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Research Article

A Systematic Review of Reverse Logistics Research: Bibliometric Study of the Years 2013-2023

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ABSTRACT
Reverse logistics has generated much interest among entrepreneurs, academics and civil society. This is because you can recover the value of products that are used and returned, which is why it has become one of the key elements in supply chain management. Through a bibliometric study and documentary analysis, this work aims to describe how the scientific production of reverse logistics has evolved quantitatively from the year 2000 to 2023. The articles retrieved from the Web of Science portal, from Clarivate Analytics, provided the primary data to conduct a bibliometric method and content analysis. The search produced 1148 articles, with production peaks in the year 2000 up to 2023. Networks of co-occurrence, citation and co-authorship were also analyzed. During the period of study (2000-2023), there were 124 working groups; it was found that the four groups of researchers who worked around the issue of reverse logistics are the ones with the highest number of citations. Of the 548 publications about the subject "reverse logistics", the researchers addressed different aspects such as competitive advantage, the firm performance, implementations in different sectors, sustainability, the study of new strategies to improve control of inventories systems, demand, supply, trying to control uncertainty both in transportation and in handling waste and returns by the final user. (All of this section was modified).

Keywords: Reverse Logistics, Bibliometric Method, Web of Science, Supply Chain Management, Competitive Advantage.

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INTRODUCTION

Reverse logistics has generated much interest among entrepreneurs, academics and civil society. There are several driving forces behind reverse logistics such as economic, legislation, corporate citizenship, environmental concerns, social responsibility and greater awareness from people and society that have resulted in a new focus on the design of supply chain networks.

This is because you can recover the value of products that are used and returned, which is why it has become one of the key elements in supply chain management. Reverse logistics which involves the return movement of goods and services in the supply chain is becoming a necessary business activity regardless of the industry or product/services involved as delivering products to the customer does not always end the business cycle.[1]

The reverse logistics discipline has undergone increasing development in the last 20 years. The main focus of the discipline has been centered on two aspects:

The organization of reverse material flows in supply chain networks (returnable packaging, commercial returns, remanufacturing) and the integration of the reverse flow and the forward flow in the so-called closed-loop supply chain.[2]

The management of products end-of-life phase (waste management, recycling), mainly from an environmental perspective.[3]

Besides, we must distinguish several types of recovery activity:[4]

Product recovery (products may be recycled directly into the original market or a secondary market, or repaired and sent back to the user under conditions of warranty), Component recovery (products are dismantled and parts can be remanufactured into the same kind of product or different products), Material recovery

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(materials are recuperated and recycled into raw materials like metal, paper or glass), Energy recovery (incineration).

Therefore, the main objective of a bibliometric study and documentary analysis, this work aims to describe how the scientific production of reverse logistics has evolved quantitatively from the year 2000 to 2023 to identify key aspects such as the most cited author, the journal with the greatest impact, the leading institution, all of the which allows the investigation to describe the main characteristics of the topic and outline future research lines.

This article is organized into five sections. The first one refers to the introductory part of the topic, followed by the section where a review of the relevant literature is approached, as well as the methodology used for the investigation. The third section presents the results of the bibliometric study and content analysis, based on quantitative data on the evolution of scientific production of reverse logistics. A discussion section of results is presented and finally, conclusions.

REVIEW OF LITERATURE

In the era of circular economies, governments and consumers are increasingly aware of environmental protection, which encourages enterprises to dedicate more attention to reverse logistics.[5] The conceptualization of reverse logistics is dated which makes the denomination of the term difficult to trace accurately. The first existing terms that referred to reverse logistics were terms such as reverse supply channels or return flux. Those already appear in the scientific literature since the seventies, but the terms were always related to recycling.[6,7] In 1983, it was estimated that the movement against "the traditional supply chain" by almost all companies was leading in the wrong direction. However, thanks to that affirmation, several variables were considered both controllable and uncontrollable and most importantly, the effects of this phenomenon would have an impact on the environment specifically on the physical distribution.[8] According to the most widely accepted definition, Reverse Logistics (RL) is:

The process of planning, implementing and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin to recapture value or proper disposal.[9]

Another definition was provided by the European Working Group and it proposes the following definition: it is the process of planning, execution and control of the returns, flaws of raw materials, inventory in-process packaging and finished products from manufacturing, distribution, or point of use, to a point of recovery or adequate disposal.[10]

In recent years, reverse logistics has been a particular interest among academicians and practitioners in the field of supply chain and operations management.[11] More precisely, RL seeks to move the merchandise from its traditional final destination to another destination to obtain value capture and/or its appropriate disposal.

Furthermore, with an increasing trend in online marketplaces, the returns have also increased, with an estimated $800 million to $1 billion being returned in the fiscal year 2015-2016, therefore causing logistical challenges and potential losses[12] in.[13] Despite well-devised return policies, there have been fraudulent returns for which systems need to be devised for tracking customer behaviors. To design these systems, organizations need to allocate adequate resources, therefore making resource commitment a critical construct in RL.

The importance of the reverse supply chain is demonstrated through a statistical study originated in the U.S. that suggests that nearly 20% of everything that is sold is returned.[14] According to the data from the study *Consumer Returns*, the annual Worldwide Business Research (WBR) finds that consumers return to the main supermarket chains and points of sale. It was found that 70% of companies have a corporate strategy for returns and 13% are in the process of creation. Additionally, the study highlights that in 25% of cases the returns to the department of operations lead them to charge 17% for quality and 13% are under the supervision of the supply chain areas. Only 8% of surveyed companies have a department specializing in reverse logistics.[15]

RL can contribute to the competitiveness of a firm. Making efficient reverse logistics processes can result in lowering supply chain costs for the firm; thereby, giving the firm a potential cost advantage.[16-19]

Govindan[20] point out that RL is adopted as a strategic tool to generate competitive advantage, both in terms of economic benefits and corporate social image. Moreover, RL activities are gaining importance in terms of size and quantity due to both economic and environmental concerns.[21]

There had been a continued focus on the forward supply chain, but with an increase in global competitiveness, it has become increasingly important for organizations to divert their attention towards the reverse chain as well.[22] According to De Souza and Da Fonseca,[23] RL has strategic importance for competitive cost savings in organizations, this being the reason why it has been occupying a prominent position within companies.

Coincidentally, Pushpamali *et al.*[24] state that RL is an environmentally friendly practice that can be critical in improving the environmental performance of construction operations. This paper examines the perceived role of RL practices on supply chain performance criteria. For example, cost, quality, time, flexibility and environment.

METHODOLOGY

Content analysis and bibliometric study were carried out. Content analysis, as a qualitative research method, identifies and analyzes scientific articles that allow building a theoretical framework around the concept, from its characteristics, types, implications, differences and similarities with other used terms. Regarding quantitative methods, there is the bibliometric study, which provides data on the evolution of the scientific production of the subject and breaks down the behavior of its information through networks, graphs and tables, elements that also allow locating gaps in the literature.

A literature review seems to be a valid approach for thoroughly reviewing and structuring a research area.[25] Therefore, a literature review helps in identifying the conceptual content of the research area[26] and guides the study toward the development of the theory. For a systematic review of the literature and to clarify the research methodology for the article, four steps such as material collection, descriptive analysis, category selection and material evaluation given by[27] are described in the following section.

Bibliometric indicators are presented through the number of articles, citations received, impact factors, number of countries, institutions, co-authors, co-keywords, clusters, etc., which evaluate the productivity and quality of the research tasks carried out by scientists. For example, the analysis of citations allows the identification of emerging areas of technological and scientific interest and the impact factor measures the visibility and dissemination of published works.[28-30]

Material collection

Material collection methodology and unit of analysis, are the first steps of the literature review process. The unit of analysis has been defined as a single research article/book/report. The study was conducted in two stages. The first stage consisted of selecting the international database Clarivate Analytics and then focusing it on the main collection of Web of Science Core Collection (https://clarivate.com/products/web-of-science/). This database was selected for its coverage and for being the most prestigious one worldwide.

The second stage established the search criteria for the database Clarivate Analytics-Web of Science, utilizing the following algorithm: TITLE (reverse logistics) and indexes (SCI-EXPANDED). This means that all documents that include only accurate titles or combined the words "Reverse logistics" in the title were analyzed. The algorithm identified 3683 documents. Subsequently, it also identified the document types (articles). Identifying 2633 of them was a continuous task, so a more refined search criterion was utilized to identify which of the publications were made in the English language and there was an opportunity to identify 1586 documents. We continue within the selected areas of research, limiting it to Management (133), Business (40) and Business Economics (173); Timespan: 2000 to 2023; indexes: SCI-EXPANDED, Science Citation Index, SSCI, AandHCI, BKCI-S, BKCI-SSH, ESCI, to finally identify 148 documents, which immediately starts with the analysis of the obtained indicators. (justification and this section was also modified).

The data processing was carried out with the assistance of the VOSviewer version 1.6.16 software. The VOSviewer is a tool that allows for mapping and visualizing available information.[31] Networks of co-authorship were built for authors, countries, institutions, the citation for sources and publications and co-occurrence between keywords. A descriptive analysis of the sample was developed from the maps created.

RESULTS

The study of RL is made up of 1148 articles. The publications are concentrated in 66 sources; 378 authors contribute to the subject; they come from 39 countries and are a part of 222 organizations. In Figure 1, the evolution of scientific production on the subject

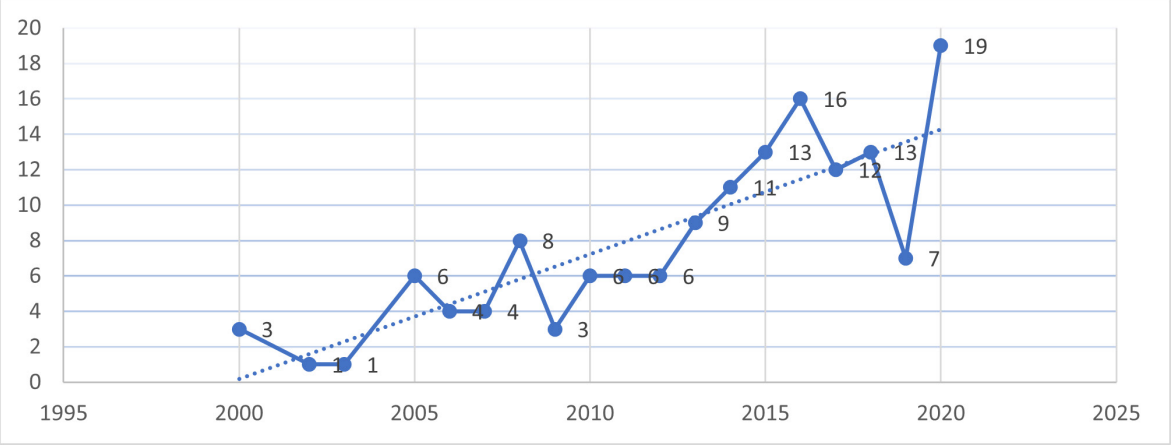

Figure 1: Number of articles published on the topic of Reverse Logistics. Source: Own elaboration based on information from the Web of Science (2000-2020).

Table 1: Number of articles per year and source.

Source	Impact factor (2019)	Registers	% Of 148	Year of publication												
				2000-2005	2006-2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
International Journal of Logistics Management.	4.664	11	7.432	0	2	1	1	2	2	1	1	0	1	0	0	11
International Journal of Physical Distribution Logistics Management.	6.571	11	7.432	0	2	1	1	2	2	1	1	0	1	0	0	11
Omega International Journal of Management Science.	7.275	10	6.757	2	2	1	0	1	2	0	0	0	0	1	1	10
Journal of the Operational Research Society.	2.724	8	5.405	1	1	1	0	1	2	1	0	0	0	0	1	8
European Journal of Operational Research.	5.646	8	5.405	0	3	0	1	1	2	0	0	0	0	0	0	7
Supply Chain Management an International Journal.	6.371	6	4.054	0	3	0	0	0	1	1	1	0	0	0	0	6
Independent Journal of Management Production.	0.876	5	3.378	0	0	0	0	0	0	0	1	1	1	0	2	5
Industrial Marketing Management.	6.287	5	3.378	2	1	0	1	0	0	1	0	0	0	0	0	5
International Journal of Logistics Research and Applications.	3.015	5	3.378	0	2	0	0	0	0	0	1	1	0	0	1	5
Benchmarking is an International Journal.	2.6	4	2.703	0	0	0	0	0	0	2	1	0	1	0	0	4
Others 56 more sources.				6	9	2	2	2	0	6	10	10	9	6	14	76
TOTAL				11	25	6	6	9	11	13	16	12	13	7	19	148

Source: Own elaboration based on information from the Web of Science (2000-2020).

is observed, especially from the year 2000 to 2020, which is the object of analysis of this article.

The scientific production of RL is classified during the analyzed 20 years, the first decade is divided into two periods (from 2000-2005 and 2006-2010) and the last decade is broken down and is shown as follows in Table 1. The most productive authors are Hanna, Joe, Hazen and Benjamin with 7 papers, followed by Hall and Diane, with 6 published papers.

Table 2, shows the 18 most cited articles out of 100 citations. The topic of RL has had its greatest academic boom since 2005 with the publication of Ravi and Shankar. These authors are the most cited with 6.44% of the total number of citations. The next most-cited publication is from Dowlatshahi in 2000 with 5.50%, Salema, Barbosa-Povoa and Novais with 5.44% and then, Srivastava with 5.07%. These four studies account for more than 22.45% of the total number of citations generated on the subject. The three journals that concentrate on these three papers are Technological Forecasting and Social Change (5,846), Interfaces (3,724) and European Journal of Operational Research (5,846). The first and the last publications have an equal impact factor value of 5.846. In other words, the articles published in the journals that concentrate the greatest production on the subject are International Journal of Logistics Management, International Journal of Physical Distribution Logistics Management and Omega International Journal of Management Science are not the ones with the greatest impact on the scientific community, even though they are the ones with the greatest number of articles published on RL.

Also, Table 2 shows the Impact Index (AIF), which is calculated from the number of times an article is cited and the journal's impact factor.[32] According to this index, articles can change their position in the citation ranking. This is true for the article by Salema,[33] from being positioned in third place for its registered citations, the AIF positioned it in second place. It is the impact factor of the European Journal of Operational Research that allows the research to be more visible.

Table 2: List of the 18 most cited articles in the sample with more than 100 citations.

Author and publication year	Total of quotes	Percentages	Impact factor	A_{IF}
(Ravi and Shankar, 2005).[34]	391	6.44%	5.846	2,676.78
(Dowlatshahi, 2000).[35]	334	5.50%	3.724	1,577.81
(Salema *et al.*, 2007).[36]	330	5.44%	5.646	2,193.18
(Srivastava, 2008).[37]	308	5.07%	5.324	1,947.79
(Min *et al.*, 2006).[38]	223	3.67%	5.324	1,410.25
(Sarkis *et al.*, 2010).[39]	190	3.13%	4.542	1052.98
(Alumur *et al.*, 2012).[40]	172	2.83%	4.213	896.63
(Krumwiede and Sheu, 2002).[41]	163	2.69%	5.324	1030.81
(Cruz-Rivera and Ertel, 2009).[42]	139	2.29%	5.646	923.79
(Klausner and Hendrickson, 2000).[43]	135	2.22%	3.724	637.74
(Lau and Wang, 2009).[44]	133	2.19%	6.371	980.34
(Jayaraman and Luo, 2007).[45]	132	2.17%	5.959	918.58
(Cardoso *et al.*, 2013).[46]	131	2.16%	4.213	682.90
(Alvarez-Gil *et al.*, 2007).[47]	111	1.83%	4.213	578.64
(Olorunniwo and Li, 2010).[48]	108	1.78%	6.371	796.06
(Barker and Zabinsky, 2011).[49]	106	1.75%	5.324	670.34
(Ramos *et al.*, 2014).[50]	105	1.73%	5.324	664.02
(Gonzalez-Torre *et al.*, 2010).[51]	103	1.70%	3.023	414.36
	2755	45.39%		

Source: Own elaboration based on information from the Web of Science (2000-2020).

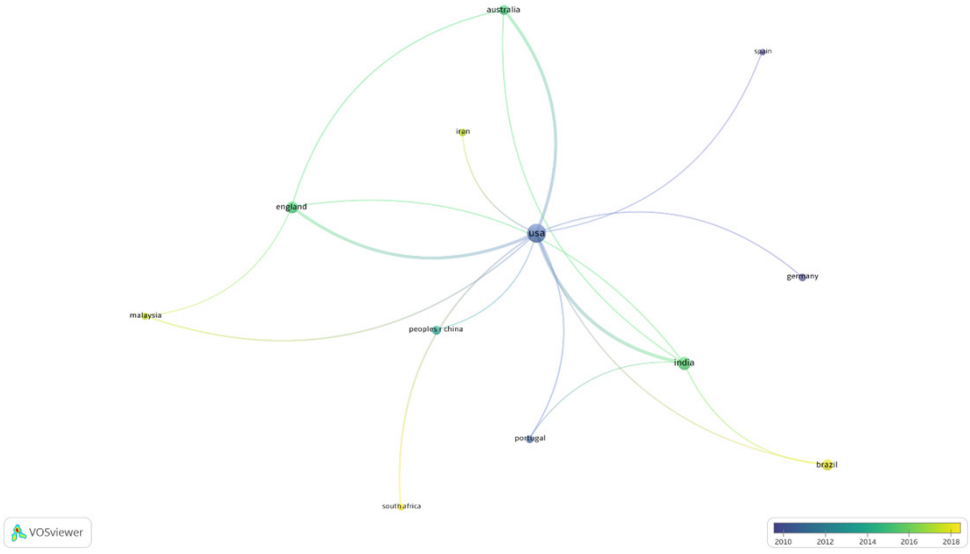

Figure 2: Countries involved in the topic of reverse logistics. Source: Own elaboration based on information from the Web of Science (2000-2020).

The data presented in Table 1, in comparison with Table 2, allow us to recognize the sources not only by the number of publications on the subject but also by the dissemination and impact achieved by these works. Moreover, with the AIF, the very expansion of the author's work is recognized by the citations already generated and the choice to publish in a certain journal. Figure 2 shows the 39 countries working on the topic of RL, represented by circles, where the size represents the activity and its impact with yellow being the color with the highest citation and the cognitive proximity between the elements with the position of the elements on the map influences their relationship. The country that stands out is the United States with 39 publications, followed by India

Table 3: Article production for the country.

America	%	Europe	%	Asia	%	Africa	%
USA	20.31	England	7.81	India	9.38	South Africa	2.60
Brazil	6.77	Australia	5.21	Peoples R China	4.69	Tunisia	0.52
Canada	1.56	Germany	3.65	Iran	3.65		
Mexico	0.52	Portugal	3.65	South Korea	1.56		
		Malaysia	3.13	Taiwan	1.56		
		Spain	2.60	Indonesia	1.04		
		Poland	2.08	Singapore	1.04		
		Turkey	2.08	Belarus	0.52		
		Denmark	1.56	Japan	0.52		
		France	1.56	Kuwait	0.52		
		Italy	1.56	New Zealand	0.52		
		Romania	1.56	Pakistan	0.52		
		Greece	1.04	Palestine	0.52		
		Netherlands	1.04	Thailand	0.52		
		Lithuania	0.52	U Arab Emirates	0.52		
		Serbia	0.52				
		Sweden	0.52				
		Switzerland	0.52				
Total	29.17		40.63		27.08%		3.13%

Source: Own elaboration based on information from the Web of Science (2000-2020).

Table 4: Production of articles per author (more than four publications).

Author	Country	Institution	Documents	Co-Dating
Hanna, Joe b	USA	Air Force Institute of Technology (AFIT).	7	287
Hazem, Benjamin	USA	Air Force Institute of Technology (AFIT).	7	287
Hall, Dianne	USA	Auburn University.	6	201
Glenn, Richey	USA	University of Alabama System.	5	228
Huscroft, Joseph	USA	North Carolina A and T State University.	4	134
Chileshe, Nicholas	Australia	University of South Australia	4	124
Rameezdeen, raufdeen	Australia	University of South Australia.	4	124
Hosseini, Reza	Australia	Deakin University.	4	124

Source: Own elaboration based on information from the Web of Science (2000-2020).

with 18, England with 15 and Brazil with 13 articles. These countries account for 57.43% of the production on the subject of reverse logistics.

According to the results above, the United States has the highest number of publications, where the author with the highest impact is Shad Dowlatshahi from the University of Missouri-Kansas City in the journal Interfaces with his paper *Developing a Theory of Reverse Logistics* with 334 citations where he lays the theoretical foundations of RL. On the other hand, the Indian author Ravi in co-authorship with Shankar, surpassed them with 391 citations in the journal Technological Forecasting and Social Change, with their work entitled *Analysis of Interactions among the Barriers of*

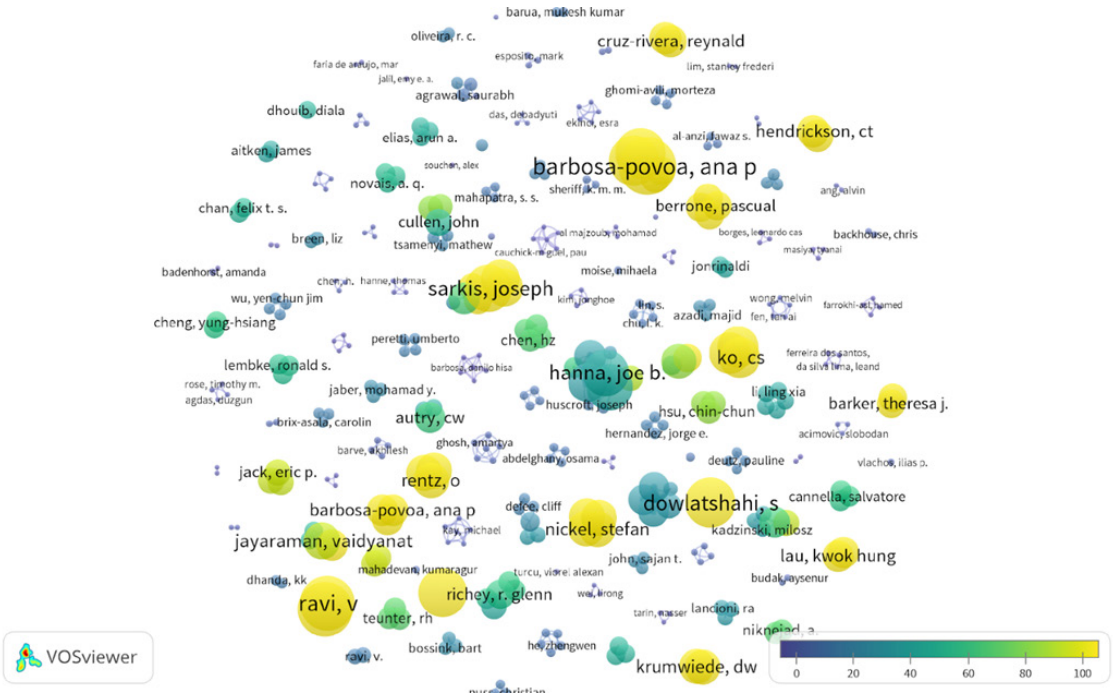

Figure 3: Countries involved in the topic of reverse logistics. Source: Own elaboration based on information from the Web of Science (2000-2023).

Reverse Logistics, in which they analyze the interaction among the major barriers, which hinder or prevent the application of reverse logistics in automobile industries.England has 15 publications and the authors with the highest impact are Michael Bernon and his co-authors Silvia Rossi and John Cullen with 79 citations for their paper entitled *Retail Reverse Logistics: a call and grounding framework for research*, published in the International Journal of Physical Distribution and Logistics Management, where they present a conceptual framework for the management of retail reverse logistics operations. Brazil has 13 articles and the article with the highest impact is collaboration between the American author's Dale Rogers and Ronald Lembke along with the Brazilian author Benjamin Melamed, where they report 53 citations with the article *Modeling and Analysis of Reverse Logistics* published in the Journal of Business Logistics. This article describes how modeling techniques can be used to improve the RL process and help solve real-world RL problems.The contextualization of the topic by continent is listed in Table 3, highlighting Europe with the highest scientific production on the topic of reverse logistics with 40.63%, followed by America with 29.17%. It should be noted that the countries work in co-authorship with other universities, institutions and researchers, as can be seen in Figures 2 and 4.

Table 4 shows the authors with a production of more than four articles. Eight researchers with 26 publications represent 17% of the production on the subject. On the other hand, Hall stands out for producing 6 articles and obtaining 201 citations; another author who stands out is Huscroft with five documents and 228 citations obtained by his co-authors and finally, the last team formed by the Australians Chileshe, Rameezden and Hosseini with four articles and 124 citations jointly. Two countries, the United States of America and Australia from the Air Force Institute of Technology and the University of South Australia respectively, have the highest number of articles per author.

The 378 authors make up 124 groups. Figure 3 shows the position of the authors according to the group to which they belong and in yellow color those who have more than 100 citations in the average citations.

The centralization map highlights four working groups (Figure 4). The most dominant cluster in terms of members is that of Joe Hanna, Benjamin Hazen, Dianne Hall and Joseph Huscroft, with 9 participants, with Michaels A. and Voordeckers W. as subgroups. The Minichilli A. cluster is formed by 11 members with Casey Cegiekski and Joseph Skipper as subgroups. Cluster 2 is led by Joseph Sarkis and has 7 members, with Marilyn Helms as a subgroup with a high impact on the topic.

Cluster 3 is led by Ana Paula Barbosa-Povoa, who has 5 members and has reports and papers with more than 100 citations. Also, in cluster 4 the authors Shankar and Ravi stand out, working together and with high citations of their published works. With the analysis of these four clusters, it is possible to identify the leaders in reverse logistics and their lines of research.

For the co-authorship analysis, the universities that were involved in the development of the subject were mapped. Five clusters are shown; the most important cluster is formed by Auburn University with 9 publications that work jointly with the United States Air Force. On the other hand, in Figure 5 universities are represented by colors as these universities work together. The red

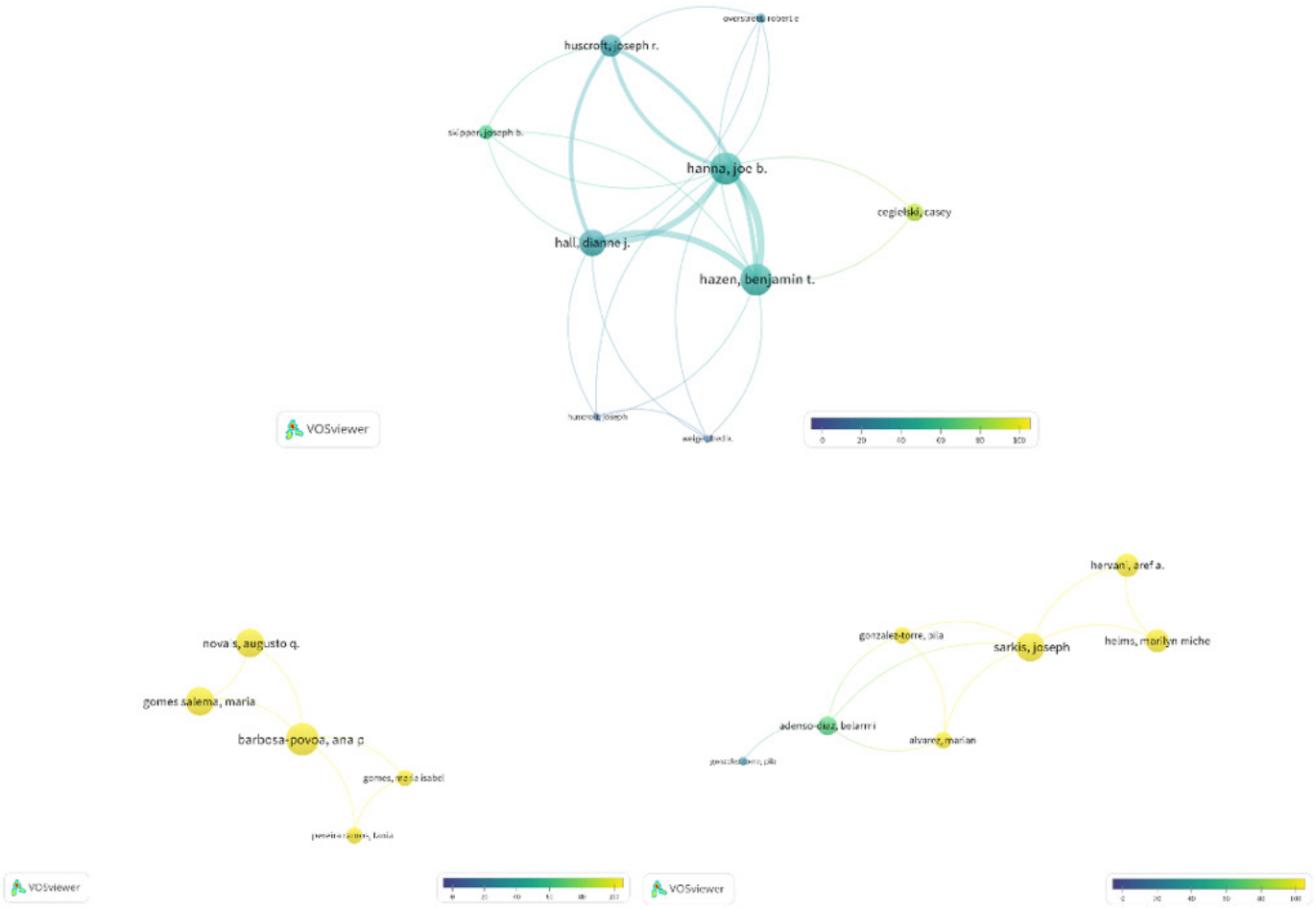

Figure 4: Centralization map of outstanding clusters with more quotes. Source: Own elaboration based on information from the Web of Science (2000-2020).

group is represented by the Air Force Institute of Technology (AFIT), Baylor University and the University of Tennessee. Cluster 3 is represented in blue color and is formed by Iowa State University of Technology (AFIT) and James Madison University to mention some of the universities.

The keyword co-occurrence network (Figure 6) was constructed to identify concepts associated with the topic of reverse logistics. A minimum number of three occurrences per keyword were assigned to build this network. A total of 711 words were detected for each of the 80 keywords and the total strength of the co-occurrence links with other keywords will be calculated. The keywords with the greatest total link strength will be selected and established by the Web of Science.

Six clusters were formed. The first cluster is formed by 23 items represented in red and is formed by the following: content analysis, demand, e-commerce, green logistics, integration, inventory control, localization, model, network design, optimization model, product returns, programs, quality, recovery, returns, reverse logistics network design, service, supply chain, supply chains, system, technology and uncertainty. The second clusters was formed by 17 items represented in green color and are the following: firm performance, formalization, impact, information, information technology, innovation, perspective, resource-based view, reverse logistics, supply chain integration, supply-chain management, sustainability and systems. Cluster three represented in blue color was formed by 15 items which were the following keywords: barriers, buildings, China, construction industry, deconstruction, distribution management, framework, issues, models, performance, perspectives, resource-based theory, South Australia, strategy and supply chain management. Cluster four was represented in yellow and was composed of 11 items, the following associations were found: green, logistics, network, operations management, optimization, product recovery, reverse logistics, transportation, vehicle-routing problem, waste and waste management. Cluster five in purple color and integrated by 10 items is associated with the following keywords: AHP, design, layout, methodology, networks, operations, opportunities, recycling, remanufacturing and selection. Finally, cluster six in light blue is associated with the following keywords: decision making, implementation, industry and management.

Table 5 shows the cluster by keywords related to reverse logistics: Model, Reverse Logistics, Supply Chain Management, Product

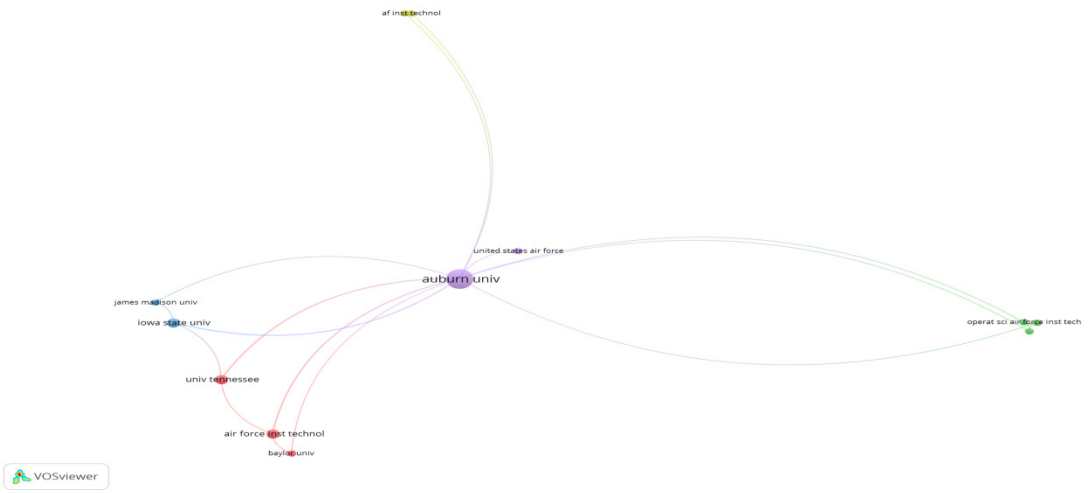

Figure 5: Universities involved in the topic. Source: Own elaboration based on information from the Web of Science (2000-2020).

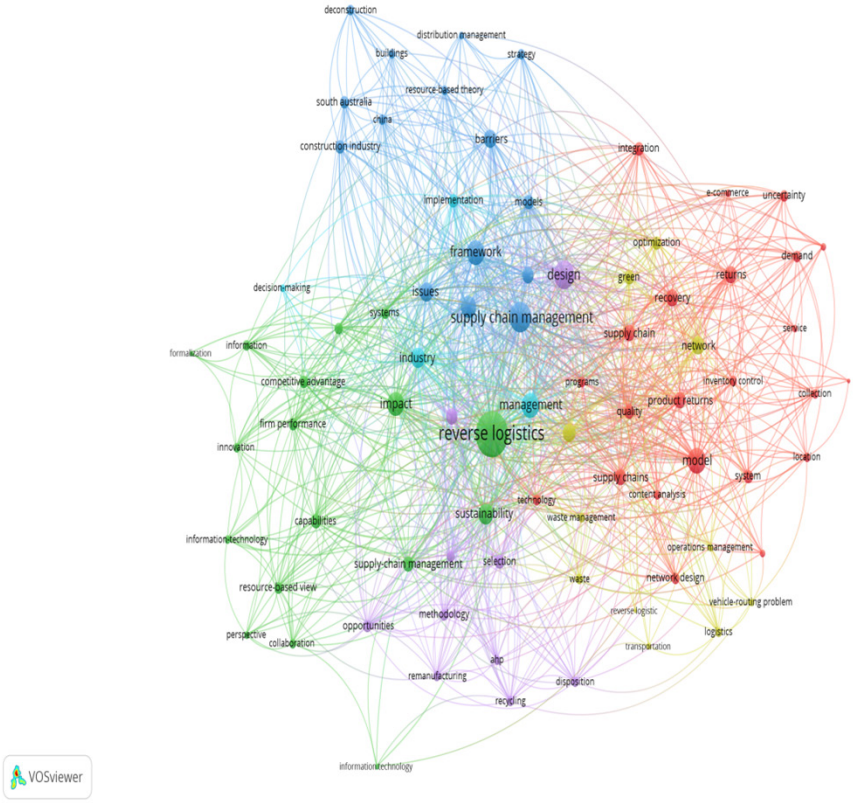

Figure 6: Co-occurrence network of keywords. Source: Own elaboration based on information from the Web of Science (2000-2020).

Recovery, Design and Management. Cluster two stands out for its highest number of occurrences with 476 and with link strength of 106. It integrates concepts such as sustainability, firm performance, competitive advantage, information technology and a resource-based view. It is followed by the clusters of supply chain management with 211, 150 occurrences, 33 and 28 links strength, respectively.

DISCUSSION

In the years before 2000, two scientific papers had been written in the business area and they are as follows: Reuse and Recycling-Reverse Logistics Opportunities Kopicki R, Berg, MJ Legg, L written by Poist[52] in a Book Review and the next was Quantitative Models for Reverse Logistics: A Review published in 1997 in the European Journal of operational research by

Table 5: Keywords Cluster.

Cluster	Weight Links	Weight Occurrences	Weight Total, link strength	Score Avg. pub. year	Score Avg. citations	Score Avg. norm. citations
Cluster 1 23 Items						
Model	49	150	28	2014.4286	54.8214	1.1975
Cluster 2 17 Items						
Reverse Logistics	76	476	106	2014.4095	37.0283	0.955
Cluster 3 15 Items						
Supply chain management	65	211	33	2014.8485	37.33	1.2401
Cluster 4 11 Items						
Product recovery	35	80	17	2011.1765	91.1765	1.3613
Cluster 5 10 Items						
Design	59	191	28	2014.7407	35.3929	0.9769
Cluster 6 6 Items						
Management	53	148	30	2013.7	63.3	1.225

Source: Own elaboration based on information from the Web of Science (2000-2023).

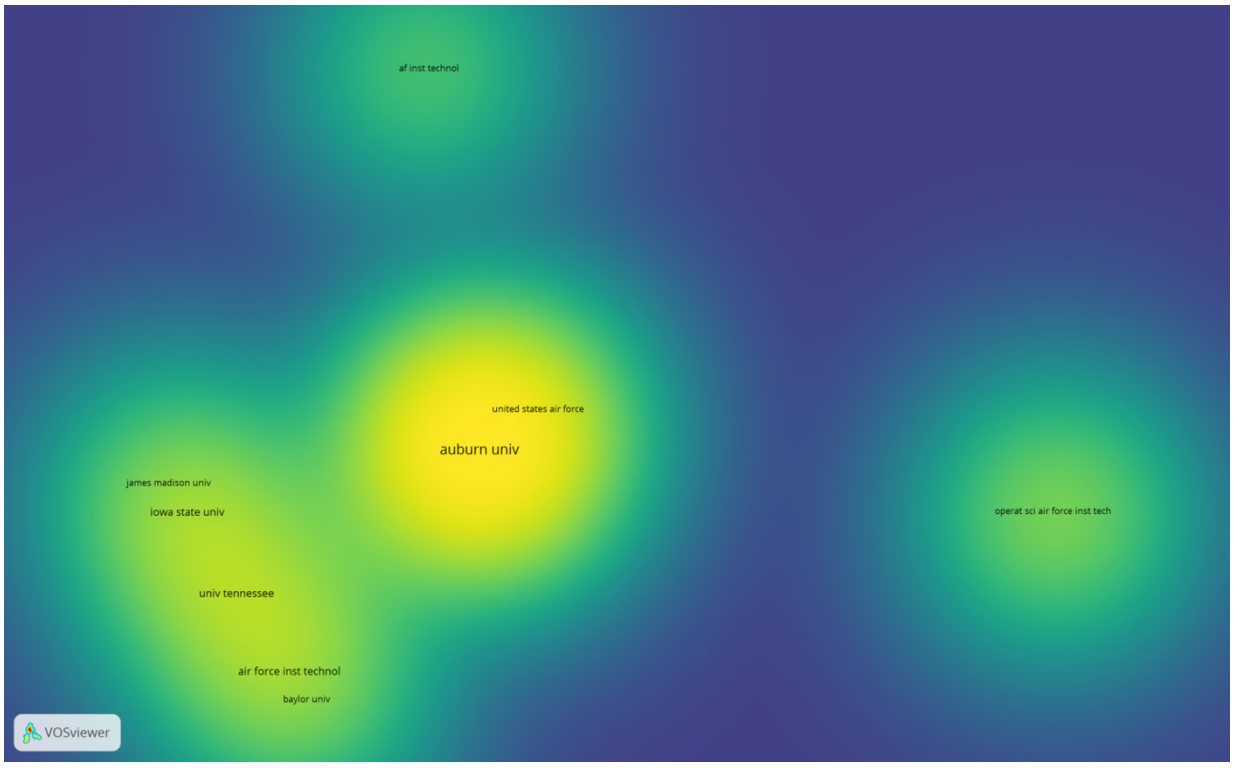

Figure 7: Universities involved in the topic. Source: Own elaboration based on information from the Web of Science (2000-2020).

Fleischmann *et al.*[53] and has received 1058 citations so far and is considered to be one of the pioneers in the field of RL, however, it was not considered because of the time frame of the study.

Taking into consideration the aforementioned, it is possible to affirm that the academy has developed 148 JCR level articles on the study of reverse logistics in the area of Management and Business during the period from 2000 to 2020. The bibliometric analysis indicates that the study of RL that has been developed by Dowlatshashi,[54] in his article entitled "Developing a Theory of Reverse Logistics", presented a conceptual level of the use of the theory of reverse logistics as a new concept within logistics. It has gained importance as a profitable and sustainable business strategy; the author delved into the strategic factors that include:

strategic costs, overall quality, customer service, environmental concerns and legislative concerns. On the other hand, the operational factors consist of cost-benefit analysis, transportation, warehousing, supply management, remanufacturing, recycling and packaging. (modified).

In the last ten years, the topic (Figure 1), has taken a greater interest, derived from its impact on performance, product recovery, management and its relationship with supply chain management. The production of articles (Figure 1), begins to stand out as an important area in 2015 with 11 articles and up to 19 in the year 2020, which is explained by the fact that there are new applications and relationships of the use of the theory of inverse logistics. However, a slight decrease in production can be observed in 2019. In the review of the articles published in the journals "International Journal of Logistics Management and International" and "Journal of Physical Distribution Logistics Management", they concentrate the largest number of researches on the subject. It was identified that they focus on green reverse logistics, the application of reverse logistics in industries, also on the impact of reverse logistics in supply chain management were the most studied topics for those years. The authors Ravi and Snakar, Dowlatshahi, Salema and Srivastava, continue to be the reference on the subject of reverse logistics (Table 2).

The authors Ravi and Shankar[55] analyze the interaction among the major barriers, which hinder or prevent the application of reverse logistics in automobile industries. In which they use the Interpretative Structural Modeling methodology to understand the mutual influences among the barriers, so that those driving barriers, which can aggravate a few more barriers and those independent barriers, which are most influenced by driving barriers are identified. On the other hand Dowlatshashi,[56] describes a holistic view of reverse logistics and distills 11 insights for successful implementation of reverse logistics from the existing literature and published case studies. For Salema *et al.*,[57] the design of a generic reverse logistics network where capacity limits, multi-product management and uncertainty on product demands and returns are considered.

Geographically (Table 3), the greatest production of investigations is concentrated in the United States. However, the authors with the largest number of articles are in European countries (England, Australia). In the last decade, the countries of Germany, Portugal and Belgium have joined. Latin American countries include Brazil (13 publications). Mexico has only one publication of Cruz-Rivera and Ertel,[58] with 139 quotes, in which they describe several features of establishing a closed-loop supply chain for the collection of End-of-Life Vehicles in Mexico. This is a wake-up call for research being conducted in the country since it is estimated that every day more organizations are applying for reverse logistics programs to obtain new forms of competitive advantage. Therefore, there is an area of opportunity for both academics and institutions to work on practical and theoretical studies that contribute to the knowledge of the subject in the Mexican context.

It was found that during the period studied (2000-2020) there are 124 working groups around the world (Figure 3) and the presence of four important groups of researchers working on the topic of reverse logistics was found and they are the ones with the highest number of citations (Figure 4). However, the authors with the highest production, Hanna, Hazen and Hall, have a lower citation rate than other working groups such as the one led by Barbosa-Povoa and the one led by Shankar and Ravi. (modified).

On the other hand, the collaborative work among the universities can be observed in four large groups grouped by the density map (Figure 7) and are specifically classified by color (Figure 5), this shows how the groups of researchers are working.

Of the six clusters constructed from the co-occurrence of keywords, "reverse logistics" stands out (Table 5). Since organizations are constantly seeking to improve firm performance and gain a competitive advantage, more and more organizations are doing so by implementing reverse logistics strategies.

Another finding of this work is the division of the database analyzed into four periods with a space of five years each; it can be seen how during the first cut from the year 2000 to 2005, the publications were mainly focused on RL and formalization, with transportation and management. This is explained because these issues were addressed more specifically inside of organizations. In the second cut of data, from the period 2006 to 2010, we found the following associations RL, Product Recovery, Management and Models. Also, the words Performance and Supply Chain Management were grouped. Here we can see that now the research is beginning to model with some quantitative techniques and now also addresses the performance linked to the management of the supply chain. In the third data cut from 2011 to 2015, we see three subgroups, where we observe that the sustainability issue became important, as well as the return of goods and the formation of an adequate framework. For the fourth period from 2016 to 2020, we found three subgroups; here we found findings such as remanufacturing, barriers, network, model and integration connected with the frameworks.

We found 148 publications on the subject of RL that address different aspects such as competitive advantage, firm performance and implementations in sectors such as construction, as well as sustainability. The study of new methodologies and strategies to improve inventory control systems, demand and supply, trying to control uncertainty both in the transportation and management of waste and returns by the end-user.

Another bibliometric paper is Kazemi *et al.*,[59] who study a combination between Reverse Logistics and Closed-Loop Supply Chain Management are universally recognized as two environmentally friendly practices that could help in greening

conventional supply chains, this paper presents a comprehensive bibliometric and content analysis of 94 studies that were published in IJPR from 2000 to July 2017. In the same vein, we find the work of Bensalem and Kin,[60] that focuses on a theoretical framework of related and often vaguely studied fields such as Supply Chain Management (SCM) a theoretical framework of related and often ambiguously studied fields such Supply Chain Management (SCM), Green Supply Chain Management (GSCM), Closed-Loop Supply Chain Management (CLSCM) and Sustainable Supply Chain Management (SSCM) and implemented it from 1992 to 2017. Consequently, we consider that our proposal helps to update all that was done by the authors previously.

Also, in Qaiser *et al*,[61] work was reviewed, where the topic of sustainable logistics was analyzed with a total of 40 articles found from 1994 to 2015, which were examined along the dimensions of publication trend, geographic distribution and collaboration, the most influential journals, affiliations and authors, as well as the key themes of the literature, we consider this review important and believe that our proposal contributes to increasing knowledge on related topics.

It is suggested for future research to find new relationships and lines of research that have a close relationship between reverse logistics and innovation in organizations.

CONCLUSION

The main purpose of this research is to describe and analyze, through a bibliometric study and a documentary analysis, how the scientific production of reverse logistics has evolved quantitatively using the Web of Science database for the period 2000-to 2020. (modified).

The principal limitation was that only the web of science was analyzed. Only the articles that were on the web of science could be downloaded if they were suitable for the parameters established for the research. For further research, it is important to analyze several databases and to contemplate using toher tools and methodologies in the analysis.

The benefits of reverse logistics programs include the following:

-Increase competitiveness and improve the profitability of companies to face the challenge of globalization and thus achieve sustainable competitive advantages.

-Improve the company's image and public opinion, positioning the organization in a better way than its main competitors.

-To optimize the national and international commercial administration where the international opportunities are visualized. To commercialize all those products that have been returned for some and to reiterate reasons already expressed previously.

-Optimal coordination of all the factors that influence the purchasing decision: quality, reliability, price, packaging, distribution, protection and service.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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