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Research Article

Lean Manufacturing: A Bibliometric Analysis, 1970-2020

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ABSTRACT
The study aims to investigate lean manufacturing from a bibliometric perspective. A systematic analysis was performed on 1893 documents extracted from the Clarivate Analytics Web of Science (WoS) Collection under the "Lean Manufacturing" (LM) subject category between 1970 to 2020. The R programming is utilized for determining the evolution and progress of lean through the topmost contributing publications, authors, journals, and countries. The network representation is performed using VOS viewer, highlighting the focus areas of LM with co-occurrence, co-citation, and bibliographical coupling of the extracted data. The results indicate LM was initially focused predominantly on topics such as lean thinking and organizational performance by various authors. Later, the LM topic was integrated with six sigma, sustainability, and environmental assessments for overall process improvements. The major contributors in this research area are the United States of America and India. The study attempts to fully comprehend LM, its application, and trends to promote further research.

Keywords: Lean Manufacturing, Bibliometric analysis, R programming, VOS viewer, Web of Science, Lean Six Sigma.

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INTRODUCTION

In 1991, the book titled "The Machine that Changed the World" introduced the world to the term Lean Manufacturing (LM).[1] LM was derived from the Toyota Production System that gained popularity in the 20th century as the least-cost production method by creating customer value and eliminating waste. After the revolutionary work of Womack *et al*., 1990, several authors (Oliver *et al*., 1994; Delbridge, 1998, 2003; Pascal, 2002; Liker, 2004; Mann, 2005) have published books that help in understanding LM. The institutes which are the pioneers in LM are the Massachusetts Institute of Technology (SLOAN Management Institute), Cambridge-MIT (Centre for Competitiveness and Innovation), and Cardiff Business School.

The previous research publications have acknowledged the ability of LM in reducing inventories, improving quality, meeting the requirements of the customers at the right time, and reducing inconsistencies during the entire manufacturing.[2] LM gives the perspective for achieving higher productivity, market effectiveness, and internal efficiency, also exposes promising development of Lean study, to attain environmental and economic benefits.[3] Six Sigma is a strategy devoted to quality that can be linked and integrated into 'Lean Six Sigma'.[4] Lean processes are mainly concerned with reducing production time, eliminate waste in all the possible areas across the production lines. While Six Sigma focuses not only on defect elimination, also on project development, reduction of process variability, and costs.[5] Lean focuses on waste removal with six sigma, which reduces variation using statistical tools to achieve quality.[6]

LM, over the years, has undergone many changes that have been conversed by plentiful researches.[7] Recent areas of interest related to LM have focused on organizational productivity, which is concerned with assigning employees for thinkers' roles by reducing human effort and promoting continuous improvement. Also, a comprehensive and holistic approach is involved in implementing LM in many organizations involving sustainability and green initiatives. A vast literature discusses the impact of the LM, both in studies of great scientific rigor and in books for practitioners, to consolidate these studies a bibliometric analysis is conducted.

Bibliometric analysis has been one of the most widely used statistical approaches for analyzing the published materials that have been gaining greater importance after the advancement of technology through computers and the internet.[8] The present study is conducted to understand the research trend on LM using bibliometric analysis with R software and Visualisation of Similarities (VOS) viewer. This study's structure is as follows: the second section contains the methodology, the third section shows analysis and quantitative results of R, followed by network representation in VOS viewer. Finally,

the fourth section provides conclusions, discussion, and limitations.

METHODOLOGY

In this study, the Web of Science (WoS) citation database developed by Thomson Reuters Corporation was used for conducting the bibliometric analysis. WoS is the world's largest and most wide-ranging collection of information resources.[9] Bibliometrics is the routine use of citation analysis and a systematized approach to the processing data repository.[10] A topic search was performed using the keyword "lean manufacturing" to obtain published literature in the WoS database. Since the search was not restricted to any timespan, it extracted the documents since the inception of LM. The search was carried on December 14, 2020. It resulted in 1893 documents that were downloaded in. txt format for analysis. The files were imported to the open-source "Bibliometrics" package in RStudio software v1.3.1093 and executed to determine the highlighting features in the data extracted. Additionally, the VOS viewer software program was used for more interpretive network visualization of keywords, journals, publications, authors, and countries.

ANALYSIS AND RESULTS

The results obtained by the R bibliometric package highlight the characteristics of the WoS data. The summary of bibliometric information, topmost authors, institution, countries, and sources of contribution to the topic of LM. This critical information is vital for understanding the subject area's growth and prominent contributors to the development.

Summary of bibliometric information

The descriptive summary of bibliometric data is represented in Table 1. The total number of keywords used in the articles is 4454, 208 are single-authored documents, 4400 are multiple-authored documents. The average citation per document is 21.72, average citation per year per document is 3.115. The co-authors per document are 3.07, and the collaboration index is 2.7.

Publication growth pattern

As mentioned earlier, the topic of LM has gained much importance, and the number of articles published has been increasing. This is evident in the growth pattern Figure 1, which depicts the plot of peer-reviewed publications in the studies on LM. The most noticeable difference that can be inferred from the graph is that the trend is not exponential. The number of studies has varied alternatively. The Annual Percentage Growth Rate (APGR) of the articles published was found to be 11 %.

Table 1: Data summary.

Description	Result
Documents	1893
Timespan	1970: 2020
Sources (Journals, Books, etc.)	558
Author's Keywords	4454
Author Appearances	5805
Authors	4608
Single-authored documents authors	208
Multi-authored documents authors	4400
Documents with a single author	263
Average citations per documents	21.72
Average citations per year per doc	3.115
References	54577
Authors per Document	2.43
Co-Authors per Documents	3.07
Collaboration Index	2.7

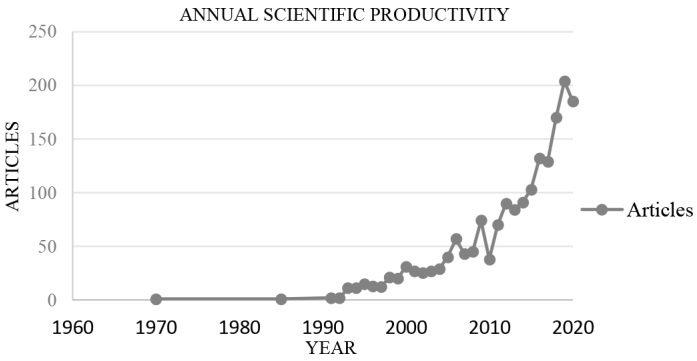

Figure 1: Annual Scientific Production.

As the present study is focused primarily between 1970-2020, the few initial years had fewer articles published ranging between 1-15 between 1970 and 1997. Gradually, the number of articles published started increasing as the years progressed with various new areas related to LM. Due to advancements in technology and economic impact, the term productivity gained greater importance, which led to an increase in studies related to lean as a tool to increase profitability with the integration of other processes and quality improvement strategies.

An appropriate explanation for such a trend is Price's law, which explains that any research topic goes through four phases. At first, there is a phase called precursor, where fewer scientists begin to focus on the novel field and publish articles, followed by an exponential growth phase where the study area begins to grab the attention of various authors to conduct a study in different ways, later following the consolidation period during which the studies conducted becomes either iterative or stagnant, then slowly that particular area of research decreases.[11] Applying this theory to the LM, the

studies conducted have already reached the maturity point but still had new potentials to collaborate with topics like supply chain, six sigma, and performance and might gain importance.

Topmost contributing journals on LM

The top 10 journals which are frequently referred to by the researchers have been represented in Table 2. Key journals in the field are the *International Journal of Productions Research* and *Production Planning and Control*, with 164 and 107 publications on the topic.

Table 2: Top 10 contributing journals on LM.

Ranking	Sources	Articles
1	International Journal of Production Research	164
2	Production Planning and Control	107
3	Journal of Manufacturing Technology Management	75
4	Journal of Cleaner Production	67
5	International Journal of Production Economics	65
6	International Journal of Lean Six Sigma	63
7	International Journal of Advanced Manufacturing Technology	62
8	Total Quality Management and Business Excellence	30
9	Proceedings of The Institution of Mechanical Engineers Part B-Journal of Engineering Manufacture	28
10	Sustainability	28

Topmost contributing authors

Authors with the most articles published on the topic of LM are ranked in Table 3. *[Anonymous]A and Vinod S* are the most productive authors with 26 publications each, followed by *Tortorella Gl* 21 publications.

Table 3: Top 10 contributing authors.

Ranking	Authors	Articles
1	[Anonymous] A*	26
2	Vinodh S	26
3	Tortorella Gl	21
4	Godinho Filho M	19
5	Garza-Reyes Ja	17
6	Antony J	16
7	Kumar M	15
8	Kumar V	13
9	Saurin Ta	13
10	Marodin Ga	10

* As obtained from the WoS database

Topmost countries contributing to LM

To continue characterizing the contributions geographically, researchers publish the most influential and productive countries.

The ranking in Table 4 is given mainly based on the total number of articles published, frequency of appearances in the journals, Single Country Publication (SCP), Multiple Country Publication (MCP), and MCP ratio. According to the findings, there is a wide range of countries publishing on the subject of LM. Countries' scientific output depends, among others, on economic and political factors.[12,13] For instance, the *USA* has the largest R&D investment of $134.1 billion.[14] Therefore, it is not surprising that its forefronts in the ranking of the most productive countries with 437 articles, followed by the *UK* with 159 papers. *India* in the third position having 144 articles.

Bibliometric analysis using VOS viewer

The study presents a bibliographic analysis using the VOS viewer software application.[15,16] The bibliometric techniques of co-citation analysis[17] and bibliographic coupling[18] are Conducted using this tool. The bibliometric metrics used to interpret the data are important to identify for bibliometric analysis.[19] The citations count from keywords, journals, sources, and countries is taken into account in the present study to reflect productivity, popularity, and impact.

Table 4: Top 10 contributing countries.

Ranking	Country	Articles	Frequency	Single Country Publication	Multiple Country Publication	MCP Ratio
1	USA	437	0.2437	376	61	0.14
2	United Kingdom	159	0.0887	112	47	0.296
3	India	144	0.0803	123	21	0.146
4	Brazil	116	0.0647	74	42	0.362
5	China	105	0.0586	78	27	0.257
6	Italy	97	0.0541	76	21	0.216
7	Spain	61	0.034	43	18	0.295
8	Germany	53	0.0296	45	8	0.151
9	Australia	50	0.0279	32	18	0.36
10	Canada	35	0.0195	24	11	0.314

Keyword co-occurrence

The keyword co-occurrence is a bibliographical analysis applied to detect significant areas and classify those frequently co-occurring terms into theme-based clusters.[20] Bibliometric data reveals that this analysis included 6294 keywords. Results of keyword occurrence were carried out by co-citation analysis in VOS viewer for a minimum threshold of 30 keywords and the 300 representative co-occurrence links, as shown in Figure 2.

The size of each node is commensurate with the frequency of the keyword. The proximate nodes indicate those have simultaneously occurred in multiple articles, and the thickness of the links that connect them is proportional to the strength of the link.[21] Keywords such as *performance, implementation, management, impact,* and *framework* have high incidences, indicating a greater research focus, and are strongly associated with the other keywords. Since the keyword *lean manufacturing* was included in the search string hence its high occurrence is predicted.

Four clusters were identified, the largest red cluster with 21 keywords including *implementation, framework, lean six-sigma* is closely linked to keywords like *performance* and *impact*. The second-largest cluster was the green cluster with 20 keywords mainly containing *management, productivity, supply chain, and performance* are linked with *critical success factors, continuous improvement*. The blue cluster contained 13 keywords, such as *systems, barriers,* and *sustainability*. Other keywords like *JIT, strategy, and operational performance* are in the yellow cluster, indicating their link with LM. Table 5 shows the quantitative details relating to the top 10 highly-occurred keywords ranked based on their strength.

Prominent journals

Co-citation refers to the relation between two items that are both cited in the same document.[16] The co-citations study is extended to consider journals with a more significant

Table 5: The top 10 co-occurrence of keywords based on link and total link strength.

Keywords	Cluster number	Cluster colour	Links	Total link strength	Occurrences
Lean manufacturing	2	Green	66	1564	443
Performance	2	Green	66	1564	323
Implementation	1	Red	66	1404	263
Management	2	Green	66	1317	284
Impact	4	Yellow	66	1189	213
Lean production	4	Yellow	66	875	239
Framework	1	Red	66	824	154
Model	2	Green	66	743	179
Lean	1	Red	66	577	136
Supply chain management	3	Blue	63	569	104

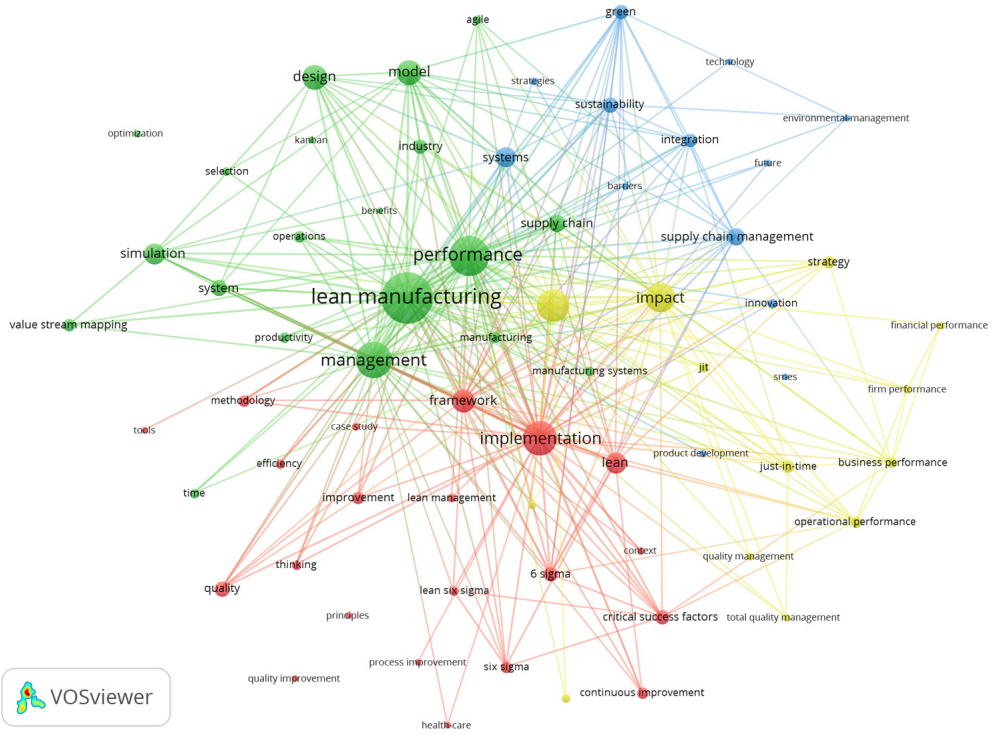

Figure 2: Co-occurrence analysis of all keywords network.

Table 6: The top 10 co-cited journals listed on link and total link strength.

Journals	Cluster number	Cluster colour	Links	Total link strength	Citation
International Journal of Production Research	2	Green	92	3149.08	3894
International Journal of Operations and Production Management	1	Red	93	2553.99	2903
International Journal of Production Economics	5	Violet	92	2480.86	2827
Journal of Operations Management	1	Red	92	2279.34	2622
Journal of Cleaner Production	2	Green	92	1553.74	2195
Production Planning and Control	3	Blue	92	1415.07	1596
Journal of Manufacturing Technology Management	3	Blue	91	1237.22	1362
International Journal of Lean Six Sigma	3	Blue	91	896.00	1050
International Journal of Advanced Manufacturing Technology	2	Green	92	744.73	823
Harvard Business Review	1	Red	91	667.21	717

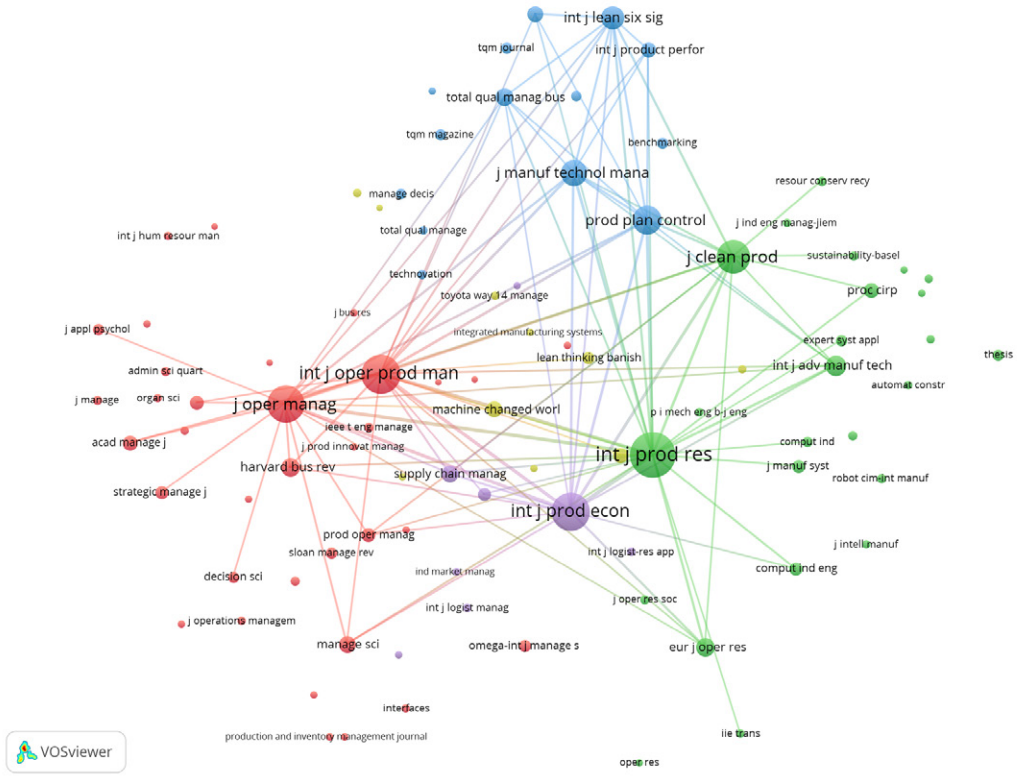

Figure 3: Co-citation analysis for journals.

impact on LM output growth. The co-citation study outcome for cited sources with fractional counting from VOSviewer, which has been at least 100 times cited, is 95 journals representing 100 co-citation links as Figure 3.

The gap between the two nodes indicates relative strength and the topic's similarity in the journals.[20] Five significant clusters are formed- closely related, red cluster with 35 items have the most prominent journals, followed by the green cluster with 25 items including *Journal of Manufacturing Technology Management* and *International Journal of Advanced Manufacturing Technology* emphasizing lean for technological improvements. The blue cluster involves the *International Journal of Six Sigma, Total Quality Management Journal,* and *International Journal of Quality and Reliability Management,* focusing on the quality aspect. The violet and yellow clusters have influential journals such as *Lean Thinking* and the *International Journal of Production Economics.*

The study related to the citation count and total link relation strengths in fractional counting can be found in Table 6. Results show that journals such as the *International Journal of Production Research,* the *International Journal of Operations and Production Management,* and the *Journal of Operations Management* have the highest citations.

Prominent publications

A related approach to prominent journals, co-citation analysis of referenced sources is adopted to obtain the most prominent publications. 49 publications meet the threshold of 50 citations out of 54594 cited references. The VOS viewer's results for the co-citation analysis are shown in Figure 4 with the most 200 representative citation links.

The analysis has resulted in four clusters, and the cluster size is small, indicating an increased accuracy.[22] A majority of the cited references are in a red and green cluster with 29 items and 19 items, respectively. The red cluster majorly focused on the onset of lean and lean thinking, which began in the Toyota Production System (*Womack J., 1990; Liker J., 2004; Womack J.P., 1996*). The green cluster contains items that involved developing lean tools and techniques (*Shah R, 2007; Hines P., 2004*). The third dominant blue cluster has 7 items belonging to the impact assessment of lean and sustainability (*Yang MG, 2011; Faulkner W, 2014*). Finally, the yellow cluster with 3 items has cited references involving topics beyond traditional lean, such as lean job design's motivational aspect and the difference between lean and agile. (*de Treville S, 2006; Narasimhan R, 2006*) The proximity of the clusters indicates a strong relationship as they are frequently cited.[23] Data obtained from the cluster analysis is available in Table 7,

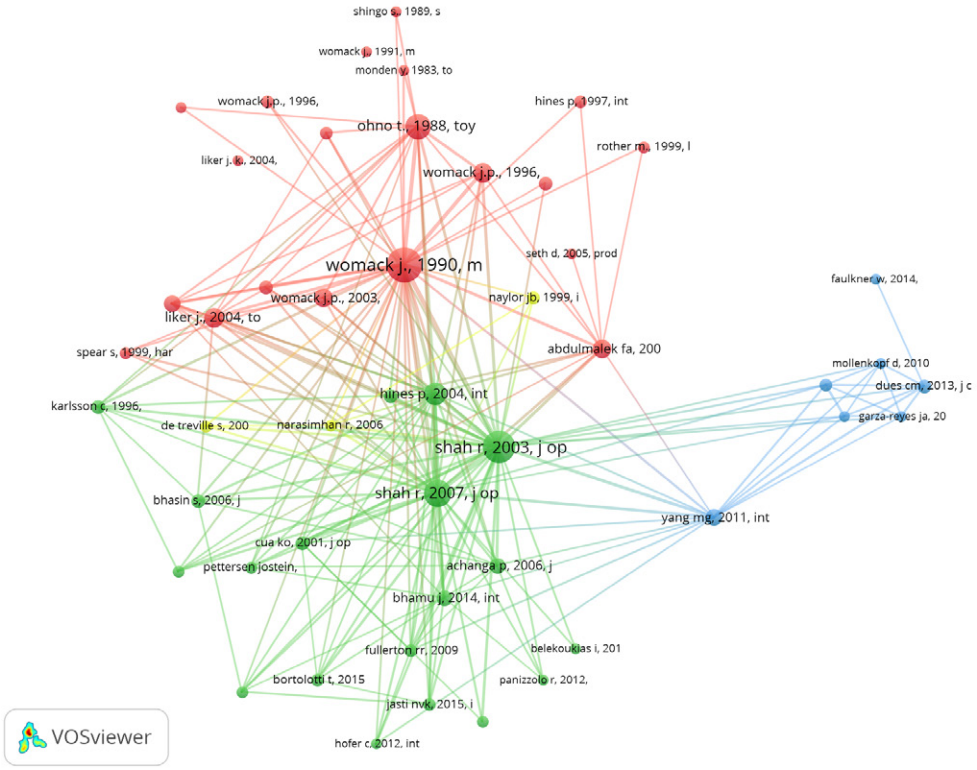

Figure 4: The co-citation analysis of cited publications map.

Table 7: The top 10 co-cited publications-based link and total link strength.

Publications	Cluster number	Cluster colour	Links	Total link strength	Citations
Shah R, 2003, J OPER MANAG, V21, P129, DOI 10.1016/S0272-6963(02)00108-0	2	Green	48	2044	318
Womack J., 1990, MACHINE CHANGED WORLD	1	Red	48	1774	367
Shah R, 2007, J OPER MANAG, V25, P785, DOI 10.1016/j.jom.2007.01.019	2	Green	48	1654	243
Hines P., 2004, INT J OPER PROD MAN, V24, P10	2	Green	48	1197	176
Ohno T., 1988, TOYOTA PRODUCTION SY	1	Red	48	1013	215
Yang MG, 2011, INT J PROD ECON, V129, P251, DOI 10.1016/j.ijpe.2010.10.017	3	Blue	48	752	104
Liker J., 2004, TOYOTA WAY 14 MuANAGE	1	Red	47	748	136
Abdulmalek FA, 2007, INT J PROD ECON, V107, P223, DOI 10.1016/j.ijpe.2006.09.009	1	Red	48	743	129
Womack J.P., 1996, LEAN THINKING BANISH	1	Red	47	729	147
Bhamu J, 2014, INT J OPER PROD MAN, V34, P876, DOI 10.1108/IJOPM-08-2012-0315	2	Green	48	713	99

ranked based on total link strength, indicating higher co-citations between researchers.

Prominent authors

The analytic unit is selected as "cited authors" in co-citation analysis in VOS viewers for establishing the influential authors in LM. Figure 5 indicates the five primary clusters can be differentiated according to the expertise of the authors by setting 50 authors' citation threshold resulting in 140 authors with the most 200 representative citation links.

These clusters are consistent with the clusters recognized in the previous prominent publication analysis to a vast degree. The red cluster with 40 items has focused on authors who have based their research on lean thinking and Toyota way of thinking (*Womack JP, Womack J, Hines, Likert JK*). Similarly, the green cluster with 33 items delves into the impact of lean on performance, tools, and techniques of lean initiatives, benefits of lean (*Vinodh S, Bhasin S, Abdulmalek FA*); and the blue cluster with 29 items emphasizes developing lean, the contribution of lean (*Shah R, Fullerton RR*). The yellow cluster with 27 items majorly focused on combing lean with green initiatives and sustainability (*JA Garza-Reyes, A Cherrafi, A Chiarini*). In comparison, the final violet cluster with 11 items has authors who have combined lean with six sigma (*Antony J, Kumar M*), all indicating the closer they are located, the greater is the relevance. Table 8 describes the data relevant to this network. With the enormous total link strength, *Shah R* indicates that other researchers have extensively co-cited his work.

Prominent institutions

The citation analysis with Organisations in VOS viewers is utilized for establishing the prominent institutions in LM. Figure 6 indicates the five primary clusters can be distinguished according to the most cited institutions by setting 8 minimum number of documents of an organization threshold resulting in 48 authors with the most 100 representative citation links.

The node size denotes the measure of publications, and the line between the two nodes demonstrates the academic link between the two institutions. The shorter the curve, the

Table 8: The top 10 co-cited authors based on full link and link strength.

Sl no	Author	Cluster number	Cluster colour	Links	Total link strength	Citations
1	Shah R	3	Blue	139	12198	627
2	Womack JP	1	Red	139	8342	621
3	Vinodh S	2	Green	138	7145	343
4	Womack J	1	Red	139	6882	511
5	Bhasin S	2	Green	138	6174	247
6	Fullerton RR	3	Blue	139	6057	360
7	Marodin GA	2	Green	135	4737	201
8	Liker JK	1	Red	139	4581	170
9	Jasti NVK	2	Green	139	4201	263
10	Ohno T	1	Red	139	4198	160

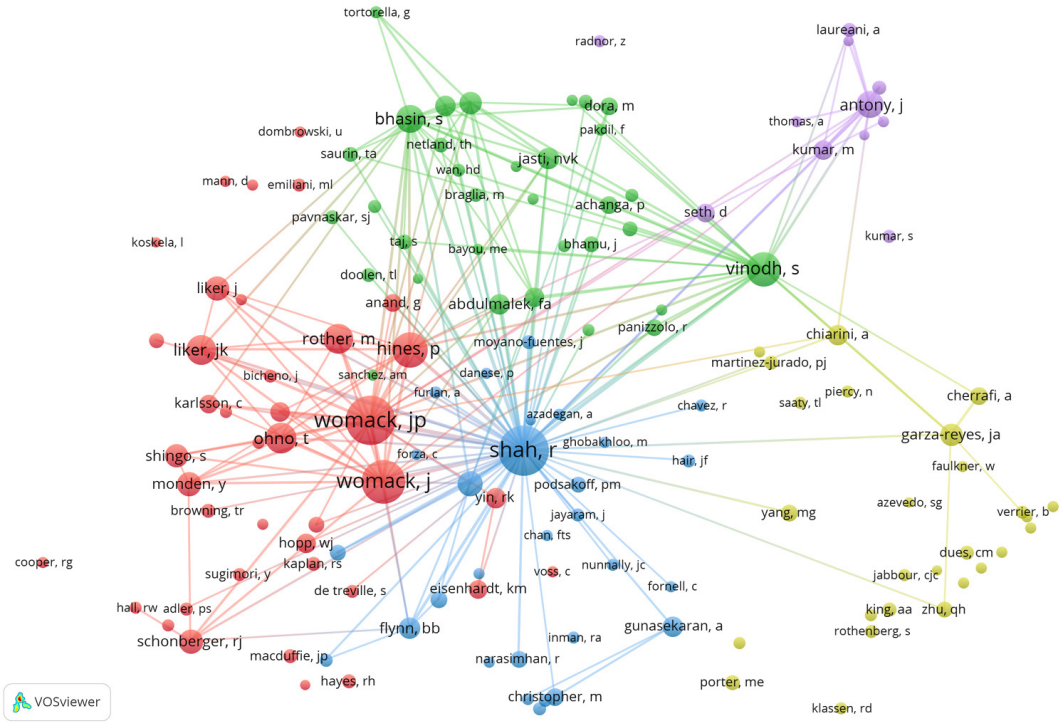

Figure 5: The co-citation analysis of the cited authors.

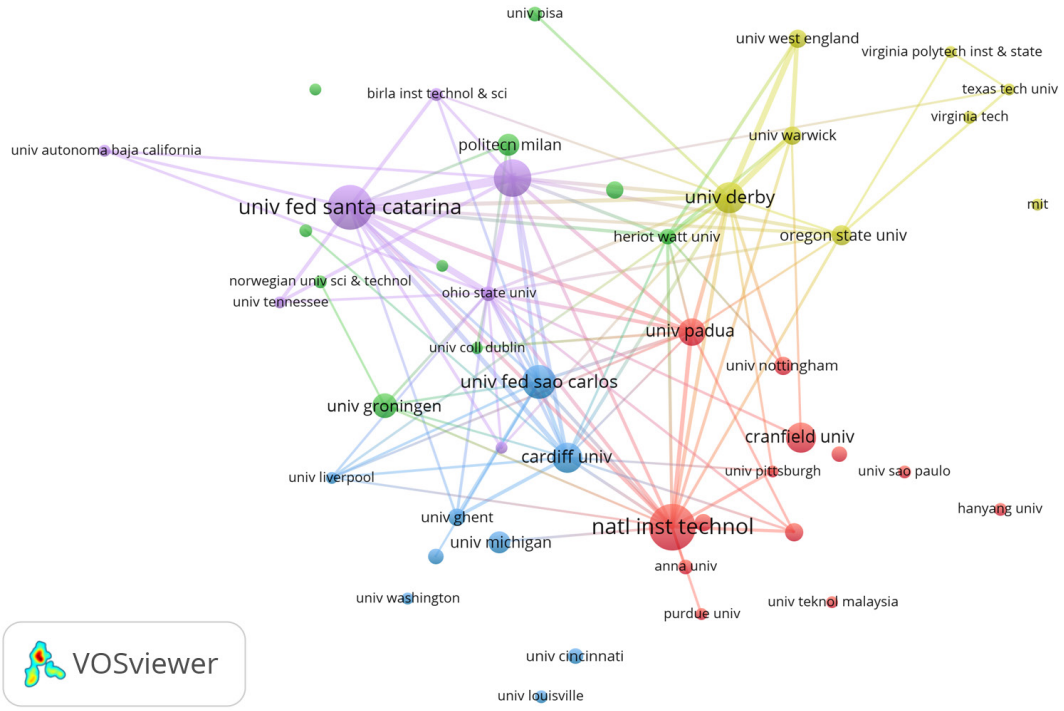

Figure 6: The citation analysis of the organization map.

Table 9: The link and total link strength of the top 10 prominent inst.

Sl no	Institution	Country	Cluster number	Cluster colour	Links	Total link strength	Citations
1	Universidade Federal de Santa Catarina	Brazil	5	Violet	40	462	491
2	Universidade Federal do Rio Grande do Sul	Brazil	5	Violet	42	420	655
3	University of Derby	UK	4	Yellow	42	390	480
4	Ohio State University	USA	5	Violet	41	342	2170
5	National Institute of Technology	India	1	Red	39	289	898
6	University of Padua	Italy	1	Red	44	279	788
7	Cardiff university	UK	3	Blue	42	259	874
8	Federal University of São Carlos	Brazil	3	Blue	39	235	348
9	Heriot-Watt University	UK	2	Green	38	206	164
10	University of Warwick	UK	4	Yellow	37	204	571

stronger the link. It is inferred from the results that the red cluster has the largest items of 13 items of institutions such as the *University of Padua, National Institute of Technology, Cranfield University, and Nottingham University*. The violet cluster with 7 items has the highest cited institutions like *Universidade Federal de Santa Catarina, Universidade Federal do the Rio Grande do Sul,* and *Ohio State University*. It can be seen in the yellow cluster that UK and USA institutions have strong research links like the *University of Warwick, University of Derby, the University of West England* with *Virginia Technology, Texas Technology* University, and *Virginia Polytechnic Institute* for LM studies. The blue cluster with 9 items has *Cardiff University, Federal University of São Carlos, University of Liverpool,* and others. The green cluster with 10 items has European institutions that have collaborated on research on LM such as *Heriot-Watt University, Norwegian University of Science and Technology, University College Dublin,* and *the University of Pisa.* Table 9 describes the data relevant to this network based on the total link strength. The Ohio State University has the highest citation of 2170.

Prominent countries

The most influential countries contributing to the development of LM are found by using a bibliographic coupling. A connection between two items that both cite the same document is a bibliographic coupling link.[24] The bibliographic analysis results for at least 30 citations per country, and the 100

most significant bibliographic coupling links are selected and shown in Figure 7.

The nodes' size is proportionate to the count of publications in the respective countries. The most dominant country is the *USA* also seen in Jasti and Kodali, 2015 and Ciano's, 2019 research with the highest link to all the countries, followed by *Brazil, India,* and *England*. The analysis has resulted in six clusters, and the red cluster contains 16 items such as the *USA, Italy, Germany, Sweden*, and *Denmark,* indicating a high amount of LM research is published in developed nations. The blue cluster with 15 items includes countries like *Brazil, India, England, France*, and *Malaysia*, and the green cluster includes *Spain, the People of Republic China, South Korea,* and *Australia* who are adapting lean philosophy. The violet cluster with 5 items, such as *Egypt, Saudi Arabia, Iran,* and *Jordan,* has close links due to their geographical proximity. *Belgium* and *Wales* are closely related, and finally, the yellow cluster has *Ireland, Croatia,* and *Hungary* are contributing to the LM research. This pattern is expected as its already shown that the authors and publications from these countries are closely linked. Table 10 shows the ranking of the top 10 countries based on

Table 10: The link and total link strength of the top 10 influential countries.

Sl no	Countries	Cluster number	Colour number	Links	Total link strength	Documents	Citations
1	USA	5	Red	49	292562	513	17183
2	Brazil	1	Blue	48	188612	131	2134
3	India	1	Blue	48	185023	168	3548
4	England	1	Blue	49	181265	180	6130
5	Italy	5	Red	49	134364	110	2388
6	Spain	4	Green	49	93760	81	1305
7	People Republic of China	4	Green	48	65280	98	2488
8	Australia	4	Green	48	57358	59	1125
9	Netherlands	5	Red	48	53891	45	880
10	Malaysia	1	Blue	48	484495	37	422

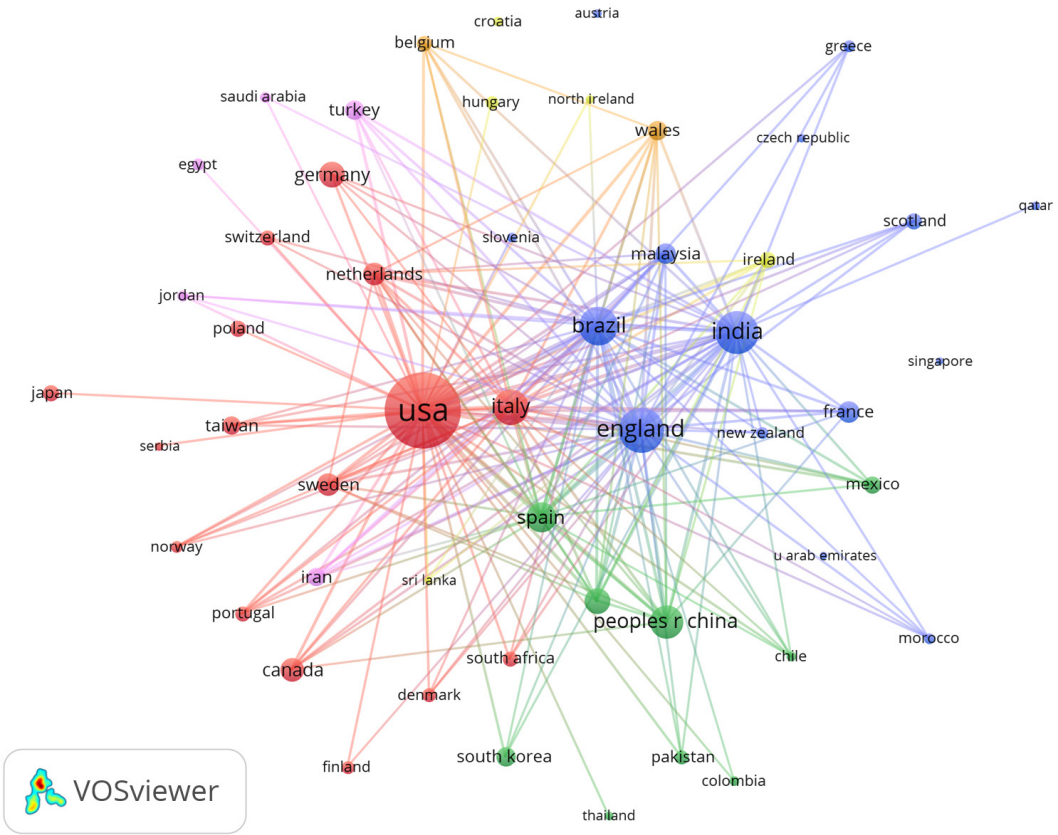

Figure 7: The bibliographical analysis of countries map.

total link strength signifying research in the top ten countries like the USA and Brazil have the number of cited references in common.

DISCUSSION

LM is a vast subject that includes implementation and integration with various management techniques to obtain optimum results. A study has been published by Oliveira *et al*. 2018 about the trends and scientific development of Lean Manufacturing implementation.[24] It covers only the articles published between 2007 and 2018 from both Scopus and WoS databases. However, the present research has analyzed LM from its inception to develop a comprehensive overview of the progress of LM.

Also, a similar bibliometric analysis was carried by Sordon (2019) on the topic of Lean Six Sigma in manufacturing processes was conducted with 508 articles identified in the Scopus and WoS database between 2002 and 2017.[25] The survey analysis identified the most cited articles, keywords, productive journals, productivity, and collaboration. The study by Ciano (2019) contributes to the literature of lean specifically derived from research published in the International Journal of Production Research (IJPR) journal of Scopus database using VOS viewer software. The results obtained were confirmed by burst detection to compare the keyword occurrences of IJPR to other journals.[26] The previous works have not entirely focused on LM to give a complete understanding of the topic, its growth and integration with various topics, and its future implications. The research results have revealed that the highest publications and citations are given higher weightage, not the quality of high-impact work published in high-profile journals. In the future researchers must consider this point to promote the understanding of high-quality journals.

CONCLUSION

The new developments in the global economy have demanded a paradigm change from profit maximization to customer satisfaction in the manufacturing sector. One such process-oriented approach for achieving sustainability in competitive markets is LM techniques. Our research provides a precedent that creates an opportunity to propose a repository of information to encourage LM-related studies.

The bibliometric analysis was performed on the data using the open-source R code and visualized using VOS viewer. Mostly increasing growth pattern of the LM subject is found based on previous publications. The *International Journal of Production Research* has been described as the most significant source chosen by researchers to publish their work. Researchers *[Anonymous] A* and *Vinod S* have been actively contributed to the field. Based on the total number of papers written by countries, the USA ranks topmost, followed by the United Kingdom and India.

Network visualizations from VOS viewers show that LM has been used to integrate with other domains such as Industry 4.0, Six sigma, and adopting LM practices in an environmental, sustainable, and organizational performance perspective in developing nations.[27-29] LM practices are currently closely linked to green initiatives and sustainability performance.[30-33] Current research would provide insight into the pattern and be relevant for future LM researchers to identify gaps and explore new areas of interest.

LIMITATIONS

The study has limited its search to only articles indexed on the WoS database. WoS has higher research toward Natural Sciences and Engineering and Biomedical Research,[34] demonstrating many researchers might have used other databases to publish their work, such as Scopus and Google Scholar. This limitation also opens a research gap to compare our results with other databases.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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