International Journal of Structural Civil Engineering and Management
Volume 2, Issue 01, 2026

A bibliometric and content analytic assessment of works published in IJPR on closed loop supply chain management and reverse logistics

Mohanlal Modak and Kalall

Research Article
Received: 27-12-2025 Revised:02-01-2025 Accepted:10-01-2026 Published:25-01-2026

ABSTRACT

Everybody knows that RL&CLSCM, or reverse logistics and closed loop supply chain management, are two eco-friendly methods that might make traditional supply chains greener. Numerous articles have emerged in the literature as a result of the growing popularity of these study areas. While several publications have helped push the discipline forward, the International Journal of Production Research (IJPR) stands out among them. In honour of the 55th anniversary of the IJPR, this review research seeks to examine the RL&CLSCM-related articles published in the journal. From 2000–2017, 94 research were published in IJPR, and this study gives a comprehensive bibliometric and content analysis of all of them. Bibliometric and mapping analyses were conducted on the studies to determine their features. We then looked closely at the sample papers to see what they included. After the publications were rigorously identified, they were grouped into two primary groups and subcategories based on the content analysis. Several research gaps that need to be addressed in IJPR were revealed by the bibliometric and content analysis.

Keywords: review; bibliometric; reverse logistics; closed loop supply chain management; IJPR

1. Introduction
2. Almost everyone now knows that our planet has finite resources and that we can't keep wasting them as we used to. Giri, Chakraborty, and Maiti (2017), Guide, Harrison, and Van Wassenhove (2003), Heydari, Govindan, and Jafari (2017), Lee, Wang, and Chen (2017), and Pedram et al. (2017) all state that most Supply Chain (SC) processes are no longer the traditional forward flows that concentrate only on production and distribution to end users. In contrast, accounting for End-of-Life (EOL) items is gaining greater attention and responsibility for environmental protection (Pauliuk et al. 2017; Govindan and Soleimani 2017; Campos et al. 2017). Since the Reverse Logistics (RL) of goods is now being considered, companies are adopting a wider view of SCs, rather than only concentrating on the forward flow (Batarfi, Jaber, and Aljazzar 2017; Zheng et al. 2017). Research by Luthra et al. (2017), Pal and Pal (2017), and Wang et al. (2017) shows that by incorporating RL into traditional SC, resource value may be maximised and waste reduced. Additionally, enterprises can benefit from material recovery, which increases their profit margin.

Over time, RL has been refined and defined in a way that everyone can agree on (De Brito and Dekker 2003). The REVLOG definition, put forward by the European Working Group on Reverse Logistics, seems to be one of the most comprehensive. They came up with the term "RL" to describe "the process of planning, implementing and control-ling backwards flows of raw materials, in process inventory, packaging and finished goods, from a manufacturing, distri-bution or use point to a point of recovery or proper disposal" (Rubio, Chamorro, and Miranda 2008). Dekker et al. (2013) and Dyckhoff, Lackes, and Reese (2013) suggest that producers may incentivize retailers to collect and return unwanted items via take-back programmes. This would generate a reverse flow in SCs. To illustrate the point, in 2014, Dell was one of the pioneers in the business world to launch a take-back scheme; the year before, the firm had recycled 10% of the plastic it had used in production. New

computers were constructed using the recovered plastics. In lieu of cardboard boxes or pallets, many businesses now use reusable packaging or returnable transportation products. Glock and Kim (2015) and Kim, Glock, and Kwon (2014) found that using this style of packaging might induce purchasers to return the material to the manufacturer. The bulk of the existing research on RL management has been on product return techniques (Choi 2013; Choi, Li, and Xu 2013). The central hub of the Closed Loop Supply Chain (CLSC) is thought to be RL. According to Carraro-Gallego, Ponce-Cueto, and Dekker (2012), the CLSC incorporates RL into the conventional SC process, which takes into consideration the flow of products in both directions. Customers often employ this strategy when they return items due to defects, unmet needs, or obsolescence; CLSC then steps in to help. As part of CLSC, remanufacturing is included into SC, marking the beginning of the second life-cycle of the product. In this process, returned items are restored to a new condition in order to be resold. Remanufacturing may involve disassembly, replacing worn or broken parts or components, fixing defective parts or components, or repackaging for sale as a remanufactured product; the specific process depends on the product type and the nature of the fault (Abbey and Guide 2017). Figure 1 displays many critical steps in a CLSC.

According to Kleindorfer, Singhal, and Wassenhove (2005), CLSC is a key component in attaining sustainable operations and is therefore undeniably a major sustainability driver. Because of its pioneering role in reducing the negative impacts of operational operations, CLSC has valued substantially (Das and Dutta 2015; San and Pujawan 2012). With CLSC, we can reduce the amount of primary materials that go into landfills, which is great since landfills throughout the world are already overflowing with metals, plastics, and non-biodegradable trash. The use of secondary resources in production is often more eco-friendly than primary materials since it reduces energy consumption and the emissions of harmful gases (Lapkin, Joyce, and Crittenden 2004; Reh 2006).
The implementation of more stringent government laws globally is another reason that has accelerated the adoption of CLSC efforts, in addition to the environmental and industrial benefits of CLSC tactics. For example, in 2002, the European Union (EU) began implementing the Waste Electrical and Electronic Equipment Directive (WEEE Directive), which states that manufacturers of electronic items are liable for collecting and recycling end-of-life (EOL) equipment inside the EU. After the European Union instituted such a policy for electrical and comparable items, over twenty other nations followed suit. Gu et al. (2016) and Pathak and Srivastava (2017) state that the regulations require businesses to be responsible for collecting and recycling electronic trash.
Agreeing with governments, RL&CLSCM adaptability has begun to be better realised by businesses, academic researchers, and non-governmental organisations (NGOs). Countless articles in the same field have evolved from this endeavour.

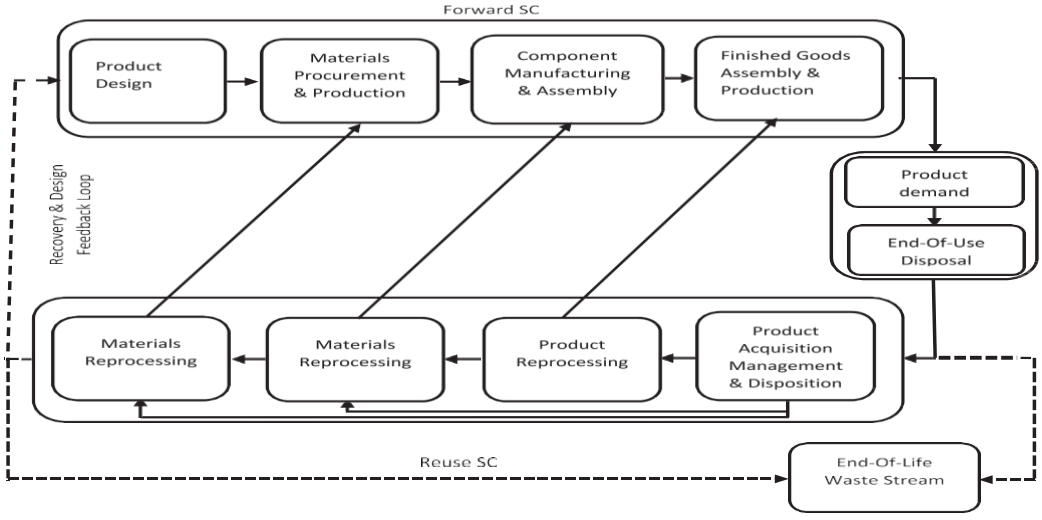


Figure 1. Fundamental processes of a CLSC (Abbey and Guide 2017).

domain of RL&CLSCM, which has elevated it to the status of a major study subject in the field of operations management (Govin-dan, Soleimani, and Kannan 2015). Research works in the domain of RL&CLSCM have been published in many publications so far (see Section 3), and it is evident that major journals like IJPR have played a significant role in advancing this topic. The impact of related publications must be included in any effort to monitor a field's development (Govindan and Soleimani 2017). According to Schlaegger, Gibassier, and Zvezdov (2013), academic journals serve as a representation of the scientific community's thematic interests and a platform for publishing key research results. When it comes to publishing research articles that are pertinent to RL&CLSCM, IJPR has been at the forefront from the beginning. The bibliometric study that is given in Section 3 emphasises the excellent contribution of IJPR. Based on the data shown here, IJPR ranks as the number two most influential journal in this area as of July 2017. We set out to shed light on the contributions of IJPR to the field by doing this bibliometric analysis and systematic review, which was motivated by this fact. Reviewing the articles published in a single publication is a novel approach to literature review, according to Govindan and Soleimani (2017). For example, Govindan, Soleimani, and Kannan (2015) are among the literature reviews on RL&CLSCM that have been published. However, out of all the reviews, only Govindan and Soleimani (2017) concentrated on a single publication. Since no prior review has been conducted specifically for the purpose of summarising the articles published in IJPR that pertain to RL&CLSCM, this research will fill that need. Readers, the journal's editorial board, and researchers in the area may all anticipate a number of advantages from this study. For example, in terms of the journal's audience, this research may provide light on the trajectory of the publication from its inception and the kinds of papers that have been accepted up to this point. Regarding the advantage for the Editorial Board, they may examine the kind of research that have not been well covered by the magazine and either create new rules or change current ones. In addition, scholars interested in submitting their future work to IJPR might benefit from a detailed template detailing the kind of studies that have been approved and the gaps in the journal's coverage. An outline of the RL&CLSC literature is provided in the next portion of the study. down Section 3, we provide a bibliometric analysis of the RL&CLSCM literature, and then we zero down on research published in IJPR. In Section 4, the substance of the sample articles published in IJPR in the domain of RL&CLSCM is examined. Section 5 lays up the groundwork for any future studies. An large bibliography is presented, and the study finishes in Section 6.

review of relevant literature

Review articles are valuable for the advancement of any scientific discipline since they provide original ideas and synthesis (Machi and McEvoy 2012). Quickly familiarising yourself with difficulties and learning about the significant contributions to any study subject may be achieved via review studies (Creswell 2013). Numerous research that survey the literature on RL&CLSCM have proliferated in the last few decades, attesting to the field's enduring relevance. Table A1 in Appendix 1 provides a

summary of the most significant reviews published since 1997. The number of publications examined, the region of coverage, and the year are all broken out in Table A1. It should be mentioned that the chart only includes review studies that have a clear emphasis on one or both disciplines; we did not include articles that just partially cover the topic, such as those reviewing sustainable supply chain management or green supply chain practices. According to our research, narrative reviews predominate among the available literature. In contrast to systematic reviews, narrative reviews often do not adhere to any particular principles while searching for relevant literature and/or do not detail the methods used to compile the review's sample (Abedinnia et al. 2017). Consequently, it is challenging to replicate research results or determine whether study results are applicable to the whole field or just a subset of the literature due to the absence of a systematic methodology (Abedinnia, Glock, and Schneider 2017; Hochrein and Glock 2012). Some review articles, like those in the narrative literature review category, make it hard to tell how many studies were included or during what time period (Table A1). Half of the 35 review articles included in Table A1 provided clear information on the study's sample size and duration; most of these studies were systematic reviews. When Rubio, Chamorro, and Mir-anda (2008) reviewed the works published in the field of RL during a 20-year period, they were the first to publish a systematic review in the academic literature. Fleischmann et al. (1997), on the other hand, examined the quantitative models in RL literature and so began the review investigations. Prior to the publication of Guide and Van Wassenhove's (2009) study in 2009, all reviews in the RL area were published after their work. These writers explored the rise of CLSC in the literature and wrote the first review article on the subject. In addition, as can be shown from Table A1, most of the review studies focused on one of the disciplines, whereas just two research combined RL and CLSCM. Govindan, Soleimani, and Kannan (2015) provided a thorough overview of the whole subject of RL&CLSCM, making it the first research to combine the domains. Considering how recently it was published, academics have given this review positive feedback. Second, a more recent evaluation focused on articles published in the Journal of Cleaner Production (JCP) by Govindan and Soleimani (2017). After sorting and analysing the content of the articles published in JCP between 2001 and 2014, the authors performed a systematic review. For the reasons mentioned above, our evaluation is developed especially for IJPR and follows the work of Govindan and Soleimani (2017). As the second research to focus on a single publication, this review adds to the growing body of work reviewing the literature on RL and CLSCM.

4. Scientific procedures

We searched and classified the corpus of literature in this research using bibliometric analysis and a systematic review. The findings of a systematic literature review are presented in a transparent, objective, and repeatable manner, and the reviews are conducted in an organised manner (Abedinnia et al. 2017; Fahimnia, Sarkis, and Davarzani 2015). (Hochrein and Glock 2012). Following a four-step methodology proposed by Mayring (2010), this paper follows the most recent reviews (i.e., Abedinnia, Glock, and Schneider 2017; Abedinnia et al. 2017; Marasco 2008; Shekarian et al. 2017) in collecting materials, analysing them descriptively (bibliometrically), and then evaluating them. Cooper (2015) and Mayring (2010) lay out the steps to follow when doing a literature review using a multi-stage technique. Here we detail the procedures used to locate and evaluate the research.

Section 4.1: Gathering Materials

To set the stage for our evaluation of the articles in IJPR, we will first provide a quantitative review of the RL&CLSCM literature. The articles published in IJPR will thereafter be the focus of our search. In the first stage of the search process, we looked through Scopus (http://www.scopus.com) and Web of Science (https://webofknowledge.com) to find the relevant statistical data for bibliometric analysis. Table 1 displays the details and outcomes of the literature search, which serves as the review process.

4.2 A review of the literature on RL&CLSC

Quantitative analysis of a research area is the goal of bibliometric study and scientometric research, which aims to provide light on the evolution of a discipline (Apriliyanti and Alon 2017; Broadus 1987; Feng, Zhu, and Lai 2017; Merigó and Yang 2017; Zupic and Čater 2015). To that end, this article presents the results of a bibliometric analysis that identifies the knowledge structure and development of the research area in IJPR using quantitative methodologies and network maps. See, for example, Akhavan et al. (2016), Charvet, Cooper, and Gardner (2008), Laengle et al. 2017a, Merigó et al. 2017, Podsakoff et al. (2008), and Wang et al. (2017) for a list of papers that follow the same format as this paper's bibliometric analysis. The search parameters outlined in Section 3.1 were used, leading to the discovery of 2566 publications. In Figure 2, we can see how the publications have been distributed over the years. Although some papers did exist before 1995, they are not reflected in this chart. RL&CLSCM has a negligible impact on the number of scholarly publications published before 2000. Despite having

Table 1. Review protocol.

Refine criteria	Description	Result
Inclusion criteria	Document type: journal articles (excluded conference papers, chapter books, books, editorial, notes, short survey, letter and erratum); Language: English; Search time: 1995 to July 2017	
Defined keywords	'Reverse Logistics' AND/OR 'Closed Loop Supply Chain Management'	
Database search	Papers containing at least one keyword from the defined keywords above were included	3076
	Some papers were found to be irrelevant by going through their title, abstract and keywords	352
Snowball approach	Finding additional papers by subjecting the references of the first sample to manual analysis	91
	Refining irrelevant or duplicated papers	84
Content analysis	Analysing the papers comprehensively in terms of their focus and content to ensure their relevance to this review. Irrelevant papers are excluded	166
Final sample	The final sample was carefully examined to categorise and summarise the contribution of the papers	2566

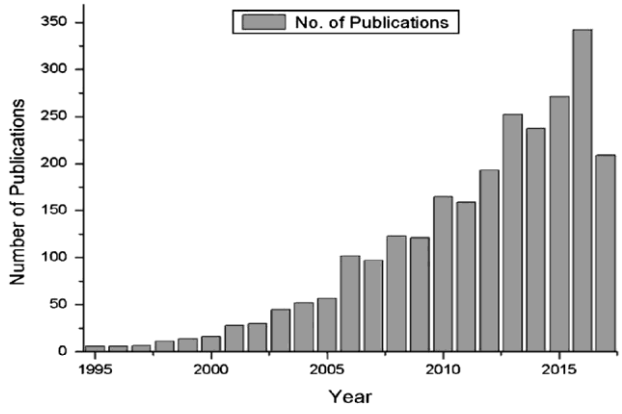


Figure 2. Year-wise publications on RL&CLSCM from 1995 to July 2017.
Note: It is necessary to note that the papers related to 2017 are shown as of July. Therefore, the bar does not show the entire selection of papers published in this year.

Before 2005, there were less than 100 publications annually in the discipline; however, 2006 is considered the year when substantial scholarship first appeared. Taking this general tendency into account, the number of publications skyrockets, following an almost geometric growth pattern that peaked in 2016. Also, the area has become increasingly popular with scholars lately, because around 80% of the articles were published in the last decade. The special issues published in some journals in the relevant years are responsible for the rather slight oscillations in the number of publications, according to a subsequent investigation. According to the numbers, 161 journals have published papers in this area, with the top 20 journals accounting for almost 34% of all publications in this topic. The 20 main journals that published field papers (as of July 2017) are ranked in Table 2. The most influential journals for RL&CLSCM research are JCP, International Journal of Production Economics (IJPE), and International Journal of Production Research (IJPR), as shown in Table 1. An integral part of every scientific field are authors. According to the study conducted by Cole and Cole (1972), scientific fields are making progress only due to the efforts of a small group of researchers. Data is taken from Scopus using the frequency-based indexing system in order to assess the field's writers' contributions.

Table 2. Top 20 journals and authors on RL&CLSC based on the search results.

No	Journal	NP	Author	NP
1	International Journal of Production Economics	117	Govindan, K.	29
2	International Journal of Production Research	98	Van Wassenhove, L.N.	21
3	Journal of Cleaner Production	80	Guide, V.D.R.	18
4	European Journal of Operational Research	63	Tavakkoli-Moghaddam, R.	16
5	Computer Integrated Manufacturing Systems	54	Adenso-Díaz, B.	15
6	International Journal of Logistics Systems and Management	48	Gupta, S.M.	14
7	Computers and Industrial Engineering	46	Hazen, B.T.	14
8	Resources, Conservation and Recycling	44	Sarkis, J.	14
9	International Journal of Advanced Manufacturing Technology	35	Barbosa-Povoa, A.P.	12
10	International Journal of Physical Distribution and Logistics Management	32	Diabat, A.	12
11	Transportation Research Part E Logistics and Transportation Review	32	Jaber, M.Y.	12
12	System Engineering – Theory and Practice	28	Kumar, S.	12
13	Computers and Operations Research	26	Da, Q.	11
14	Journal of Manufacturing Systems	25	Georgiadis, P.	11
15	Production and Operations Management	25	Krikke, H.	11
16	Supply Chain Management	25	Shankar, R.	11
17	Applied Mathematical Modelling	23	Soleimani, H.	11
18	Kongzhi yu Juece/Control And Decision	23	Vlachos, D.	11
19	Espacios	20	Chan, F.T.S.	10
20	Expert Systems with Applications	19	Jayaraman, V.	10

Abbreviations: NP = Number of Publications.

quency of the appearance of author's name. Table 2 further analyses the field based on the influence of authors. As the Table reveals, K. Govindan, L.N. Van Wassenhove, and V.D.R. Guide reside at the top of the list of the main contribu-tors to the field. A closer analysis on the authors indicates that all of them have a research background in Industrial Engineering and Operations Management. The research profile of the majority of the authors, such as R. Tavakkoli-Moghaddam and M.Y. Jaber, illustrate that a high percentage of the authors mostly tend to work on analytical and theo-retical models, while only a few authors such as K. Govindan, V.D.R. Guide, and J. Sarkis conducted both theoretical and empirical studies (see Taticchi et al. 2015).

2.1 *Bibliometric analysis of RL&CLSCM studies based on publications in IJPR*

This part of study will limit the focus on the studies in IJPR and present a bibliometric analysis of the studies. The same procedure as in Section 3.1 was followed to find the relevant papers published in IJPR. Scopus and WOS databases were searched for papers with the settings specified in Section 3.1, with the exception that the source title was only lim-ited to IJPR. In an initial search phase, 98 papers were found that were further checked to examine their relevance to the field of RL&CLSCM. Four papers were found irrelevant based on their content, and thus were eliminated from the sample. Hence, 94 papers were identified and included in the analysis that constitutes almost 4% of the total papers pub-lished in the field. Figure 3 shows the distribution of the publications over the years. The journal's first paper was pub-lished in 2000, which is almost one decade after the first publication appeared in the field. Over the 17-year period, the number of papers published each year varies from 0 to 21. Interestingly, no paper was published in years 2002 and 2004, which may be due to a delay in the peer-review process and the publication schedule of the journal. The highest number of publications over the 17-year period belongs to 2012 with 21 publications. A closer look at the issues pub-lished during this year discloses that IJPR published one special issue on 'Sustainable supply chain management and reverse logistics', which is why the number of publications stood far higher in this year than others. If we overlook the data from 2012, the general trend is still on the rise, indicating that RL&CLSCM is becoming a popular topic for sub-mission in IJPR. This finding is in line with the popularity of the field among researchers.

A further bibliometric analysis was performed on the publications. The contribution of the authors and their coun-tries were analysed to gain additional insights. Table 3 shows the contribution of the authors to IJPR based on the num-ber of published papers. It should be noted that we cite only authors with a minimum of two papers; a significant number of authors had only one paper published in the journal. F.T.S. Chan, S. Dowlatshahi, T. Paksoy, and E. Özcey-lan lead the list with five or four papers. However, none of the leading authors in the field as showed in Table 2 are among the top authors published in IJPR, except for L.N. Van Wassenhove, with three papers.

In this part, the evolution of the RL&CLSCM in IJPR was assessed with respect to geographical hotspots and affili-ations of the authors. For this purpose, the country/territory part of the search result, as well as the affiliation of the authors, was extracted from Scopus and summarised in Table 3. In terms of the contribution of countries, authors from the United States, China and India display the highest number of contributions to the journal. If we assign the countries to their corresponding continent, from North America two countries (US and Canada), from Asia five countries (China,

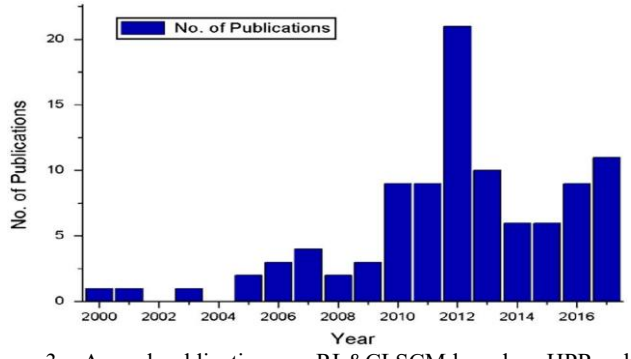


Figure 3. Annual publications on RL&CLSCM based on IJPR publications.

Table 3. Top 10 Contributing Countries, Universities/institutions, and Authors in publication of RL&CLSCM research in IJPR.

No.	Country	NP	Universities/Institutions	NP	Authors	NP
1	United States	25	Erasmus University Rotterdam	6	Chan, F.T.S.	5
2	China	11	Hong Kong Polytechnic University	5	Dowlatshahi, S.	4
3	India	10	University of Missouri-Kansas City	4	Paksoy, T.	4
4	Turkey	8	University of Windsor	4	Özceylan, E.	4
5	Hong Kong	7	SelcukUniversitesi	4	Jayaraman, V.	3
6	United Kingdom	7	INSEAD Europe	3	Van Wassenhove, L.N.	3
7	Canada	6	Central South University China	3	Yuan, K.F.	3
8	Germany	6	Chongqing University	3	Cai, X.	2
9	Netherlands	6	Huazhong University of Science and Technology	3	Chan, H.K.	2
10	Iran	5	Guizhou University of Finance and Economics	2	Gao, Y.	2

India, Turkey, Hong Kong and Iran), and from Europe three countries (UK, Germany and Netherlands) contributed arti-cles in the journal.

It is clear that authors from Asian countries have been more successful in publishing, while there is no author from Africa and Australia among the top 10 contributed countries to the journal. Looking into the 'filter by country/territory' section in Scopus reveals that no author from African countries has contributed so far, while only one author from Aus-tralia is represented in the list. Table 3 also ranks the universities/institutions according to the number of papers they published in IJPR. In contrast to the ranking with respect to countries, the university with the highest number of publi-cations is from Europe, followed by two universities from Asia and the US.

The next area of focus is the citation structure of the studies. Reviewing the citations of a research work is important since it is the benchmark that represents how often a study is referred and discussed in other scientific studies, and therefore how much is its impact on the field (Schaltegger, Gibassier, and Zvezdov 2013). To calculate this benchmark, the total citation structure of the sample papers was extracted from Scopus as of July 2017. Figure 4 depicts the information retrieved. It appears from the figure that the studies in the area of RL&CLSCM have received increasing citations over the years. The citations overview suggests that the journal has been able to maintain good quality for publications in this area of RL&CLSCM. Next, we analysed the most influential studies according to number of citations received. Different approaches have been applied to measure the significance of a paper. The most prevalent approach is counting the number of citations a paper receives. For instance, Ding et al. (2009) pointed out that citations is a tool that not only shows the popularity of a scientific work, but also indicates how prestigious a research work is. Accordingly, we used citation as a measure to illustrate the most important publications. Table 4 lists the 10 most cited papers collected from Scopus as of July 2017. In order to analyse the citation using a different database, citations from Google Scholar are provided as well. Generally, the citations trend shows that the papers published in IJPR have been well-received by the scientific community and they demonstrate a fairly intense level of discussion. Based on the data taken from Scopus, five papers have been cited more than 100 times. However, regarding the citation records of Google Scholar, all 10 papers have been cited more than 100 times. As we know, the number of citations in Scopus is typically

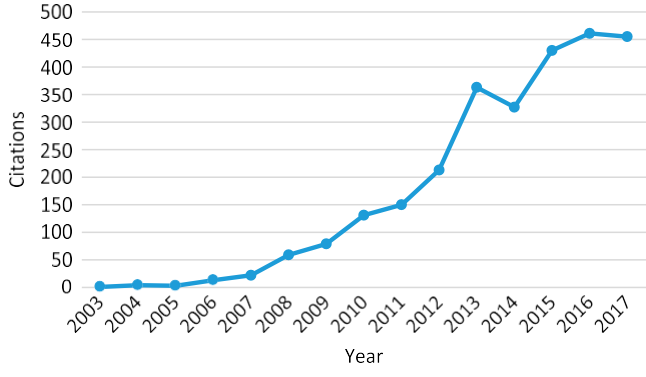


Figure 4. Citation overview of the studies over the years.

Table 4. The most cited publications in the area of RL&CLSCM published in IJPR (as of July 2017).

No.	Author (year)	Scopus	Google Scholar
1	Krikke, Bloemhof-Ruwaard, and Van Wassenhove (2003)	211	353
2	Rubio, Chamorro, and Miranda (2008)	136	275
3	Jayaraman (2006)	119	185
4	Dowlatshahi (2005)	112	224
5	Teunter, Bayindir, and Den Heuvel (2006)	104	165
6	Presley, Meade, and Sarkis (2007)	92	153
7	Akçalı and Cetinkaya (2011)	81	125
8	Daniel, Guide, and Jayaraman (2000)	79	155
9	Kannan, Noorul Haq, and Devika (2009)	77	116
10	Quariguasi Frota Neto et al. (2010)	72	125

indexed in fewer journals than Google Scholar, which is why it is inferior in quality. The chart shows that the most referenced papers were published between 2003 and 2009, which suggests that the quality of the articles published in this section of IJPR has improved over the years. Because it will take time for more recent articles to be acknowledged and thoroughly debated in the scientific community, the table does not include publications that came out after 2009. Bibliometric maps were created in this section of the research using VOSviewer software. These maps were utilised to analyse publication characteristics. According to Chang and Hsieh (2008) and Merigó and Yang (2017), VOSviewer is useful for visualising bibliometric data utilising bibliometric indicators. Because VOSviewer can directly use the Scopus data to generate network visualisation, we found it to be the superior software to alternatives such as Pajek, Citnetexplorer, Bibexcel, BibliometrixR, HistCite graph maker, and Gephi. This is in contrast to the limitations of the other software mentioned in previous studies (Chang and Hsieh 2008; Laengle et al. 2017b; Merigó and Yang 2017). Contrarily, VOSviewer is an intuitive programme that supplies bibliometric networks in a visual format.

There are a number of methods proposed for bibliometric network visualisation in bibliometric investigations. According to Van Eck and Waltman (2014), the most common types of maps are those that are based on distance, graphs, or timelines. According to Van Eck and Waltman (2014), VOSviewer is designed to assist in creating distance-based visualisations of bibliometric networks, as opposed to graph-based or timeline-based visualisations. Castillo-Vergara, Alvarez-Marin, and Placencio-Hidalgo (2018) and Van Eck and Waltman (2014) found that VOSviewer's ability to display bigger networks is a strong asset. According to Van Eck and Waltman (2010), in bibliometric networks that use distance as a measure of relatedness, the closer two nodes are to one another, the more closely they are considered. With VOSviewer, you may create a map using a co-occurrence matrix. To begin, the nodes' co-occurrence matrices are used to compute a similarity matrix. The second step is to construct a map using the VOS mapping method applied to the similarity matrix. The map may then be rotated, translated, and reflected. In their work, Van Eck and Waltman (2010) provide readers with extensive descriptions of the method of producing a map in VOSviewer. Figure 5 shows the results of the VOSviewer analysis of the sample studies according to the keywords. Excel Comma Separated Values Files created from the Scopus database were used to get the necessary data for Figure 5. The reference list that was acquired from Scopus was carefully cross-validated with the complete manuscript in the sample to ensure that it was error-free. Note that the authors' usage of keywords in the articles' titles, abstracts, and keywords was the basis for the analysis. Figure 5 shows the clustering of the terms, with different colours representing the various groupings. This figure displays not only the terms that were used in the articles, but also the frequency with which they occurred together. The co-occurrence rate is a measure of how often one term occurred alongside another. Figure 5 shows that the two most common clusters or keywords associated with RL&CLSCM are remanufacturing and recy-cling. Separately, Figure 5 shows which keywords have been most often used with RL and CLSCM. While RL is more often associated with inventory management, manufacturing, and game theory, CLSCM is more commonly employed with production planning, different evolution, genetic algorithms, optimisation, and multi-period.

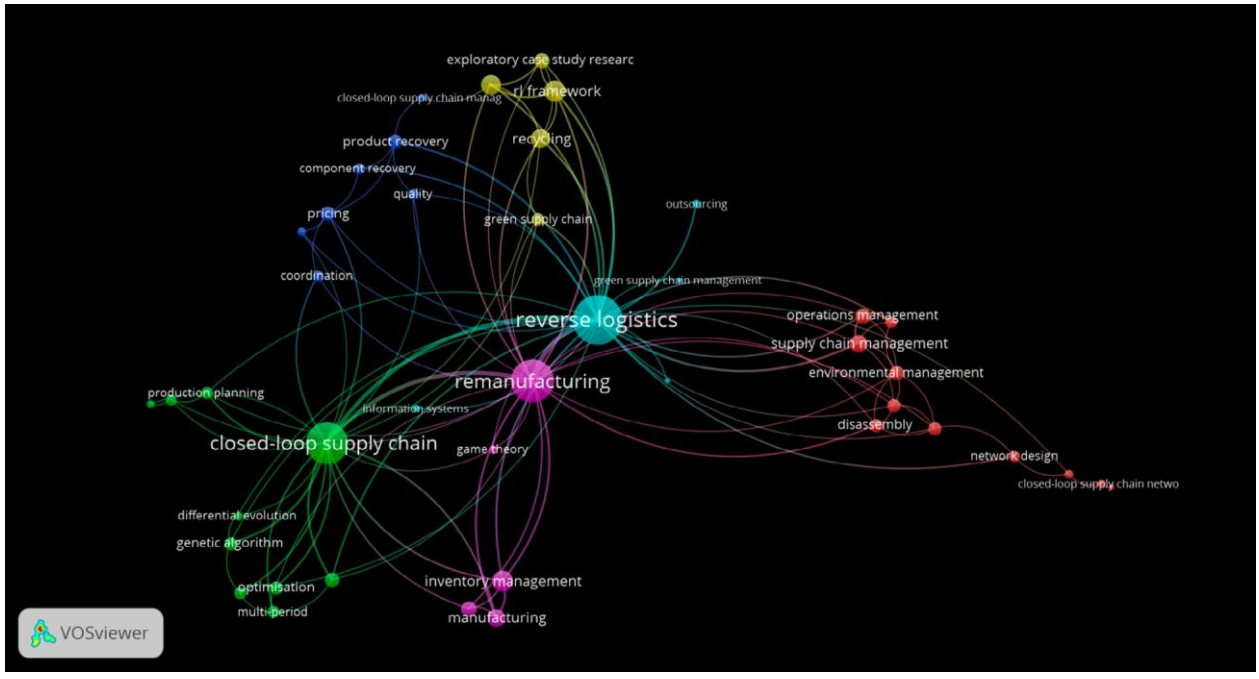


Figure 5. Co-occurrence of author-keywords used in the papers.

3. Content analysis

To explore the advancement of the studies, a content analysis of the sample papers was performed. Content analysis is a necessary step to recognise different topics that are covered by IJPR and to give a clear indication of the areas that require further scholarship. Content analysis is a methodology that can help in assessing a high volume of data in a structured and systematic approach. Both inductive and deductive approaches were adopted to categorise the papers into a set of groups so that they reflect the important characteristics of the studies and the contributions made. This ensures that the classification is trustworthy and thorough. The difference between inductive and deductive approaches lies in the method of deriving keywords and categories. In the deductive approach, keywords and categories are defined in advance before analysing the contents, whereas in the inductive approach they are identified by analysing the sample (Abedinnia et al. 2017; Shekarian et al. 2017). The deductive approach produced a set of 34 different keywords based on the previous review papers in the literature (see Table 2) representing the characteristics of RL&CLSCM. Then, the keywords were arranged into five main classes as: (1) Type of problem, (2) Objective, (3) The model's characteristics,
(4) Solution approaches, and (5) Case studies. Subsequently, using the inductive method, the contents of the sample papers were searched thoroughly to identify the theoretical foundations and keywords of the studies. In this stage, 12 extra keywords were derived, which were not in the original set of keywords identified from the deductive stage. In addition, the two sets of keywords were examined and compared in a number of stages based on sample papers in order to highlight similarities and differences among keywords. In this stage, the two keyword sets were compared, which revealed that some of the keywords that were defined in deductive approach were not frequently used in the sample paper. This subsequently led to the removal of some keywords. The remaining keywords were combined to form the new set of keywords. Subsequently, 42 keywords were categorised into seven main groups which will be discussed in the following. In order to analyse the sample papers better, a database from the sample was created in an Excel file to facilitate classification of the sample.

3.1 *Result of the content analysis*

Figure 6 shows the classifications of the papers based on keyword categories and the percentage that each category makes up. The sectors shown in Figure 6 can be classified in two general categories: mathematical and non-mathemati-cal models. Generally, mathematical models make up 80% of the total papers published, and 20% are built on non-mathematical models. The mathematical models can be further divided into the following categories: (1) Inventory

and

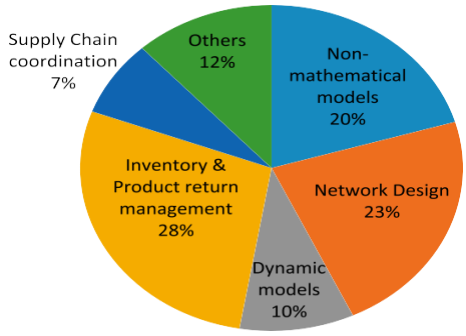


Figure 6. Classification of Publications Regarding their Main Focus.

Product Return Management, (2) Network Design, (3) System Dynamics, (4) Supply Chain Coordination and others. As to the mathematical models, IJPR showed more interest into publishing the first two topics (Inventory and Product Return Management and Network Design). Nonetheless, the journal covered fewer topics about dynamic models and Supply Chain coordination. Generally, two categories, Inventory and Product Return Management and Network Design, constitute almost half of the total papers and 60% of all mathematical models published in IJPR. Supply Chain Coordi-nation is the smallest class in the sample, with only 7% of papers belonging to this category. In the Appendix (Tables A2–A4 in Appendix 1), we looked into Figure 6 with more detail and we classified the studies according to the cate-gories outlined in Figure 6. In what follows, the characteristics of the sample papers are discussed with more details.

Inventory and Product Return Management: This category, the most popular category among the mathematical mod-els, investigates managing inventories at different levels in RL&CLSCM as well as collecting the used products from the market; both actions integrate the process of the return flow back to the manufacturer or remanufacturer. Some mod-els considered both aspects concurrently in their study, whereas the other ones studied them separately. The observation revealed that the studies which took Inventory and Product Return Management decisions simultaneously into account mostly formulated their problem in a multi-layer supply chain with multiple facilities.

Network Design: This type of model typically studied the design of a RL&CLSCM network with the aim to suggest an optimal system that collects used, refurbished, or defective products from market and processes their recovery activi-ties efficiently. Authors tried to incorporate different tactical and strategic decision variables into their models (i.e. capacity of facilities, number of items supplied by facilities, quantity of items shipped between facilities, and price decisions).

Dynamic Models: These studies looked at RL&CLSCM models from the aspect that some of the planning parame-ters (i.e. product return rate, demand) are dynamic and could vary over time.

Supply Chain Coordination: The models that fall within this category tried to address the issue of aligning the objec-tives and functions of individual companies to improve their performance (for instance, reducing costs or increasing profit). In the papers published in this line of research, authors tried to study the issue of CLSC coordination under dif-ferent power structures and/or channels (Stackelberg game, Nash game), channel coordination (centralised and decen-tralised), with the involvement of different supply chain entities (supplier, manufacturer, remanufacturer, retailer and collector).

Others: This category refers to the mathematical models that are different in nature with the three defined categories and includes different analysis such as assemblies and inventory strategies, lot scheduling, RL project selection, vehicle routine problem, and supplier selection. We also put technical notes in this category as they are the different type of studies compared to the ones already categorised.

In the following section, the sample will be analysed further to identify the characteristics of the published model.

3.1.1 *Solution methodologies*

The papers in the sample were analysed meticulously with regard to the type of solution methodologies they applied. In searching for the solution methodologies, any specific method described in the abstract, keywords, or body of the paper was initially recorded. Next, the bodies of the papers were checked carefully to search for the solution methodologies applied or developed. Subsequently, general classes were defined based on the methodologies observed, and afterward

the solution methodologies were allocated to the class that they belonged to, with the help of an Excel file. The classifi-cation of the type of solution methodologies resulted in six different classes, as shown in Figure 7. Most of the papers applied one specific solution methodology in their model; nonetheless, there were a few papers that utilised/developed more than one methodology. This means that some papers contributed to more than one methodology in Figure 7. From Figure 7 it appears that mathematical programming, heuristics, and classical differential approaches are by far the most popular methodologies of the papers published in IJPR. However, the journal showed less interest in publishing the papers that used MCDM and Simulation methodologies in their studies. Mathematical programming applied by authors includes a wide variety of sub-categories such as: linear programming, non-linear programming, goal programming, and some combination with different sort of uncertainties like possibilistic linear, stochastic and fuzzy programming. How-ever, a number of methodologies such as dynamic programming were applied by authors. Due to the limitation of math-ematical programming in solving large-scale problems, authors mostly used heuristics approaches that are more flexible and reliable in solving the models. In contrast to mathematical programming and heuristics methodologies, some classi-cal differential approaches were used to derive analytical solutions where authors tried to find a closed-form solution for the problem formulated. Other methodologies, which were not frequently used, were categorised in the class titled 'Others'. This class comprises the methodologies that were used fewer than five times in the publications.

3.1.2 *Type of parameters*

In this part of the study, we investigated the models in light of whether the parameters were considered deterministic or uncertain. Out of all papers, 67 papers which have the mathematical base fell into this category for analysis. The analy-sis showed almost half of the papers (54%) treated the parameters and variables in deterministic form, while the other half (46%) incorporated uncertainty into their decision analysis. The importance of uncertainty in supply chain manage-ment is already discussed extensively in the literature (Peidro et al. 2009; Simangunsong, Hendry, and Stevenson 2012). Figure 8 shows different approaches applied to formulate the uncertainty. The models quantified uncertainty using four different approaches: 1- Stochastic, 2- Fuzzy, 3- Fuzzy-Stochastic and 4-Disrupted. As specified by Figure 8, the stochastic approach was by far the most popular approach; 24 papers (almost three quarters of the papers) applied this

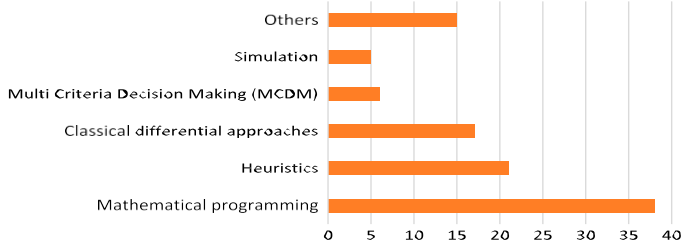


Figure 7. The frequency and types of solution methodologies applied in the studies.

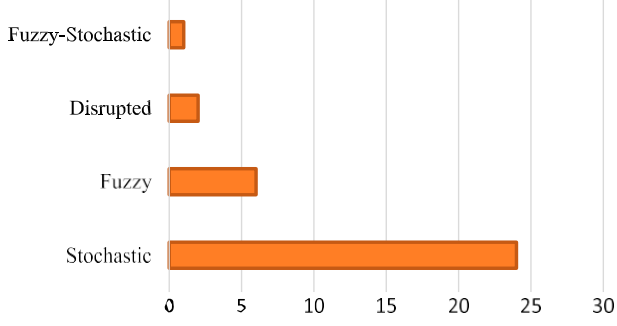


Figure 8. Distribution of the papers in terms of the method used for modelling uncertainty.

approach to tackle uncertainty, followed by the fuzzy approach found in six papers. The other two approaches, Fuzzy-Stochastic and Disrupted, were less favoured, because only three papers applied them in their modelling methodology.

3.1.3 *Data analysis*

In this part of the analysis, the studies were evaluated in terms of the type of data they used to evaluate their models. Our analysis showed that 88% of papers in the sample, including 83 papers, were purely numerical and did not use any case study/studies in order to evaluate their model. The main objective of this type of models was, typically, to generate a sample data-set or adopt data sets from previous studies, to come up with recommendations for real-world applica-tions. Nonetheless, only 12% of studies, or 11 papers, were found empirical, relying on real cases or real data-sets. This percentage is very low given that the mission of the journal is linking the studies in production, manufacturing and operations research with their industrial applications. Among this category of studies, a few of them combined numerical examples with the analysis of real cases to consolidate model's outcomes. Meanwhile, a few other studies chose to eval-uate their model merely based on empirical studies.

In Table 5, we examined the case study papers more rigorously. Generally, the studies before 2009 were all pure numerical; just after 2009 the studies began to be more empirical-oriented. As shown, case study papers include applica-tion of the models in different industrial sectors and various geographical areas. It should be noted that half of the case study papers are pure empirical studies, while the other half use a combination of numerical and empirical studies. When reviewing case study papers, there is some confusion regarding the ways authors collected data for analysis. For instance, a number of studies titled numerical examples as case studies, while there was actually no real case study pre-sented in the papers. A number of other papers used partial information from real cases, but there was no indication of how data had been collected and which source had been chosen for the case studies. Consequently, these models were categorised as numerical examples. As to case study locations in Table 5, they are clearly specified in eight publications, all of which were conducted in different countries. Among this category, four of them were conducted in Asian coun-tries and only one in the USA. This result is indicative of how Asian countries are becoming more interested in RL&CLSCM issues. Concerning data collection in Table 5, only five papers clearly specified the type of data they used to conduct the study. Secondary sources and interviews are the most commonly accepted type of data.

Table 5. Analysing case study papers.

Paper	Number of case studies	Industrial sector	Case study location	Type of data collection	Purely empirical	Empirical and numerical
Tsai and Hung (2009)	1	Electronic equipment	NA	NA	✓	
Kannan, Noorul Haq, and Devika (2009)	2	Tyre and plastic	India	NA		✓
Tuzkaya, Gülsün, and Önsel (2011)	1	White goods	Turkey	Interview, secondary sources	✓	
Agarwal, Barari, and Tiwari (2012)	1	NA	NA	Survey	✓	
Piplani and Saraswat (2012)	1	After-sale service of electronic products	NA	Secondary sources	✓	
Alinovi, Bottani, and Montanari (2012)	1	Confectionery and croissant	Italy	NA		✓
Li (2013)	1	Household appliances	China	Secondary sources		✓
Lehr, Thun, and Milling (2013)	1	Electronics	Germany	Semi-structured interviews	✓	
Wilhite et al. (2014)	1	Military	USA	NA	✓	
Chen, Chan, and Chung (2015)	1	Cartridge recycling	Hong Kong	NA		✓
Hasani, Zegordi, and Nikbakhsh (2015)	1	Medical device	Iran	NA		✓

4. Research gaps and future research opportunities

As evidenced by analysis of the sample papers, the number of studies published by IJPR in the area of RL&CLSCM has been on the rise. While the journal has accomplished much in publishing these studies, there are some areas of research that have not received much coverage. After careful examination of the existing literature in IJPR, the follow-ing research gaps have been identified that may be pursued for future studies in IJPR. On the basis of the analysis implemented in this paper, the research gaps are presented in two categories: (1) bibliometric analysis and (2) content analysis. They are as follows:

Gaps and research opportunities based on bibliometric analysis:

- The geographic dispersion of the studies published showed that researchers from North America, Asia, and Europe have the highest number of works published in IJPR. Although the relative concentration of authors in specific areas might lead to more productive studies from influential scholars, this concentration can limit the diversity of research in the journal. This fast-moving field is still relatively immature, and including scholars from different geographical areas can globalize the research significantly. This may lead to more fruitful research that addresses problems associated with disparate cultures. IJPR can become a journal that considers more diversity in publica-tion in the field of RL&CLSCM.
- The lack of versatility in geographical areas was not the only issue in authorship. A thorough survey of the authors' profiles shows that the majority of them are purely academic or have an academic background. That is, the absence of the authors with industrial background or practical experience was observed. Perhaps this is one of the reasons why the majority of studies have a theoretical or conceptual base. In order to enhance the rate of prac-tical-oriented research in RL&CLSCM, the journal must promote studies that are cross-sector and are carried out with the collaboration of a team including both academic and industrial practitioners.
- Our analysis shows that RL&CLSCM keywords are usually coupled with typical keywords such as logistics and SCM, signifying that the focus of the research remains mostly on the link between RL&CLSCM with their origins (logistics and SCM). As demonstrated by a bibliometric map, there is a low rate of co-occurrence between RL&CLSCM and other keywords, particularly between the keywords coupled with RL with the ones coupled with CLSCM. Conducting studies that interconnect the keywords of the two fields will likely create extensive opportu-nities to expand the current state of research.
- Our analysis illustrates that the most influential authors of the field have not been very active in publication in IJPR. A handful of studies discovered that a distinctive field of science has been shaped and progressed by the contribution of a few leading scholars in the field (e.g. Fahimnia, Sarkis, and Davarzani 2015; Mishra et al. 2016, 2017; Schaltegger, Gibassier, and Zvezdov 2013). It is also emphasised that intent monitoring the influential author's studies can provide useful directions for further research (Fahimnia, Sarkis, and Davarzani 2015). Conse-quently, the contribution of influential authors to the journal is important as they might inspire new stages direc-tions for future development of IJPR, and they may trigger more researchers and readers of the field to follow their work in IJPR. The editorial board of the journal might want to invite the leading authors to submit their stud-ies in IJPR to increase the quality of research and perhaps this may increase the number of readers of the journal.
- Concerning the citation of the studies, although it is shown that the studies have received a fairly acceptable num-ber of citations, there are only five studies that have received more than 100 citations (according to the data retrieved from Scopus as of July 2017). To increase the impact of the studies, and to improve the quality of the journal, the suggestions regarding bibliometric analysis are likely to improve the quality and significance of the studies.

5. Conclusion

When it comes to the topic of Production and Operations Management, IJPR is among the top journals, and it has had a remarkable impact on developing the profession. Understanding how the journal may foster more fruitful research in specific areas of study is, however, critical, as is acknowledging the journal's supplementary role in generating significant field-wide issues. IJPR is the second publication for RL&CLSCM, a hot issue in the realm of operations and production management.

of research in this area. Consequently, we set out to examine the RL&CLSCM publications published in the IJPR in order to provide this research. Journal of Public Relations research submissions may benefit from this evaluation. This review could help them understand the journal's overall focus, the range of published topics, and research gaps that need to be filled. Journal editors may also use this review report to assess the track record of IJPR in publishing field research; this evaluation may then inform decisions about the journal's future focus.

An overview of the field was included at the beginning of the article before the emphasis was shifted to the role of IJPR. According to the data, IJPR is the second venue where RL&CLSCM research is published. This fact explains why this study is necessary and highlights the role of IJPR in the field's advancement. A systematic evaluation was performed to assess the research, and a total of ninety-four publications published in the International Journal of Public Relations (IJPR) between the years 2000 and 2017 were located. First, the articles were analysed bibliometrically with regard to publication year, author contributions, affiliations, and citations. According to the data, the number of publications in the subject is increasing, with the exception of 2012, when there was a little fluctuation caused by a special issue. After then, the sample articles were categorised based on their primary topics. Two broad groups were established for the papers: mathematical and non-mathematical models. Within the former, four subgroups were established for the mathematical studies. The articles were subsequently evaluated and examined according to their different attributes. Last but not least, the analysis led to many suggestions for further study.

Our suggestions for future study focused on areas that have received little attention in the history of IJPR. The bulk of the studies have been created without taking industry-specific factors into account or being industry-oriented. An essential step that IJPR might take is to focus future research on other businesses. The area and IJPR as a whole may benefit from more studies examining practical, industry-specific examples and their implementations. Additionally, we found that there is a dearth of interdisciplinary research in the field of RL&CLSCM. More research of this kind may be sparked by IJPR, which is another important function it can play. In addition, there are a lot of management choices in RL&CLSCM that affect the environment, but research on how these decisions affect RL&CLSCM performance is still in its early stages. For those interested in IJPR, this may be a fruitful field of study.

This article has some limitations, despite its attempts to employ a well-established and scientifically robust research approach. A review paper's categorisation of sample articles is the most significant potential shortcoming. Because some publications do not clearly indicate their emphasis on RL&CLSCM, developing a method to categorise the sample papers becomes a subjective and judgemental process. Therefore, other research may come up with other classification strategies, which might lead to results that vary from ours. As a result of the paper's length and the incorporation of bibliometric analysis, we also chose to examine the publications' basic features rather than individually analyse each one.

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