al.*,2002) | Analyzing supply chain performance using a balanced measurement method. *International Journal of Production Research*, *40*(15), 3533-3543. | 89 |
| (Hajmohammad *et al.*, 2013) | Lean Management and supply Management: their role in green practices and performance. *Journal of Cleaner Production*, *39*, 312-320. | 78 |
| (Perez *et al.*, 2010) | Development of Lean supply chains: a case study of the Catalan pork sector. *Supply Chain Management: An International Journal*, *15*(1), 55-68. | 76 |
| (Knight and Haslam, 2010) | The relative merits of Lean, enriched, and empowered offices: An experimental examination of the impact of workspace Management strategies on well-being and productivity. Journal of Experimental Psychology: Applied, 16(2), 158. | 76 |
| (Rydenfält, *et al.*, 2017) | Organizing for teamwork in healthcare: an alternative to team training? *Journal of health organization and Management*. | 70 |
| (McCann *et al.*, 2015) | Casting the Lean spell: The promotion, dilution, and erosion of Lean Management in the NHS. *Human relations*, *68*(10), 1557-1577. | 70 |

**Table 1:** The most relevant authors based on production.

The document with the greatest number of citations, "Lean, green, and the quest for superior environmental performance", was published in 2001 in "Production and Operations Management", which is ranked as the fifth journal in number of citations (321). Of the 15 most cited documents shown in Table 3, three were published in the Journal of Cleaner Production, the third most cited journal (508 citations) behind the International Journal of Production Research (663), which featured 2 of the most relevant articles with 195 citations between them (see Figure 4).

Keyword research and analysis provide insight into research trends and topics in a given discipline (Okumus *et al.*, 2018). Cloud keyword is very useful to get a clearer mental picture of what is going on (Tayebi *et al.*, 2019). In this research, we have distinguished the most common words in the title of the documents and keywords in the papers below the abstract. Although it is logical because they are words in the search equation for articles, in both cases, we can see that the most common terms used by the authors are lean, management and lean management. Although it can be seen that in the title, the word lean is used more intensely, in the keywords are seen both lean and management, as independent terms and as a single term. In the latter case, the introduction of other words such as Industry 4.0, performance or value chain should also be highlighted.

*3.4. Authors*

The impact of an author reflects the influence they have in a given field of research, measured by the number of citations received. In this way, it is possible to identify the most relevant authors in an area of knowledge (Garfield, 2006). The data shows that, out of the 468 analyzed works, there was participation from 1245 authors of whom 89.06% only published a single work in the field in question. Table 2 lists the most relevant authors, classifying them by the number of documents they published and their h-index. Three authors, Alarcon, Rundall, and Shortell lead the production, each with a total of 8 published articles. Alarcon has the highest h-index with 6 and the other 2 most productive authors have a h-index of 4, but they do not have the largest number of total citations (TC). Those with the latter are Bortolotti with 450 citations in 4 published articles on the theme and a h-index of 4, and Danese with 358 citations in 2 articles and a h-index of 2.

In turn, Table 1 analyses the documents with the greatest impact on WoS and the highlights are as follows: "Lean, green, and the quest for superior environmental performance" (Rothenberg *et al.*, 2001) with 321 citations, and "Successful Lean implementation: Organizational culture and soft Lean practices" (Bortolotti *et al.*, 2015) which is cited 294 times. In terms of the most cited article, it can be noted that the authors have a total of 321 citations and each one has a single article published in this field. The second most cited document is by the author with the most citations, Bortolotti (450), who has produced 4 articles. There are 2 authors who co-wrote said document: Boscari, with 294 citations and only 1 article; and Danese, who has the second-highest number of citations with 358 and 2 articles published on Lean Management.

| **Author** | **h index** | **Total Citations** | **Articles** |
|---|---|---|---|
| ALARCON LF | 6 | 84 | 8 |
| RUNDALL TG | 4 | 30 | 8 |
| SHORTELL SM | 4 | 30 | 8 |
| BLODGETT JC | 4 | 30 | 7 |
| CREMA M | 5 | 68 | 6 |
| VERBANO C | 5 | 68 | 6 |
| JING SW | 3 | 43 | 6 |
| MOYANO-FUENTES J | 4 | 140 | 5 |
| TORTORELLA GL | 4 | 126 | 5 |
| BORTOLOTTI T | 4 | 450 | 4 |
| HUSSAIN M | 4 | 120 | 4 |
| MOURGUES C | 4 | 36 | 4 |
| PELLICER E | 4 | 48 | 4 |
| VAN HARTEN WH | 4 | 85 | 4 |
| HERRERA RF | 3 | 30 | 4 |
| KLEIN LL | 2 | 17 | 4 |

| | | | |
|---|---|---|---|
| NIU ZW | 2 | 33 | 4 |
| REPONEN E | 1 | 4 | 4 |

**Table 2.** The most relevant authors based on production.

*3.5. Conceptual Structure*

As (Martín-Navarro *et al.*, 2023) did, we analyzed the thematic map to delineate the conceptual structure of the topic. The latter consists of a network analysis of co-occurrence of words to define what science in a given field is discussing, the main themes and trends. More specifically, the thematic map allows us to visualize four different typologies of themes, as shown in figure 5. The size of the clusters is proportional to the number of associated documents.

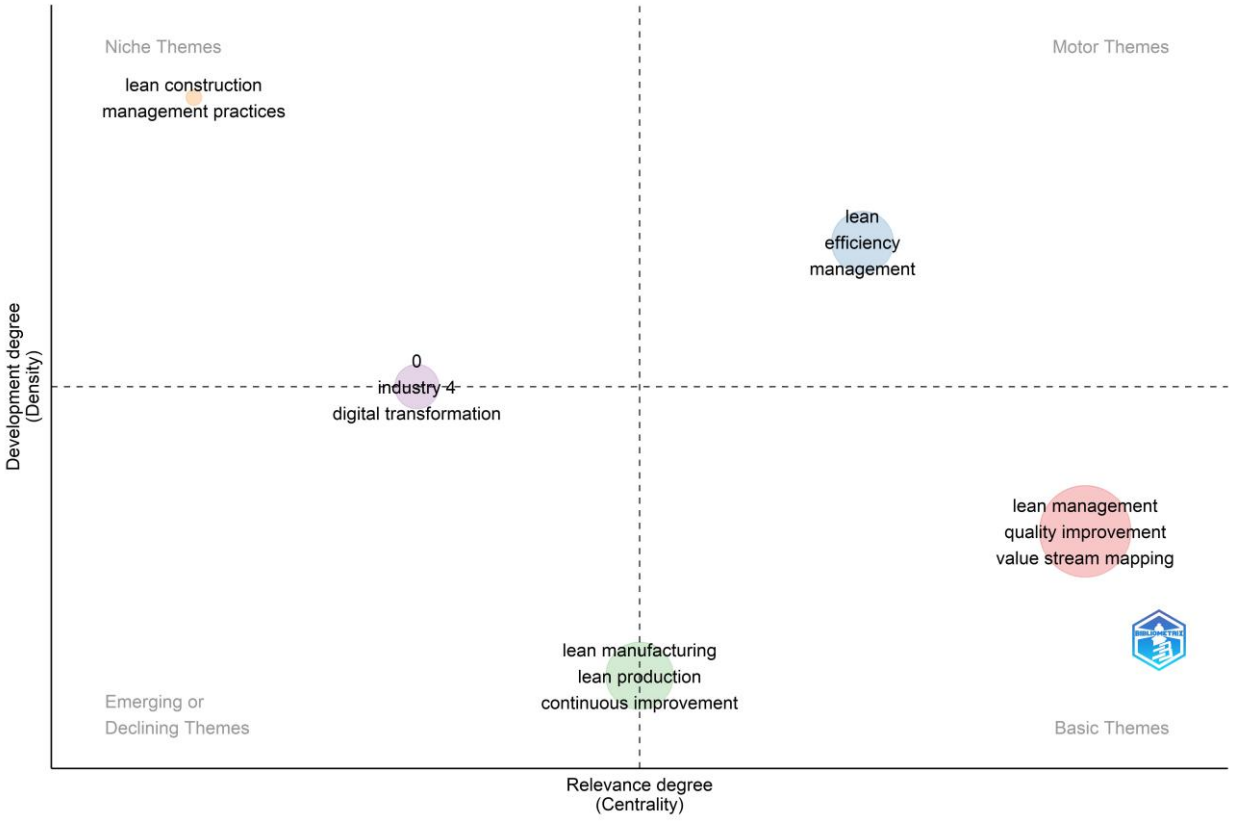


**Figure 5:** Thematic map of Lean Management topic distribution.

This thematic map allows the clusters to be put into four quadrants and enables the conceptual structure of the theme to be delineated, using an analysis of the network of word co-occurrence to define what the scientific community is talking about in a specific field, the main themes that comprise it, and future trends within it. The thematic map can be used to divide the various types of research themes into the four quadrants defined below:

**Motor themes.** This quadrant contains themes that were formerly niche themes but started to become motor themes, and they include Lean, efficiency and management. They are gathered into a single cluster, with a total of 9 keywords and the following top keywords: Lean (in 38 works), efficiency (12) and Management (7). They are included in a total of 47 works in 36 journals. The journals with the highest number of publications include: Sustainability (5), the International Journal of Production Research (3) and, with 2 articles each: BMJ Quality & Safety, the International Journal of Operations & Production Management, the Journal of Cleaner Production, the Journal of Medical Systems, and the Leadership & Organization Development Journal. The journals with the highest number of citations are: The Journal of Production Economics (294), the International Journal of Production Research (96), the Journal of Cleaner Production (83), the International Journal of Operations & Production Management (74) and Production Planning & Control (60). All of these are in the field of production management, and they feature articles which aim to analyze potential improvements in quality and production efficiency, using the implementation and development of Lean.

**Basic themes.** This quadrant is formed of two clusters. The first and biggest, as seen in Figure 8, is composed of 24 keywords with the most noteworthy being: Lean Management (200 works), quality improvement (15), Value Stream Mapping (14), case study (12), sustainability (12) and Lean Healthcare (10). The themes they address are Lean Management for the improvement of quality and business sustainability with tools such as Value Stream Mapping or Six Sigma. 203 articles feature various case studies that are not only about the application of Lean Management but also about other philosophies which are based on it, such as Lean Healthcare, Lean Six Sigma, Lean Practices and Lean Leadership. The articles are published in a total of 51 journals. The journals with the greatest number of publications are: Production Planning & Control (18), Sustainability (11), the International Journal of Lean Six Sigma (9), the Journal of Cleaner Production (9), Quality Management in Health Care (7) and the International Journal of Production Research (6). The journals with the greatest number of citations are: The Journal of Cleaner Production (328), Production Planning & Control (295), the International Journal of Production Research (154), Safety Science (132) and Human Relations (102), with the latter 3 having published less than 6 papers on this theme.

The second cluster is formed of 9 keywords and is located between the basic theme quadrant and the emerging or declining themes quadrant. The most repeated keywords are: Lean manufacturing (26), Lean Production (22), continuous improvement (18), productivity (7) and project management (7). They occur in works which analyze the implementation and development of Lean manufacturing or Lean Production (both terms refer to the same concept and are used indistinctly) in the search for continuous improvement, as well as increased productivity in the production department and in project management. They are featured in 57 works in a total of 43 different publications. The journals with the most works published are: The Journal of Manufacturing Technology Management (5), the International Journal of Operations & Production Management (3), the International Journal of Production Research (3) and Applied Sciences (3). The two journals with the highest number of citations only have one

work each in this area, and they are Production and Operations Management (321) and the Journal of Operations Management (185). Next is the Journal of Manufacturing Technology Management (108) which has four published works.
**Niche themes.** These are important themes for the field of research but with a low level of development, combining transversal and basic themes, i.e., themes with some relevance but not yet a lot. The cluster is formed of 2 terms, Lean construction (4) and management practices (4), as included in publications which analyze specific tools applied to the execution of works and installing a production system which eliminates or minimizes waste. They are featured in 7 journals, with the most noteworthy being Buildings with 23 citations, the Journal of Management in Engineering with 21 citations, and the Journal of Construction Engineering and Management with 12 citations. There are 7 journals, each with a single published work on the theme in question, and they were published between 2018 and 2022, i.e., in the last 5 years.

**Emerging or declining themes.** This quadrant is unique in that the cluster is shared with the niche themes in quadrant 3, and it can therefore be considered to be comprised of undeveloped themes which are becoming niche themes with a greater relevance to the field of research. The keywords are gathered in a cluster, with the biggest number of repeated words being: Industry 4.0 (14), along with digital transformation (4) and optimization (4). The works analyze the development of the concept of Industry 4.0 and the importance of the digital transformation in the field of production, and they were published in 12 journals in total. The journals with the highest number of citations are: The International Journal of Production Research with 106 citations, and Production Planning & Control with 26 citations. The other works have less than 20 citations.

The literature about Lean Management has evolved over time, applying various keywords to describe the content of the studies and with new themes emerging and others disappearing. In addition, there is a set of keywords which have remained unchanged in consecutive sub-periods. Figure 6 shows this evolution in the keywords related to this field of study.

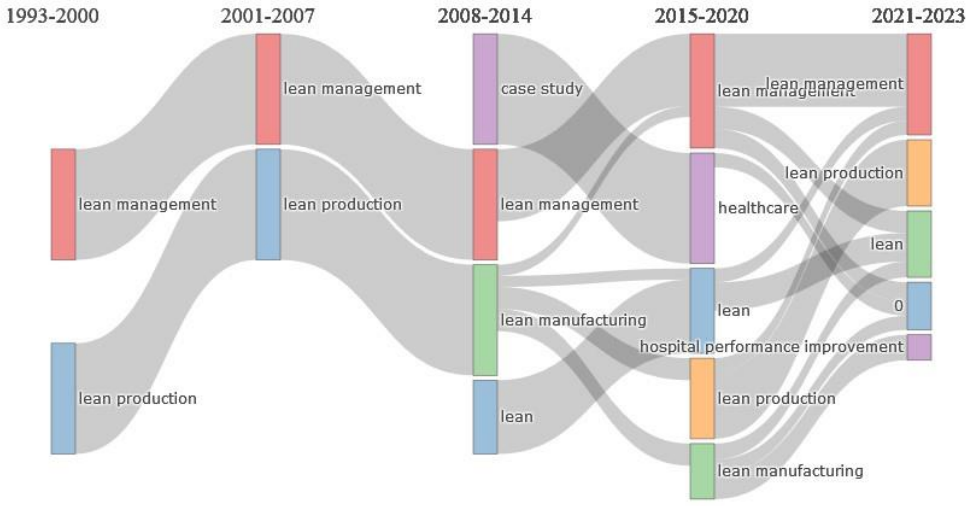


**Figure 6:** Thematic evolution of Lean Management, 1993-2022.

Having analyzed the network of keywords in Figure 8, a longitudinal analysis was carried out to find the bibliometric map of the evolution of the research themes during the five stages defined in the analyzed period (Figure 9). To carry out this analysis, the articles were labelled with the most significant keyword in all cases. There are only 2 clusters between 1993 and 2000. The first, Lean Management, has a single keyword with 2 occurrences and the second, Lean Production, has a single word with 2 occurrences.

The situation repeats itself in the 2001 to 2007 period, with two initial clusters. The first is Lean Management, the second is Lean Production, each has two occurrences and the two synonymous terms refer to the same concept.

The next analyzed period (2008-2014) shows four clusters. Two of these are brand new, i.e., they are not a consequence of other works with other keywords. The first cluster is formed of a single keyword, case study, which has two occurrences, and the second, Lean, contains two keywords, Lean and efficiency, with 6 published articles. The third cluster, Lean Management, is inherited from the two previous periods and is a constant throughout all the analyzed periods of time. In this case, it is formed of the keyword term Value Stream Mapping which has 3 occurrences, along with Lean Management, Lean Six Sigma and process improvement, which occur in 38 articles, continuous improvement with an occurrence of 3, and benchmarking with 2. Last is the Lean manufacturing cluster which originates from the Lean Production cluster and contains the terms Lean Production and Lean manufacturing, each with an occurrence of 4, alongside management and Toyota Production System which each have an occurrence of 2.

In the 2015 to 2020 period, the Case Study cluster evolved towards the Healthcare cluster and was formed of the keywords case study and management, each with 8 occurrences, and in more recent years it evolved towards the terms related to research into Industry 4.0. The Lean Management cluster remained constant throughout the analyzed period, as shown in Figure 9, and it is formed of keyword terms such as Industry 4.0, with an occurrence of 4; quality improvement and human factors, each with an occurrence of 9; and Lean Management, Lean Leadership and sustainability with an occurrence of 93. In the last period, it evolved towards the Lean Management, Lean, and Industry 4.0 clusters.

In the 2015-2020 period, the Lean manufacturing cluster evolved towards two clusters: Lean Management (analyzed previously) and Lean. It is formed of the keywords healthcare and Value Stream Mapping, with occurrences of 4, and efficiency, with 5. The evolution in the last period was towards Lean, occurring in 22 published articles. The works are based on the themes of Lean Management and Lean in the last period. Lean Production remains as Lean Production in the last period and is formed of Lean Production with 9 occurrences, Lean Healthcare with 5 and leadership with 3. Lastly, it evolves into Lean manufacturing in which the noteworthy keywords are: Lean manufacturing with 16 articles, continuous improvement with 9 and patient satisfaction with 3.

The keyword study shows how the research has evolved over time towards the importance of applying the concept and tools which form Lean Management, Lean manufacturing and Lean Production, all of which are used in the search for continuous improvement, business leadership and quality improvement in the production management of companies.

## 4. Discussion

This study has analyzed the evolution of the field of Lean Management in various periods between 1993 and 2022. After the initial analysis of the most relevant works, authors, countries and keywords, it went further into an analysis of the evolution of keywords and study themes in each period. This longitudinal analysis provided a bibliometric map and depicted how the focus points of the research have evolved over time in the field of study of Lean.

We were guided by five research questions during this process, the conclusions for which we provide below. RQ1 sought to analyzes the historical evolution of literature. Although the first paper was published in WOS in 1993, the results indicate that since 2012 there has been an increase in academic publications. Still, it has been in the last three years that this growth has taken an exponential form, indicating the importance and the interest of academics in this subject in recent years. RQ2 sought to know the main journals that have published on the topics under analysis. In response to this question, the journals that have published the highest number of articles are Sustainability and Production, Planning and Control, this is more focused on engineering issues. The journal with the highest impact factor is the Journal Cleaner Production, followed by International Journal of Production Research. Of the five journals with the highest number of articles published, Sustainability is the journal with the most publications and the one that has seen the greatest increase in scientific

production on these topics. We call on the other journals to call for special issues to increase the number of publications on this topic and, consequently, to broaden the sources where papers relating to entrepreneurship and the food sector are published.

RQ3 focused on studying the most influential papers in the intellectual structure. Of all the papers analyzed, only 7 obtained more than 100 citations. The paper written by Rothenberg et al., in 2001 is the most cited. Regarding RQ4, we observe that Three authors, Alarcón, Rundall and Shortell lead the production, each with a total of 8 published articles. Alarcón has the highest h-index with 6 and the other 2 most productive authors have a h-index of 4.

Finally, RQ6 refers to the conceptual structure of the research topics, Lean management. In recent decades, the Lean philosophy has expanded into various sectors all over the world and the Lean Management model has become an innovative managerial system, constituting an important supplement to the automation and digital transformation process in the global economy (Cardoso, (2019); Snick, (2018); Chiarini, *et al.*, 2016; Buer *et al.*, 2018; Kämpf, 2018; Rosin *et al.*, 2019). In this regard, it has been shown how keywords in Lean Management have followed a pattern over time. The works carried out in the first 15 years were primarily focused on the study of Lean Management and Lean Production, without making specific reference to the tools of which they are comprised, or to the benefits that their implementation may have within an organization at the production or decision-making levels (Teixeira *et al.*, 2022 ; Filser, da Silva and de Oliveira, 2017; Ciano *et al.*, 2019; Oliveira *et al.*, 2019; Redeker *et al.*, 2019; Taddeo *et al.*, 2019; Akmal *et al.*, 2020; Apostu, Vasile and Veres, 2021; Furstenau *et al.*, 2021).

However, as time passed, the keywords continuous improvement, innovation, efficiency and quality improvement, referring to production management, began to be increasingly used in relation to the field under study. Furthermore, tools such as Six Sigma and Value Stream Mapping started to be addressed (Farrukh *et al.*, 2020; Hernández-Lara, *et al.*, 2021; Niñerola *et al.*, 2021a, Niñerola *et al.*, 2021b; Puram and Gurumurthy, 2021; Da *et al.*, 2022; Prakash *et al.*, 2022; Sá *et al.*, 2022)

Which study Lean Management (Birgün and Kulakli, 2020; Uriona Maldonado *et al.*, 2020; Barud *et al.*, 2021; Lalmi *et al.*, 2021; Nedjwa *et al.*,2022), they have not proliferated in the same proportion as those which perform a bibliometric analysis of Lean in general. Furthermore, there are none which analyze the trends in the topics of Lean Management and therefore, the evolution and trends of the field of research into Lean Management as a management tool have also never been analyzed.

## 5. Conclusion

The keyword evolution reflects the growing importance of the concept of Lean Management and its tools in business management, as used to seek efficiency and improvement in decision-making processes. It also reflects the expansion of the research themes to address broader aspects related to production process management via the application of Lean manufacturing and Lean Production. The

evolution of the themes shows progression from the centrality of the concept of Lean Management to a greater diversification of themes and a more specific focus on various aspects of this area of study, related not only to the pillars of the concept but also to the various tools and methodologies such as Six Sigma and Value Stream Mapping. These changes reflect the evolution of research in the field in response to the changing preoccupations of researchers and stakeholders over time.

This work provides relevant information on the status quo of the Lean Management research field and establishes a roadmap for researchers who want to publish in this field. Furthermore, this study can help researchers compare and evaluate the different terms used. This allows us to suggest different paths for future research, as well as show progress in scientific progress.

Furthermore, for future researchers, it is useful to have an overview of the main authors and institutions to consider within the discipline, and the topics of interest for review. For current and potential authors, it can serve as a guiding guide in relation to the content, topics of interest and, in general, provide them with information that can help them in their intention to publish their research.
Limitations should be acknowledged. First, the data were retrieved solely from the Web of Science Core Collection, which may have biased the results of this study. Second, limiting the keyword search to topic (Lean management) may be the major reason for the size of the final set and may also result in missing a portion of relevant studies. Third, due to language preference, some keywords may not be included in the search formula and thus may also lead to compromised integrity of the search results.

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