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ARTICLE

Thirty years of the *International Journal of Computer Integrated Manufacturing*: a bibliometric analysis

Sigifredo Laengle[a], Nikunja Mohan Modak[b], José M. Merigó[a] and Catalina De La Sotta[a]

[a]Department of Management Control and Information Systems, School of Economics and Business, University of Chile, Santiago, Chile; [b]Palpara Vidyamandir, University of Kalyani, Chakdaha, India

ABSTRACT

The *International Journal of Computer Integrated Manufacturing* was established in 1988 with the idea of advancing research in computer integrated manufacturing (CIM) technologies and promoting the application of those technologies within industry. The journal was created to facilitate the exchange of new knowledge between industry and academia derived from both research and practical application. To celebrate the 30-year journey of the journal, this study develops a bibliometric analysis of all the publications of the journal to 2017. Information was collected using the Web of Science Core Collection database. The present study has been conducted to highlight the significant contributions of the journal in terms of impact, topics, authors, universities and countries. Finally, visualisation of similarities (VOS) viewer software was used to present graphical representations of the bibliographic coupling, co-citation, citation, co-authorship and co-occurrence of keywords.

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Bibliometrics; journal; web of science; VOS viewer

1. Introduction

The *International Journal of Computer Integrated Manufacturing* (IJCIM) was launched in 1988 along with the International CIM Society. The purposes were the expansion of CIM technologies and upholding the application of those technologies within the industry. The journal is now celebrating its 30th anniversary with notable contributions in CIM technologies. The journal was established mainly to endorse and meet new knowledge from both industry and academia derived from both research and practical application. The journal publishes research studies on diverse topics of CIM technologies such as service-oriented architecture, dematerialised manufacturing systems, wireless manufacturing and digital enterprise technologies. The inaugural issue consisting of seven original articles and two book reviews set the tempo of the journal to meet its objectives through a variety of papers as research papers, state-of-the-art and tutorial reviews and case studies. In the introductory year of 1988, the IJCIM released its first volume consisting of four issues under the supervision and guidance of the editor-in-chief, Professor David Hughes. Each year starting from 1989 to 2002, the journal released six issues. The journal grew again in 2003, and until 2008, it published 8 issues per year. From 2009, the journal has been publishing 12 issues per volume year. According to the 2016 Journal Citation Reports of Clarivate Analytics, the IJCIM has an impact factor of 1.949 and an Eigen factor score of 0.001620 with a total of 1482 citations.

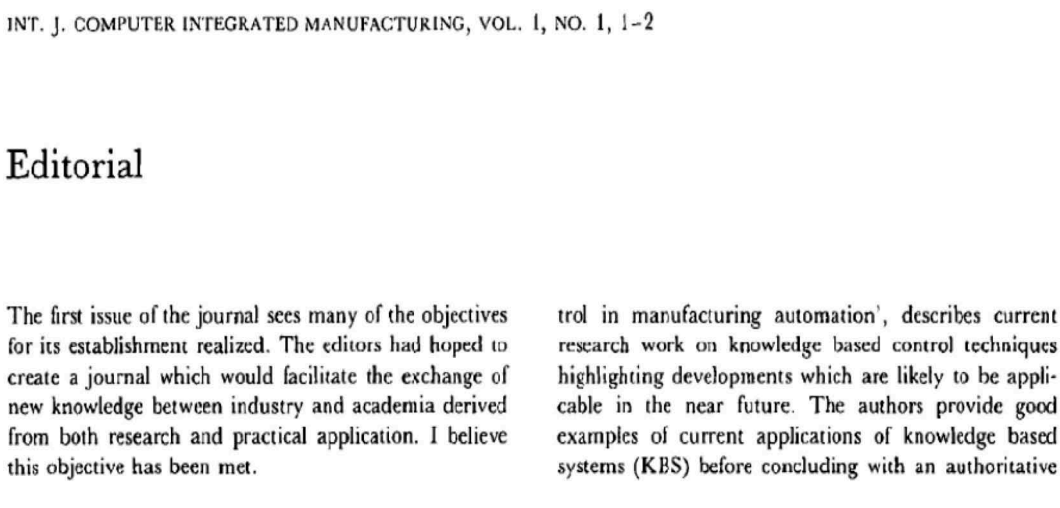
This study aims to analyse the growth of the IJCIM over the last three decades through a general bibliometric study. The most reliable database, the Web of Science Core Collection, has been used to collect the data. This study wants to explore the importance, specialty, productivity and influence of the journal and demonstrate its leading topics, authors, institutions and countries. Bibliometric study originated from the field of library and information science and is defined as the science of quantitative study of bibliographic materials (Broadus 1987). In the literature, bibliometric studies are used to measure the relevance of a topic (Merigó and Yang 2017), the contribution of journals (Glänzel and Schoepflin 1995), universities (Moed et al. 1985; Linton 2004) and countries (Bonilla, Merigó, and Torres-Abad 2015). Topic-based bibliometric studies are common in the literature. There are many instances of bibliometric studies used to analyse a variety of topics such as corporate social responsibility and corporate social performance (De Bakker, Groenewegen, and Den Hond 2005), social sciences and the humanities (Nederhof 2006), innovation entrepreneurship (Landström, Harirchi, and Aström 2012) and fuzzy research (Blanco-Mesa, Merigó and Gil-Lafuente, 2017; Merigó, Gil-Lafuente, and Yager 2015a). Bibliometric study is useful to analyse the behaviour of a journal and helps to realise the publication patterns of a journal. Bibliometric study also provides information about the quality of the publications of a journal through citation analysis. Bibliometric studies are often used in celebrating and reviewing the performance of journals during their momentous anniversaries. Table 1 provides instances of bibliometric studies used to celebrate significant anniversaries of journals.

Table 1 indicates that more than three decades ago, in 1986, Heck and Bremser presented a bibliometric study to celebrate the diamond jubilee of the journal *The Accounting Review*. All publications from the beginning through the next 75 year journey of the Journal of Risk and Insurance were studied by Weiss and Qiu (2008) through bibliometrics. To celebrate the 30th anniversary of the Journal of Environmental Psychology,

CONTACT José M. Merigó jmerigo@fen.uchile.cl

Table 1. Bibliometric studies celebrating anniversaries of journals.

Journal	Interval	Publication
The Accounting Review	1926–1985	Heck and Bremser (1986)
Journal of Financial Economics	1974–1991	Schwert (1993)
Journal of Consumer Research	1974–1988	Hoffman and Holbrook (1993)
Financial Management	1972–1994	Borokhovich et al. (1995)
Strategic Management Journal	1980–2000	Ramos-Rodríguez and Ruíz-Navarro (2004)
Technovation	1981–2004	García-Merino, Pereira-do-Carmo, and Santos-Álvarez (2006)
Journal of Product Innovation Management	1984–2003	Biemans, Griffin, and Moenaert (2007)
Family Business Review	1988–2005	Casillas and Acedo (2007)
The Journal of Risk and Insurance.	1932–2006	Weiss and Qiu (2008)
Total Quality Management & Business Excellence	1995–2008	Dereli et al. (2011)
Journal of Business Research	1973–2014	Merigó et al., (2015b)
Knowledge-Based Systems	1991–2014	Cobo et al. (2015)
International Journal of Intelligent Systems	1986–2015	Merigó et al. (2017)
Journal of Business & Industrial Marketing	1986–2015	Valenzuela et al. (2017)
European Journal of Operational Research	1977–2016	Laengle et al. (2017)
Computers & Industrial Engineering	1976–2015	Cancino et al. (2017)
Information Sciences	1968–2017	Merigó et al. (2018)
European Journal of Marketing	1967–2017	Martínez-López et al. (2018)
Int J Uncertainty, Fuzziness and Knowledge-Based Systems	1993–2016	Wang et al. (2018)
Group Decision and Negotiation	1992–2016	Laengle et al. (2018)



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Editorial

The first issue of the journal sees many of the objectives for its establishment realized. The editors had hoped to create a journal which would facilitate the exchange of new knowledge between industry and academia derived from both research and practical application. I believe this objective has been met.

trol in manufacturing automation', describes current research work on knowledge based control techniques highlighting developments which are likely to be applicable in the near future. The authors provide good examples of current applications of knowledge based systems (KBS) before concluding with an authoritative

Figure 1. Beginning part of the first editorial note of IJCIM.

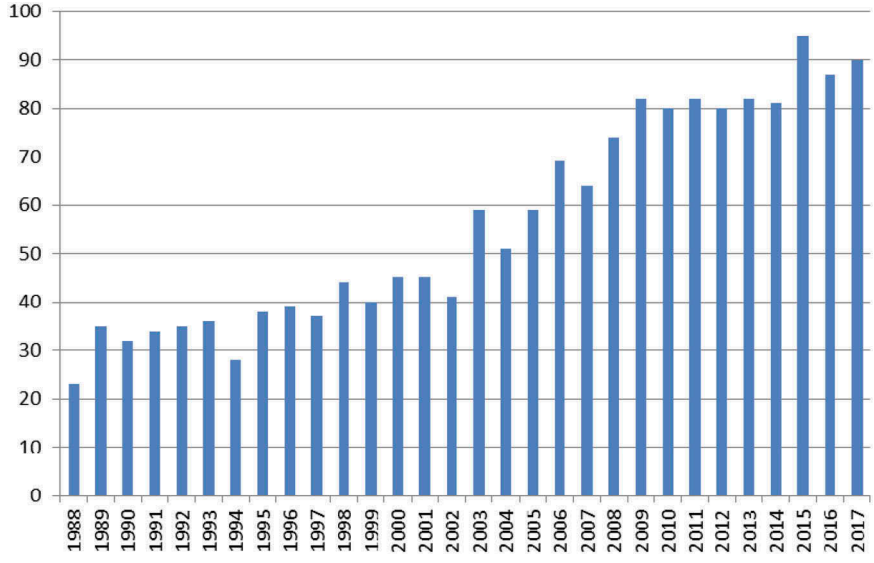

Figure 2. Annual number of papers published in IJCIM.

Table 2. Annual citation structure of IJCIM.

Year	TP	TC	≥100	≥50	≥20	≥10	≥5	≥1
1988	23	95	0	0	1	2	8	16
1989	35	186	0	0	2	7	13	29
1990	32	287	0	1	3	9	13	23
1991	34	365	0	1	4	9	18	31
1992	35	299	1	1	4	6	15	28
1993	36	421	0	1	6	14	25	31
1994	28	289	0	1	4	10	16	26
1995	38	391	0	2	5	12	21	37
1996	39	379	1	2	4	9	17	35
1997	37	340	0	0	5	14	21	35
1998	44	310	0	0	3	9	27	41
1999	40	430	0	1	7	11	26	38
2000	45	377	0	0	5	12	22	41
2001	45	635	0	1	15	25	32	44
2002	41	532	0	2	7	21	26	38
2003	59	685	0	1	9	24	43	59
2004	51	535	0	1	8	15	35	50
2005	59	636	0	2	10	23	33	56
2006	69	718	0	0	8	32	51	68
2007	64	725	1	2	13	22	45	58
2008	74	739	0	0	11	29	55	73
2009	82	924	0	1	13	29	55	79
2010	80	729	0	0	7	26	52	77
2011	82	880	1	1	12	33	51	76
2012	80	596	0	0	4	23	47	75
2013	82	604	0	0	4	20	48	79
2014	81	376	0	0	0	12	27	72
2015	95	414	0	0	3	8	26	82
2016	87	147	0	0	1	1	5	59
2017	90	86	0	0	1	1	1	40
Total	1687	14,130	4	21	179	468	874	1496
%	100%		0.2%	1.2%	10.6%	27.7%	51.8%	88.7%

Abbreviations: TP and TC = Total papers and citations; ≥ 100, ≥50, ≥20, ≥10, ≥5, ≥1 = Number of papers with equal or more than 100, 50, 20, 10, 5 and 1 citations.

Milfont and Page (2013) presented a bibliometric review of all full-length articles published in this journal. Merigó et al. (2015b) analysed all the publications in the Journal of Business Research from 1973 to 2014 by using a bibliometric approach. The trends of journal celebrations through bibliometric study have increased significantly in recent years. In 2018, two well established journals, *Information Sciences* and *European Journal of Marketing*, analysed their performance through bibliometric study to celebrate their golden jubilee.

This study measures the performance of the IJCIM using both quantity and quality indicators and explores the leading topics and top contributing authors, institutions and countries and their collaborations during its journey of 30 years. The visualisation of similarities (VOS) software (Van Eck and Waltman 2010) has been used to prepare network visualisation of collaborations such as bibliographic coupling (Kessler 1963), co-citation (Small 1973), co-authorship and co-occurrence of keywords. IJCIM as an academic journal plays a major role in the progress of CIM by highlighting new research, applications, opportunities and limitations of CIM in today's information-based epoch of global manufacturing. The present study discusses and analyses the reasons behind the achievements of IJCIM during its journey of three decades. This study aims to find answers to the following questions: What was the yearly publication and citation structure of the IJCIM since its creation? Among all the publications, which topics and research papers received the most citations? Which topics have higher potential and influence for future research directions? Which are the most cited documents among all IJCIM publications? Which authors, institutions and countries have contributed highly during its 30 year journey? Which authors' institutions and countries are mostly cited in IJCIM publications? How are the authors, institutions and countries connected in collaborative work to contribute to this journal?

This study will provide practical information of the journal to its readers, researchers, academicians and even to the editorial board members. For instance, it will provide information to its readers about the aim and scope of the journal since the first publication. Researchers/academicians who want to prepare their future research for the IJCIM can obtain information about the most cited studies and topics, as well as research gaps that still remain to be filled in the journal. Furthermore, it will help the editorial board decide new policies for the journal or modify the current policies by looking at the types of studies that have more impact.

The remainder of the paper is organised as follows: The methodology of the bibliometric study is discussed in Section 2. Section 3 deals with the results, including the publication and citation structure, and the top contributing authors and institutions. Section 4 presents a graphical visualisation of the collaborations for bibliographic data with the help of the VOS viewer software. Section 5 summarises the main findings and concludes the paper.

2. Methods

The Web of Science (WoS) Core Collection, the most reliable database (Yang et al. 2013), is used to collect the information for the bibliometric analysis of 30 years of performance of IJCIM. The Institute for Scientific Information (ISI) initially formed this database from the concept of Eugene Garfield, the father of citation indexing of academic literature (Jacso 2010). Later, Thomson and Reuters owned this database, and presently, Clarivate Analytics operates this online subscription-based scientific citation indexing database. Web of Science now has indexing coverage from the year 1900 to the present, including more than 18,000 high impact journals, over 180,000 conference proceedings, and over 80,000 books from around the world. The present bibliometric study collects citation data for all IJCIM publications from the WoS. Collected data are classified and summarised through both quantitative and qualitative methods. To analyse the collected data both in quantitative and qualitative ways, the present study uses different bibliometric indicators. The total number of papers as a quantitative parameter indicates productivity of the journal. Qualitative parameters such as the total number of citations, cites per paper and *h*-index (Hirsch 2005) are used to measure the influence of the journal. No universal parameters, which can measure all characteristics of a bibliometric study, accepted by all exist. Some people prefer bibliometric productivity indicators, whereas other people might prefer quality indicators. The *h*-index is an indicator that combines publications with citations. If a variable has an *h*-index of *N*, then there are *N* papers inside the set of papers considered

Table 3. The 50 most-cited documents in IJCIM.

R	TC	Title	Author/s	Year	Citations per year
1	119	Computer-aided process planning – A critical review of recent developments and future trends	Xu, X; Wang, LH; Newman, ST	2011	19.83
2	114	Analysis of periodic and event-driven rescheduling policies in dynamic shops	Church, LK; Uzsoy, R	1992	4.56
3	102	A simulated annealing-based optimisation approach for integrated process planning and scheduling	Li, WD; McMahon, CA	2007	10.20
4	102	Comparison of the bionic, fractal and holonic manufacturing system concepts	Tharumarajah, A; Wells, AJ; Nemes, L	1996	4.86
5	97	Supply chain dynamics	Towill, DR	1991	3.73
6	87	A state of the art review of IDEFO	Colquihoun, GJ; Baines, RW; Crossley, R	1993	3.63
7	69	Predictable scheduling of a single machine subject to breakdowns	Mehta, SV; Uzsoy, R	1999	3.83
8	65	On the architecture of intelligent STEP – compliant CNC	Suh, SH; Cho, JH; Hong, HD	2002	4.33
9	65	CIM – OSA 1 Total enterprise modelling and function view	Jorysz, HR; Vernadat, FB	1990	2.41
10	64	A simulation optimisation methodology for supplier selection problem	Ding, HW; Benyoucef, L; Xie, XL	2005	5.33
11	60	Towards a classification frameworks for interoperability of enterprise applications	Panetto, H	2007	6.00
12	60	Feature-based modelling approaches for integrated manufacturing – state of the art survey and future research directions	Allada, V; Anand, S	1995	2.73
13	57	Heterarchical control of highly distributed manufacturing systems	Duffie, NA; Prabhu, VV	1996	2.71
14	56	Standards on enterprise integration and engineering – state of the art	Chen, D; Vernadat, F	2004	4.31
15	56	Recent and future trends in cost estimation	Layer, A; Ten Brinke, E; Van Houten, F; et al.	2002	3.73
16	56	Scheduling and control of flexible manufacturing systems – a critical – review	Basnet, C; Mize, JH	1994	2.43
17	55	Wireless manufacturing: a literature review, recent developments, and case studies	Huang, GQ; Wright, PK; Newman, ST	2009	6.88
18	55	CAD/CAM solutions for STEP -compliant CNC manufacture	Newman, ST; Allan, RD; Rosso, RSU	2003	3.93
19	53	Next-generation manufacturing systems: key research issues in developing and integrating reconfigurable and intelligent machines	Molina, A; Rodriguez, CA; Ahuett, H; et al.	2005	4.42
20	51	A distributed, open, intelligent product data management system	Kim, Y; Kang, SH; Lee, SH; et al.	2001	3.19
21	50	Machine performance monitoring and proactive maintenance in computer-integrated manufacturing – review and perspective	Lee, J	1995	2.27
22	49	Hedging production schedules against uncertainty in manufacturing environment with a review of robustness and stability research	Sabuncuoglu, I Goren, S	2009	6.13
23	49	A new marketing approach to mass customisation	Piller, FT; Muller, M	2004	3.77
24	48	ALPS – a language for process specification	Catron, BA; Ray, SR	1991	1.85
25	48	CIM – OSA 2 Information view	Jorysz, HR; Vernaday, FB	1990	1.78
26	46	A state of the art survey of cloud manufacturing	He, W; Xu, L	2015	23.00
27	46	Integration of process planning and scheduling: a state of the art review	Phande, RK; Jain, A; Verma, R	2011	7.67
28	46	Agent-based workflow management for RFID-enabled real-time reconfigurable manufacturing	Zhang, YF; Huang, GQ; Qu, T; et al.	2010	6.57
29	45	A framework for RFID applications in product lifecycle management	Jun. HB; Shin, JH; Kim, YS; et al.	2009	5.63
30	45	Closed-loop CAPP/CAM/CNC process chain based on STEP and STEP-NC inspection tasks	Brecher, C; Vitr, M; Wolf, J	2006	4.09

(*Continued*)

Table 3. (Continued).

R	TC	Title	Author/s	Year	Citations per year
31	44	Digital enterprise technology – defining perspectives and research priorities	Maropoulos, PG	2003	3.14
32	43	Rapid manufacturing facilitated customisation	Tuck, CJ; Hague, RJM; Ruffo, M; et al.	2008	4.78
33	43	Application of product data management technologies for enterprise integration	Gao, JX; Aziz, H; Maropoulos, PG; et al.	2003	3.07
34	43	Web-based design and manufacturing support systems: implementation perspectives	Cheng, K; Pan, PY; Harrison, DK	2001	2.69
35	43	An integrated model of process planning and production scheduling	Zhang, HC; Mallur, S	1994	1.87
36	43	Feature technology – an overview	Case, K; Gao, J	1993	1.79
37	42	RFID in product lifecycle management: a case in the automotive industry	Cao, H; Folan, P; Mascolo, J; et al.	2009	5.25
38	42	Feature-based modelling and neural networks-based CAPP for integrated manufacturing	Devireddy, CR; Ghosh, K	1999	2.33
39	41	Minimizing total intercell and intracell moves in cellular manufacturing – genetic algorithm approach	Gupta, YP; Gupta, MC; Kumar, A; et al.	1995	1.86
40	41	A review of scheduling rules in flexible manufacturing systems	Gupta, YP; Gupta, MC; Bector, CR	1989	1.46
41	40	Towards lean product and process development	Khan, MS; Al-Ashaab, A; Shehab, E; et al.	2013	10.00
42	40	Distributed engineering change management for allied concurrent engineering	Chen, YM; Shir, WS; Shen, CY	2002	2.67
43	40	A multilevel multilayer architecture for intelligent shop floor control	Jones, A; Saleh A	1990	1.48
44	39	A review of localisation algorithms for distributed wireless sensor networks in manufacturing	Franceschini, F; Galetto, M; Maisano, D; et al.	2009	4.88
45	38	Real-time information capturing and integration framework of the internet of manufacturing things	Zhang, YF; Zhang, G; Wang, JQ; et al.	2015	19.00
46	38	An intelligent search algorithm-based methods to derive assembly line design alternatives	Michalos, G; Makris, S; Mourtzis, D	2012	7.60
47	38	Asking the right questions to elicit product requirements	Wang, M; Zheng, Y	2009	4.75
48	38	CAD-CAM integration using machining features	Miao, HKK; Sridharan, N; Shah, JJ	2002	2.53
49	37	Radio frequency identification-enabled real-time manufacturing execution system: a case study in an automotive part manufacturer	Dai, QY; Zhong, RY; Huang, GQ; et al.	2012	7.40
50	37	The effects of routing flexibility on a flexible manufacturing system	Chan, FTS	2001	2.31

Abbreviations are available in the previous tables except for: R = Ranking.

that have received at least *N* citations or more. Moreover, several citation thresholds such as more than 100, 50, 20, 10, 5 and one citation are presented in this study to identify the number of quality publications. These citation thresholds provide information about the percentage of the total number of publications that received more citations than a particular threshold; for example, if *m* publications among the total of *n* publications in a year have received more than 50 citations. Then, this year has (50 *m*/*n*)% publications that received more than 50 citations in this year. Threshold indicators help to prepare a comparative study of quality contributions. In a publication, citations are used to acknowledge words and ideas from other sources. We use a total citation index to prepare the list of the top 50 contributed papers in IJCIM. Leading authors, institutions and countries are listed based on the total publication index.

The visualisation of similarities (VOS) viewer software can construct network connections of scientific publications, scientific journals, researchers, research organisations, countries, keywords, or terms based on co-authorship, co-occurrence, citation, bibliographic coupling, or co-citation links (Van Eck and Waltman 2010). The VOS viewer software counts both the number of links and the total strength of those links to prepare the graphical network visualisation. The size of a circle represents relevance of a topic while network connections show the link strength of that topic in a graphical representation. Using the VOS viewer software, this work presents network visualisation of bibliographic coupling (Kessler 1963), co-citation (Small 1973), co-authorship and co-occurrence of keywords. Bibliographic coupling and co-citation provide information for related research works. Two documents are said to be bibliographically coupled if both of them cite one or more

Table 4. Top 30 most-cited documents in IJCIM publications.

Rank	Year	First author	Source Title	Vol	Page	Type	TC	Co-cit
1	1991	Rumbaugh J	Object Oriented Mode	-	-	B	31	22
2	1989	Goldberg D	Genetic Algorithms S	-	-	B	27	16
3	2006	Chryssolouris G	Manufacturing System	-	-	B	24	14
4	1981	Peterson JL	Petri Net Theory Mod	-	-	B	23	16
5	1988	Joshi S	Comput Aided Design	v20	p58	A	22	16
6	1983	Kirkpatrick S	Science	v220	p671	A	22	14
7	1989	Murata T	P IEEE	v77	p541	A	21	13
8	1996	Vernadat FB	Enterprise Modelling	-	-	B	21	11
9	2011	Xu X	Int J Comput Integ M	v24	p1	A	21	14
10	1990	Chang TC	Expert Process Planning	-	-	B	20	13
11	1980	Saaty TL	Anal Hierarchy Process	-	-	B	20	5
12	2005	Xu XW	Int J Prod Res	v43	p3703	A	20	19
13	2007	Li WD	Int J Comput Integ M	v20	p80	A	19	16
14	1996	Vernadat FB	Enterprise Modeling	-	-	B	19	11
15	1990	Jorysz HR	Int J Comp Integ M	v3	p144	A	18	13
16	1965	Zadeh LA	Inform Control	v8	p338	A	18	9
17	1989	Alting L	Int J Prod Res	v27	p553	A	17	15
18	1974	Baker KR	Intro Sequencing Sch	-	-	B	16	14
19	1991	Booch G	Object Oriented Design	-	-	B	16	11
20	2012	Xu X	Robot Cim-Int Manuf	v28	p75	A	16	11
21	1990	Suh NP	Principles Design	-	-	B	14	8
22	2006	Xu XW	Comput Ind	v57	p141	A	14	13
23	1996	Beitz W	Eng Design Systemati	-	-	B	13	6
24	1984	Choi BK	Comput Aided Design	v16	p81	A	13	11
25	2002	Deb K	IEEE T Evolut Comput	v6	p182	A	13	7
26	1979	Garey MR	Computers Intractability	-	-	B	13	7
27	1993	Gruber TR	Knowl Acquis	v5	p199	A	13	1
28	1975	Holland JH	Adaptation Natural A	-	-	B	13	7
29	1990	Jorysz HR	Int J Comp Integ M	v3	p157	A	13	12
30	1995	Kennedy J	IEEE Int Conf Neural Networks	v1–6	p1942	C	13	8

Abbreviations: Vol = Volume; TC = Total citations; Co-cit = Co-citations; B = Book; A = Article; C = Conference Proceedings.

documents in common (Kessler 1963). However, if two documents are given a citation from a third document, then both documents gets a score in the co-citation index (Small 1973). Co-occurrence of author keywords helps to find those articles that used common keywords.

There are some limitations in the WoS data that will, in turn, affect this study in the following perspectives. First, when one is carrying out a country/institution analysis in academic research, there are many people that work in one country having different nationalities. Second, WoS does not consider different weights for a publication based on the number of co-authors, the number of pages, or other related issues that can be conditions in the analysis. WoS always provides one unit to any co-author of a paper and one unit to each participating institution and country. This procedure provides an advantage to papers written by many authors rather than a single-author paper.

3. Results

The search engine of the WoS Core Collection database provides a total of 1687 documents from IJCIM from 1988 to 2017, and these documents have received a total of 14,130 citations up to 31 December, 2017. Figure 1 shows the beginning part of the very first page of issue 1 of volume 1 of the IJCIM. This first editorial note was written by the founding editor Professor David Hughes.

This editorial demonstrates that from the beginning, the editors of this journal were clearly focussed on new research findings and practical applications related to CIM. According to Professor Hughes, the first issue reveals different views of CIM through a variety of papers such as research papers, state-of-the-art and tutorial reviews, and case studies. More importantly, authors and researchers from around the world contributed for this very first issue. 'The international implications of computer integrated manufacturing', authored by Roobeek and Abbing, was the very first article published in this journal that discussed the impact of CIM on organisational and national competitiveness from an international perspective. IJCIM published its first issue of volume 1 in April 1988. After publishing the 12th issue of the 30th volume in 2017, the journal completed its 30-year journey. The next subsection analyses the yearly publication and citation structure of IJCIM.

3.1. Publication and citation structure of IJCIM

In its inaugural year, the IJCIM published 23 articles through four issues. In the 30th year, i.e. in 2017 with an approximately 300% increase, the journal published 90 papers. Figure 2 represents the annual number of publications in the IJCIM from 1988 to 2017.

During the first decade of its publication, the journal published a total of 337 papers with an average of 33.7 papers per year. The per-year publication rate of the journal in the second and last 10 years is 51.7 and 83.3, respectively. The results clearly show that the per-year publication rate of the journal increased consistently. In 2015, the IJCIM published the highest number of papers in a year. In 2016, and 2017, the journal released 87 and 90 papers, respectively. Since 2009, the journal has published more than 80 papers per year. The journal has been publishing 12 issues per year from that year. For a more in-depth analysis of the publication pattern of the

Table 5. Top 50 leading authors in IJCIM.

R	FULL NAME	University	TP	TC	TH	TC/TP	>50	>10
1	Chryssolouris, George	U Patras	26	280	10	10.77	0	11
2	Huang, George Q	U Hong Kong	17	351	11	20.65	1	11
3	Mourtzis, Dimitris	U Patras	14	158	8	11.29	0	6
4	Newman, Stephen T	U Bath	14	357	8	25.50	3	8
5	Makris, Sotiris	U Patras	12	161	7	13.42	0	6
6	Ranky, Paul G	New Jersey Inst Tech	12	44	5	3.67	0	0
7	Papakostas, Nikolaos	U College Dublin	11	97	7	8.82	0	4
8	Rahimifard, Shahin	Loughborough U	11	107	7	9.73	0	5
9	Jardim-Goncalves, Ricardo	New U Lisbon	10	50	3	5.00	0	2
10	Suh, Suk-Hwan	Pohang U Sci Tech	10	143	6	14.30	1	3
11	Tiwari, Manoj Kumar	IIT Kharagpur	10	38	3	3.80	0	1
12	Young, Robert IM	Loughborough U	10	162	8	16.20	0	7
13	Chen, Yuh-Min	Nat Cheng Kung U	9	145	5	16.11	0	5
14	Maropoulos, Paul G	Aston U	9	144	6	16.00	0	4
15	Nof, Shimon Y	Purdue U	9	83	6	9.22	0	4
16	Qu, Ting	U Hong Kong	9	183	7	20.33	0	7
17	Tavakkoli-Moghaddam, Reza	U Tehran	9	47	4	5.22	0	2
18	Xu, Xun	U Auckland	9	238	6	26.44	1	6
19	Zhang, Ying Feng	Northwest Polytec U	9	181	7	20.11	0	7
20	Jones, Albert	NIST – USA	9	158	6	17.56	0	6
21	Weston, Richard H	Cranfield U	9	59	5	6.56	0	2
22	Chan, Felix T.S.	Hong Kong Polyt U	8	106	4	13.25	0	3
23	Cho, Hyunbo	Pohang U Sci Tech	8	62	4	7.75	0	3
24	Mak, Kai Ling	U Hong Kong	8	104	5	13.00	0	4
25	Wang, Lihui	KTH Sweden	8	164	4	20.50	1	2
26	Case, Keith	Loughborough U	7	99	5	14.14	0	2
27	Chen, Yonghua	U Hong Kong	7	82	4	11.71	0	3
28	Choi, Byoung Kyu	KAIST – S. Korea	7	84	4	12.00	0	4
29	Chu, Xuening	Shanghai Jiao Tong U	7	46	4	6.57	0	2
30	Fu, Jian-Zhong	Zhejiang U	7	13	2	1.86	0	1
31	Gunasekaran, Angappa	California St U Bakersfield	7	73	5	10.43	0	5
32	Jolai, Fariborz	U Tehran	7	21	3	3.00	0	0
33	Kulvatunyou, Boonserm	NIST – USA	7	67	5	9.57	0	3
34	Renna, Paolo	U Basilicata	7	50	3	7.14	0	2
35	Xirouchakis, Paul	U Strathclyde	7	127	6	18.14	0	5
36	Azadeh, Ali	U Tehran	6	23	2	3.83	0	1
37	Bell, Robert	Loughborough U	6	56	4	9.33	0	3
38	Chen, Tsung-Yi	National Tsing Hua U	6	27	3	4.50	0	1
39	Cheung, Wai M	Northumbria U	6	103	6	17.17	0	4
40	Ciurana, Joaquim	U Girona	6	22	2	3.67	0	1
41	Egbelu, Pius J	New Jersey Inst Tech	6	67	4	11.17	0	3
42	ElMaraghy, Hoda A	U Windsor	6	118	6	19.67	0	6
43	Fan, Yushun	Tsinghua U	6	52	4	8.67	0	2
44	Grilo, Antonio	New U Lisbon	6	28	2	4.67	0	1
45	Kiritsis, Dimitris	EPF Lausanne	6	121	5	20.17	0	4
46	Lin, Zone-Ching	Nat Taiwan U Sci Tech	6	12	2	2.00	0	0
47	Mavrikios, Dimitris	U Patras	6	94	6	15.67	0	4
48	Michalos, George	U Patras	6	76	4	12.67	0	2
49	Roy, Rajkumar	Cranfield U	6	81	5	13.50	0	4
50	Wright, Paul K	Carnegie Mellon U	6	112	5	18.67	1	4

Abbreviations are available in the previous tables except for: TH = h-index; TC/TP = Cites per paper; >50 and >10 number of papers with more than 50 and 10 citations, respectively.

journal, Table 2 presents information about the total number of publications (TPs), total number of citations (TCs), and the more than 1, 5, 10, 20, 50, and 100 citations received by these papers until 31 December 2017.

Table 2 presents quantitative as well as qualitative measures of the publications of IJCIM. The publications of 2009 lead Table 1 with respect to TC followed by 2011 with 880 citations. From 2001 to 2013, the journal showed consistent performance in the total citation index. During that interval, at least 15 publications of each year received 10 citations or more. It would be unscientific if we compared citation structure of recent publications with the old publications using the indicator TC because time periods are different. For example, consider citation data of two years; one is a recent year such as 2014, and the other year is relatively old, such as 2001. The 81 publications of 2014 have received 376 citations with an average of 4.64 citations per publication while in 2001, 45 papers have received 635 citations with an average of 14.11 citations per publication. Hence, according to the TC, the index performance of 2001 is far better than the index performance of 2014. However, based on average citations per publication per year, publications of 2014 and 2001 receive a score of 1.5467 and 0.83, respectively. Thus, publications of 2014 have a better citation receiving rate than publications of 2001. The trend of the table indicates that recent publications are receiving citations at a high rate. Table 1 also depicts that only 4 papers have more than 100 citations and 21 papers have more than 50 citations. Notably, 10.9% of total documents have more than 20 citations. The 468

Table 6. Temporal analysis of most contributing authors.

R	AUTHORS	TP	TC	TH	TC/TP
1988–1992					
1	Li, RK	4	22	4	5.50
2	Young, RE	3	31	3	10.33
1993–1997					
1	Nof, SY	4	47	3	11.75
2	Billo, RE	3	10	2	3.33
3	Colquhoun, GJ	3	98	2	32.67
4	Dori, D	3	25	3	8.33
5	Egbelu, PJ	3	28	2	9.33
1998–2002					
1	Lin, ZC	5	10	2	2.00
2	Mak, KL	5	65	4	13.00
3	Chan, FTS	3	42	2	14.00
4	Cho, H	3	15	1	5.00
5	Gourgand, M	3	37	2	12.33
6	Huang, GQ	3	60	3	20.00
7	Kim, Y	3	81	3	27.00
2003–2007					
1	Chryssolouris, G	7	126	7	18.00
2	Rahimifard, S	6	66	5	11.00
3	Maropoulos, PG	5	124	5	24.80
4	Mouritzis, D	5	82	5	16.40
5	Newman, ST	5	97	4	19.40
2008–2012					
1	Huang, GQ	10	257	9	25.70
2	Qu, T	7	156	6	22.29
3	Chen, TY	5	26	3	5.20
4	Chryssolouris, G	5	78	5	15.60
5	Suh, SH	5	63	4	12.60
6	Wang, LH	5	134	3	26.80
7	Xu, X	5	162	4	32.40
8	Zhang, YF	5	97	4	19.40
2013–2017					
1	Chryssolouris, G	11	41	3	3.73
2	Jardim-Goncalves, R	8	30	2	3.75
3	Tavakkoli-Moghaddam, R	8	34	4	4.25
4	Jolai, F	7	21	3	3.00
5	Makris, S	7	44	3	6.29
6	Zhang, C	7	15	3	2.14
7	Azadeh, A	6	23	2	3.83
8	Mourtzis, D	6	23	2	3.83
9	Fu, JZ	5	3	1	0.60
10	Grilo, A	5	26	2	5.20
11	Papakostas, N	5	20	2	4.00
12	Renna, P	5	31	2	6.20
13	Wang, JB	5	24	3	4.80
14	Zhao, FQ	5	24	3	4.80

Abbreviations are available in the previous tables. The list only shows authors with 3 or more papers in the periods 1988–1992, 1993–1997 and 1998–2002, and 5 papers or more in the periods 2003–2007, 2008–2012 and 2013–2017.

publications out of 1687 published have more than 10 citations while more than 50% of the total documents have more than 5 citations. If we exclude publications of the last 4 years, then 61.09% of the total documents have received more than 5 citations. A total of 191 papers have yet to receive any citation, and more than 40% of them are published in the last 2 years, i.e. 2016 and 2017. Therefore, most documents that are still not cited are from recent years, and it is obvious that these documents will receive citation with the progress of time. Thus, which papers and authors contribute highly to this journal? Which topics are receiving a huge amount of attention by the scientific community? Which types of research works are receiving more citations? To answer the above queries, the next subsection depicts and discusses those published papers of the journals that are most cited.

3.2. Influential papers in IJCIM

Table 2 provides the information about the number of papers that have citations more than particular thresholds such as 100, 50, 20 citations, etc. However, there is no information in the table about title, authors, total citation and citation rate of most-cited papers. Table 3 provides all related information about the top 50 cited papers from IJCIM.

A review paper written by Xun Xu, Lihui Wang and Stephen T. Newman on computer-aided process planning leads the list of top 50 cited papers of IJCIM. This work, published in 2011, and according to WoS, received a total 119 citations at an average of 19.83 citations per year within 6 years. According to the Google Scholar, it has 235 citations. Leading from the front, the present editor-in-chief, Professor Newman, has been working as an author for this review paper. A survey paper entitled 'A state of the art survey of cloud manufacturing' written by Wu He and Lida Xu has the highest citation rate per year. This work was published in 2015, and within only 2 years, the paper received a total of 46 citations. Many other review papers appear in the list. Thus, clearly review and survey papers tend to have strong importance in the journal.

Another article published in 2015 entitled 'Real-time information capturing and integration framework of the internet of manufacturing things' has 38 citations with an average of 19 citations per year. These statistics provide the evidence about the importance of web-based manufacturing research in the present competitive business scenario. Stephen T. Newman has three papers in the top 20 most-cited papers of IJCIM. There are six papers of 2009 in the list of top 50 most cited papers. The paper entitled 'Analysis of periodic and event-driven rescheduling policies in dynamic shops' is the second most-cited paper of the list and was published in 1992. The work on intelligent shop floor control prepared by Jones and Saleh in 1990 is the oldest paper of the list. Fifteen of the top 50 influential papers have been receiving more than five citations per year, and five among them have been receiving more than 10 citations per year.

Next, we investigated the documents that are most cited by documents published in IJCIM. Table 4 shows the top 30 documents cited in the IJCIM publications.

The book written by the first author, James Rumbaugh, about object-oriented modelling and design leads the Table 4 with 31 citations and 22 co-citations. Interestingly, top four positions of Table 4 are books. The fifth ranked document, written in 1988 and published in Computer-Aided Design, is in the top among journal papers. The oldest paper in the list was written by the legendary professor Lotfi A. Zadeh in 1965 and published in the journal Information and Control. The paper by Xun Xu in Robotics and Computer-Integrated Manufacturing, v28, p75, is the newest paper on the list. The top 30 papers have only seven documents, more than or equal to the 15 co-citation indices. Interestingly, the top 30 have only four documents from IJCIM, and all others are from different journals and books. This result shows diversity in its citation pattern. The top 30 most cited documents in IJCIM publications have 15 journal articles, 14 books and one conference proceeding article. Most contributing authors, institutions and countries of IJCIM are depicted in the next subsection.

Table 7. The most productive and influential institutions in IJCIM.

R	University	Country	TP	TC	TH	TC/TP	>50	>25	>10	ARWU	QS
1	Loughborough U	UK	67	754	15	11.25	1	7	28	-	237
2	U Hong Kong	CHN	42	636	16	15.14	1	9	21	101–150	27
3	Shanghai Jiao Tong U	CHN	37	254	11	6.86	0	1	12	101–150	61
4	Purdue U	USA	30	427	11	14.23	2	2	14	63	92
5	U Patras	GRC	30	330	11	11.00	0	5	13	-	651–700
6	U Bath	UK	29	527	11	18.17	3	4	13	301–400	159
7	National Cheng Kung U	TWN	22	239	7	10.86	0	5	7	401–500	241
8	U Tehran	IRN	22	96	6	4.36	0	0	4	301–400	551–600
9	Cranfield U	UK	20	246	10	12.30	0	3	10	-	-
10	Hong Kong Polytechnic U	CHN	20	123	6	6.15	0	1	4	301–400	111
11	Zhejiang U	CHN	20	68	5	3.40	0	0	2	101–150	110
12	National Tsing Hua U	TWN	19	133	8	7.00	0	1	7	301–400	151
13	City U Hong Kong	CHN	18	131	8	7.28	0	0	3	201–300	55
14	Indian Institute of Technology	IND	18	97	6	5.39	0	0	3	-	-
15	Tsinghua U	CHN	18	196	8	10.89	0	2	7	58	24
16	Chung Yuan Christian U	TWN	16	108	6	6.75	0	0	4	-	-
17	Nanyang Technological U	SGP	16	130	7	8.13	0	0	5	101–150	13
18	National Chiao Tung U	TWN	16	109	6	6.81	0	1	3	401–500	174
19	U Windsor	CAN	16	179	8	11.19	0	2	8	-	651–700
20	U Nova de Lisboa	PRT	15	99	5	6.60	0	0	4	-	366
21	U Auckland	NZL	14	260	8	18.57	1	2	7	151–200	81
22	Arizona State U	USA	13	133	6	10.23	0	1	4	101–150	222
23	Penn State U	USA	13	169	9	13.00	0	1	9	85	95
24	U de Toulouse	FRA	13	53	5	4.08	0	0	0	-	701+
25	U North Carolina	USA	13	89	5	6.85	0	0	3	35	78
26	U Nottingham	UK	13	97	6	7.46	0	0	5	101–150	75
27	Islamic Azad U	IRN	12	100	6	8.33	0	1	5	-	-
28	National U Singapore	SGP	12	96	6	8.00	0	1	3	83	12
29	Wichita State U	USA	12	81	5	6.75	0	0	3	-	-
30	Xi An JiaotongU	CHN	12	146	6	12.17	0	1	4	151–200	318
31	Guangdong U Technology	CHN	11	106	5	9.64	0	1	4	-	-
32	Northwestern Polytech U	CHN	11	113	6	10.27	0	1	5	-	-
33	U Porto	PRT	11	57	4	5.18	0	0	2	301–400	323
34	Seoul National U	KOR	10	68	5	6.80	0	0	2	101–150	35
35	Sharif U Technology	IRN	10	60	4	6.00	0	0	3	-	431–440
36	U Politec Valencia	ESP	10	63	4	6.30	0	0	2	301–400	431–440
37	U Grenoble Alpes	FRA	10	101	6	10.10	0	1	3	151–200	206
38	U Lille Nord de France Comue	FRA	10	113	6	11.30	0	1	5	-	-
39	U Lorraine	FRA	10	198	7	19.80	2	3	5	201–300	701+
40	Brunel U	UK	9	80	5	8.89	0	0	3	401–500	345
41	Joseph Fourier U	FRA	9	98	6	10.89	0	1	3	151–200	206
42	North Carolina State U	USA	9	64	5	7.11	0	0	2	201–300	277
43	U Maryland College Park	USA	9	52	3	5.78	0	0	2	52	131
44	Durham U	UK	8	149	6	18.63	0	2	5	201–300	74
45	Polytechnic U Milan	ITA	8	24	3	3.00	0	0	0	201–300	183
46	Polytechnic U Turin	ITA	8	73	5	9.13	0	1	1	201–300	551–600
47	U Minho	PRT	8	38	4	4.75	0	0	1	401–500	-
48	U Basque Country	ESP	8	74	5	9.25	0	0	4	401–500	-
49	U Cambridge	UK	8	115	6	14.38	0	2	5	4	4
50	U Manchester	UK	8	19	3	2.38	0	0	0	35	29

Abbreviations are available in the previous tables except for: >25 = Number of papers with more than 25 citations; ARWU = Academic Ranking of World Universities; QS = Quacquarelli and Symonds University Ranking. Note that Joseph Fourier University is now part of the University of Grenoble Alpes.

3.3. Leading authors, institutions and countries

This subsection explores leading authors, institutions and countries in IJCIM. First, look at the leading authors. Table 5 presents the information of the 50 most contributing authors of IJCIM based on the number of publication. The list also provides information about affiliation, total citation, *h*-index, total citations per paper and citations more than the threshold 10 and 50 citations.

George Chryssolouris with 26 publications leads the list of most contributing authors of IJCIM followed by George Q. Huang. Interestingly, the first publication of the leading author for this journal is in issue 3 of the very first volume and the 26th publication appeared in the last issue of volume 30. Professor Huang from the University of Hong Kong leads in the *h*-index category as his 11 articles have at least 11 citations. He also has been contributing to this journal since 1998. The articles entitled 'Web-integrated manufacturing: recent developments and emerging issues' and 'Radio frequency identification-enabled real-time manufacturing execution system: a case study in an automotive part manufacturer' are the top two cited documents of Professor Huang. The present editor-in-chief, Professor Stephen T. Newman, leads in the total citation category. Three articles of Professor Newman have more than 50 citations and eight articles have more than 10 citations. Xun Xu of University of Auckland leads in the citations per paper category. Professor Xu is the first author of the most cited paper of IJCIM (see Table 3). Thirteen authors among the top 50 leading authors have at least five publications having more than 10 citations each. Seven authors have an

Table 8. Temporal analysis of the 30 most contributing institutions.

R	University	TP	TC	TH	TC/TP
1988–1992					
1	National Chiao Tung University	7	51	5	7.29
2	Purdue University	7	153	5	21.86
3	University of Maryland College Park	7	29	3	4.14
4	Loughborough University	6	45	4	7.50
5	North Carolina State University	6	36	3	6.00
6	University of North Carolina	6	36	3	6.00
1993–1997					
1	Purdue University	10	130	7	13.00
2	Loughborough University	8	112	6	14.00
3	Penn State University	6	67	5	11.17
4	Wichita State University	6	43	4	7.17
1998–2002					
1	University of Hong Kong	11	177	7	16.09
2	Loughborough University	10	91	6	9.10
3	City University of Hong Kong	9	85	7	9.44
4	Arizona State University	6	85	5	14.17
5	National Cheng Kung University	6	118	4	19.67
2003–2007					
1	Loughborough University	22	291	11	13.23
2	Hong Kong Polytechnic University	9	65	5	7.22
3	University of Patras	8	138	7	17.25
4	University of Hong Kong	7	100	5	14.29
5	National University of Singapore	6	66	4	11.00
2008–2012					
1	Shanghai Jiao Tong University	17	154	8	9.06
2	University of Bath	16	303	8	18.94
3	University of Hong Kong	16	303	10	18.94
4	Loughborough University	15	184	7	12.27
5	Tsinghua University	10	142	6	14.20
6	Indian Institute of Technology IIT	8	29	4	3.63
7	National Cheng Kung University	8	62	4	7.75
8	University of Auckland	8	194	6	24.25
9	University of Nottingham	7	44	5	6.29
10	University of Windsor	7	129	6	18.43
11	Xi An Jiaotong University	7	100	5	14.29
12	Zhejiang University	7	31	4	4.43
13	Cranfield University	6	94	5	15.67
14	National Tsing Hua University	6	65	4	10.83
15	University of Patras	6	116	6	19.33
16	Wuhan University of Technology	6	55	4	9.17
2013–2017					
1	University of Tehran	21	83	5	3.95
2	University of Patras	15	61	4	4.07
3	Zhejiang University	11	22	2	2.00
4	Shanghai Jiao Tong University	10	31	3	3.10
5	Islamic Azad University	9	43	4	4.78
6	Universidade Nova de Lisboa	9	35	3	3.89
7	NorthwesternPolytechnical University	7	66	4	9.43
8	Sharif University of Technology	7	20	3	2.86
9	Indian Institute of Technology IIT	6	11	2	1.83
10	Loughborough University	6	35	3	5.83
11	Universite de Toulouse	6	19	2	3.17
12	University of Bath	6	64	3	10.67

Abbreviations are available in the previous tables.

average of more than 20 citations per paper category. To extend this analysis on a time basis, Table 6 provides the information of most contributing authors for the time intervals 1988–1992, 1993–1997, 1998–2002, 2003–2007, 2008–2012, 2013–2017.

During the first five years of the journal, only two authors, R.K. Li and R.E. Young, have 3 or more papers. Only five and seven authors have 3 or more publications in the periods 1993–97 and 1998–2002, respectively. G. Chryssolouris leads in the time periods 2003–2007 and 2013–2017 with 7 and 11 papers, respectively. Huang, GQ leads in the time periods 2008–2012 with 10 papers. R. Jardim-Goncalves and, R Tavakkoli-Moghaddam are in the second and third position with eight publications each in the time periods 2013–2017. Table 7 presents the top 50 productive and influential institutions in IJCIM.

Loughborough University of the United Kingdom is the leading institution of IJCIM in both the TP and TC categories. Two Chinese Universities, University of Hong Kong and Shanghai Jiao Tong University, occupy second and third place in the list of top 50 productive universities. University of Hong Kong leads in the TH category with a score of 16. That is, out of 42 publications of University of Hong Kong in IJCIM, 16 publications have at least 16 citations. Ten publications of University of Lorraine have a total of 198 citations. As a result, the University of Lorraine leads in the TC/TP category. The last two indicators of Table 7, i.e. the Academic Ranking of World Universities (ARWU) and the Quacquarelli Symonds (QS) World University Rankings, are used to analyse the present world ranking of the leading universities in IJCIM. China, UK and the USA have nine, eight and seven universities, respectively, in the list of the top 50 universities. France has five institutions in the top 50. Only seven universities of the top 50 appear in the top 100 of the world university rankings and according to the QS World University Rankings, 13 universities of Table 7 are in the top 100 in the world. The results of Table 7 clearly show that the IJCIM has a universal profile in publishing papers from universities of different countries around the world. Table 8 intensifies this analysis by presenting most contributing institutions for the intervals 1988–1992, 1993–1997, 1998–2002, 2003–2007, 2008–2012, 2013–2017.

The list of Table 8 shows only institutions with 6 or more papers in the periods 1988–1992, 1993–1997 and 1998–2002, and 5 papers or more in the periods 2003–2007, 2008–2012 and 2013–2017. Loughborough University of the United Kingdom consistently holds its position in the top four in all intervals except the recent interval, i.e. 2013–2017. Interestingly, the University of Tehran leads the interval 2013–2017 with 21 publications, although it has no position in the previous intervals. The University of Tehran has a total of 22 publications in IJCIM. Therefore, this Iranian University has only one publication before 2013, and it certainly emerges in the interval 2013–2017 with the best performance. Thus, it will be interesting to observe whether it can continue its performance in the future or not. Shanghai Jiao Tong University leads in the interval 2008–2012 with 17 publications and gets fourth position in the interval 2013–2017. The temporal analysis is clearly showing the dominance of Asian Universities in the recent years because, during the last two decades, Asian countries such as China, Taiwan, Iran, Korea, and India have been growing rapidly in CIM. These results are consistent with Tables 5 and 6, where the number of Asian authors publishing significantly in the journal is growing significantly through time.

To obtain a more general perspective of the results, we examine the publications at the country level. Table 9 presents the 30 most productive countries for IJCIM.

The rankings of the top 50 countries are prepared based on total publications. The USA has occupied the top position in the TC, TP and TH categories. In terms of total publications, China and UK have taken second and third place, respectively. UK is ahead of China in total citation category. New Zealand and Belgium are in the first and second positions, respectively, in citation per publication index. Ten

Table 9. The most productive and influential countries in IJCIM.

R	Country	TP	TC	TH	TC/TP	> 100	> 50	Population (thousands)	TP/Pop	TC/Pop
1	USA	310	2998	27	9.67	7	41	32,312,751	0.96	9.28
2	China	293	2374	24	8.10	1	35	1,378,665	0.21	1.72
3	UK	225	2516	24	11.18	6	31	6,513,823	3.45	38.63
4	Taiwan	131	1010	16	7.71	0	12	2,349,200	5.58	42.99
5	France	120	1041	17	8.68	3	15	6,680,838	1.80	15.58
6	South Korea	89	698	13	7.84	2	8	5,061,700	1.76	13.79
7	Canada	72	713	14	9.90	0	11	3,585,177	2.01	19.89
8	Iran	66	411	13	6.23	0	3	8,027,743	0.82	5.12
9	Germany	65	394	13	6.06	0	2	8,141,315	0.80	4.84
10	Italy	64	466	11	7.28	0	5	6,080,208	1.05	7.66
11	Spain	49	341	10	6.96	0	3	4,641,827	1.06	7.35
12	India	42	298	10	7.10	0	5	131,105,053	0.03	0.23
13	Portugal	37	217	9	5.86	0	0	1,034,865	3.58	20.97
14	Greece	36	343	11	9.53	0	6	1,082,373	3.33	31.69
15	Turkey	36	253	9	7.03	0	2	78,665,83	0.46	3.22
16	Singapore	30	242	9	8.07	0	5	560,719	5.35	43.16
17	Netherlands	25	189	7	7.56	1	1	1,693,652	1.48	11.16
18	Sweden	22	240	7	10.91	1	2	990,312	2.22	24.23
19	Switzerland	22	181	7	8.23	0	4	837,210	2.63	21.62
20	Brazil	21	120	6	5.71	0	0	20784753	0.10	0.58
21	Japan	19	129	7	6.79	0	2	12,695,847	0.15	1.02
22	Australia	17	181	6	10.65	1	1	2,378,117	0.71	7.61
23	New Zealand	16	322	9	20.13	2	4	459,570	3.48	70.07
24	Israel	14	120	7	8.57	0	2	838,040	1.67	14.32
25	Finland	13	90	5	6.92	0	1	549,510	2.37	16.38
26	Ireland	13	130	7	10.00	0	2	47,731	2.72	27.24
27	Belgium	12	190	6	15.83	1	4	1128572	1.06	16.84
28	Hungary	11	52	5	4.73	0	0	981796	1.12	5.30
29	Mexico	11	124	4	11.27	1	3	12,701,722	0.09	0.98
30	Denmark	10	53	4	5.30	0	1	573,112	1.74	9.25
31	Thailand	9	34	4	3.78	0	0	6,886,351	0.13	0.49
32	Saudi Arabia	8	56	4	7.00	0	0	3,227,569	0.25	1.74
33	Slovenia	7	43	4	6.14	0	1	206,484	3.39	20.82
34	Tunisia	7	79	4	11.29	0	2	1,140,325	0.61	6.93
35	Algeria	5	14	3	2.80	0	0	4,060,605	0.12	0.34
36	Malaysia	5	39	4	7.80	0	0	3,118,726	0.16	1.25
37	South Africa	5	7	1	1.40	0	0	103,301,146	0.00	0.01
38	Colombia	4	8	1	2.00	0	0	549,510	0.73	1.46
39	Pakistan	4	3	1	0.75	0	0	19,320,348	0.02	0.02
40	Poland	4	8	2	2.00	0	0	3,799,949	0.11	0.21
41	Byelarus	3	22	2	7.33	0	0	950,712	0.32	2.31
42	Chile	3	20	3	6.67	0	0	1,794,814	0.17	1.11
43	Croatia	3	26	3	8.67	0	0	417,060	0.72	6.23
44	Kuwait	3	24	3	8.00	0	0	405,258	0.74	5.92
45	Serbia	3	10	1	3.33	0	0	705,741	0.43	1.42
46	Czech Republic	2	1	1	0.50	0	0	1,056,163	0.19	0.09
47	Egypt	2	17	1	8.50	0	0	9,568,868	0.02	0.18
48	Jordan	2	7	2	3.50	0	0	94,558	0.21	0.74
49	Norway	2	14	2	7.00	0	0	523,293	0.38	2.68
50	Oman	2	2	1	1.00	0	0	442,476	0.45	0.45

Abbreviations are available in the previous tables except for: >100 = Number of papers with more than 100 citations; TP/Pop and TC/Pop = Number of papers and citations per million inhabitants, respectively.

countries have contributed more than 50 publications in the IJCIM, and five among them have more than 100 publications. Different countries have different populations. To provide a population-based study and comparison among the countries, the last two columns of Table 9 present data of publication and citation per million inhabitants. Both Taiwan and Singapore with an average of more than five publications per million people are leading the TP/Pop index. New Zealand leads in the TC/Pop category, well ahead of its challengers Singapore and Taiwan. More than 40% of the top 50 productive and influential countries in IJCIM are from Europe. Four countries of Asia, China, Taiwan, South Korea and Iran, are in Top 10. Brazil leads the Latin American countries with 21 publications. USA, China, and UK have more than two thousand citations. Considering the yearly contribution of the top 30 countries presented in Table 10, in terms of number of publications, China is increasingly improving its presence over time. During the last decade, Iran also improved significantly. However, numbers of publications of UK and USA during last five years are fewer compared to China. Graphical representation of yearly number of publications during the last 10 years of the top eight countries is presented in Figure 3.

Table 11 presents publication and citation information on a supranational region basis. For this, we consider nine supranational regions: Western Europe, East Asia, North America, Rest of Asia, Middle East, Latin America, Oceania, Eastern Europe and Africa.

Interestingly, Western Europe has a comfortable lead in all categories except TC/TP. Recall that four out of the top 10

Table 10. Temporal evolution of the publications in IJCIM by countries.

R	Country	Pre 2003	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	Total
1	USA	184	16	8	14	9	2	13	14	7	5	7	6	7	9	6	3	310
2	China	45	5	7	7	10	19	9	21	16	21	28	15	22	28	17	23	293
3	UK	89	11	10	6	13	10	11	10	17	7	8	13	5	9	4	2	225
4	Taiwan	59	4	1	5	1	3	3	7	8	6	10	5	6	6	4	3	131
5	France	31	6	5	4	5	7	12	2	5	10	4	9	6	3	5	6	120
6	South Korea	30	2	4	4	7	1	8	7	3	4	1	3	3	4	5	3	89
7	Canada	21	3	1	2	7	3	6	8	2	0	6	1	4	3	1	4	72
8	Iran	0	0	0	0	1	0	1	1	1	9	5	4	14	11	13	6	66
9	Germany	15	4	3	3	6	0	4	4	1	3	1	4	2	1	8	6	65
10	Italy	11	0	6	2	2	4	0	5	4	3	1	6	6	7	2	5	64
11	Spain	5	1	2	5	2	2	0	4	3	6	3	3	4	2	5	2	49
12	India	5	0	0	1	1	1	2	3	3	7	7	2	2	2	3	3	42
13	Portugal	6	2	2	3	0	0	0	0	6	0	1	6	2	0	0	9	37
14	Greece	2	1	0	1	3	3	1	1	1	2	2	1	0	7	6	5	36
15	Turkey	7	1	1	0	1	0	4	4	1	1	3	2	3	2	2	4	36
16	Singapore	12	2	3	2	2	4	1	0	0	0	1	1	1	1	0	0	30
17	Netherlands	11	3	1	0	0	1	0	1	3	0	3	0	2	0	0	0	25
18	Sweden	3	0	0	0	0	1	0	1	1	5	2	2	2	1	0	4	22
19	Switzerland	2	1	1	0	3	1	0	2	0	0	0	2	0	6	2	2	22
20	Brazil	3	1	1	1	1	0	1	0	3	0	0	3	1	1	4	1	21
21	Japan	7	1	1	0	1	3	1	1	0	0	0	3	0	1	0	0	19
22	Australia	10	0	0	0	0	1	0	0	0	0	0	2	1	1	1	1	17
23	New Zealand	1	0	0	1	3	2	3	1	0	2	2	0	0	1	0	0	16
24	Israel	11	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	14
25	Finland	1	0	0	2	1	1	0	0	0	1	1	1	0	3	0	2	13
26	Ireland	4	0	1	1	1	0	0	2	0	0	1	1	0	0	0	2	13
27	Belgium	5	0	0	1	0	0	3	0	0	0	0	0	0	2	0	1	12
28	Hungary	3	0	0	1	0	0	1	1	1	0	0	0	1	0	2	1	11
29	Mexico	1	0	0	3	0	0	1	0	0	0	0	0	2	1	0	3	11
30	Denmark	5	1	0	0	1	0	0	0	0	0	0	1	0	0	2	0	10

Abbreviations: Pre-2003 = Number of publications between 1988–2002. The remaining years indicate the number of publications in that year.

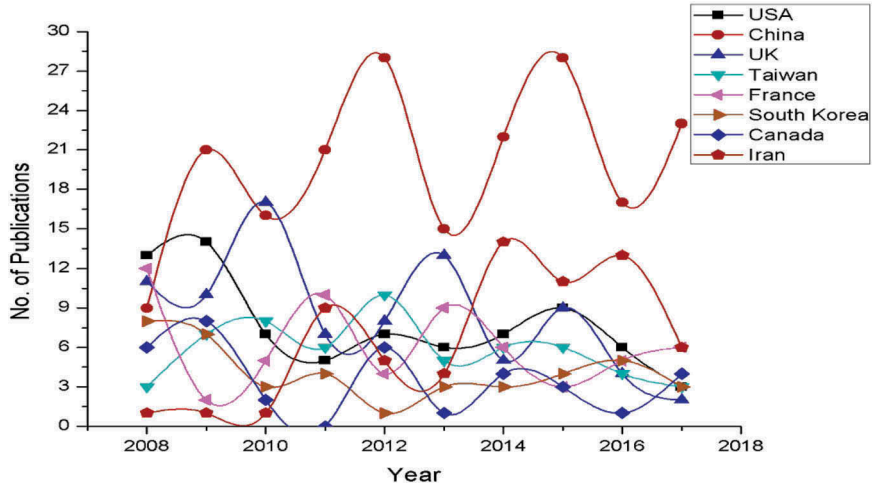

Figure 3. Number of publications of the top eight countries during 2008–2017.

Table 11. Productivity by supranational regions.

Regions	TP	TC	TH	TC/TP	>100	>50	Population	TP/Pop	TC/Pop
Western Europe	651	5803	31	8.91	2	11	388,891	1.67	14.92
East Asia	522	4134	28	7.92	0	3	1,641,908	0.32	2.52
North America	371	3646	29	9.83	1	7	358,400	1.04	10.17
Rest of Asia	142	946	15	6.66	0	0	2,449,768	0.06	0.39
Middle East	46	301	10	6.54	0	0	371,000	0.12	0.81
Latin America	40	295	10	7.38	0	1	639,048	0.06	0.46
Oceania	33	504	11	15.27	1	3	40,117	0.82	12.56
Eastern Europe	28	126	6	4.50	0	0	410,000	0.07	0.31
Africa	21	124	6	5.90	0	0	1,225,080	0.02	0.10

Abbreviations are available in the previous tables. Population is in thousands.

productive countries are from the Western European region and that is why it leads with a huge margin. Beating the North American region, East Asia occupied the second position in both the TP and TC indices. Recall from Table 9 that three East Asian countries (China, Taiwan and South Korea) are in the top 10 productive countries of IJCIM. Performance of the Eastern Europe and African countries needs to improve significantly.

3.4. Citing articles and comparison with other journals

Finally, we examine the citing articles of all IJCIM publications. To do so, Table 12 presents the authors, institutions, countries and journals that have the highest number of articles citing IJCIM.

Table 12. Citing articles of IJCIM: Countries, universities, and journals.

R	University	TP	Country	TP	Journal	TP
1	Loughborough U	158	China	1569	Int J Computer Integrated Manufacturing	818
2	Shanghai Jiao Tong U	138	USA	1197	Int J Production Research	641
3	U Hong Kong	138	UK	822	Int J Advanced Manufacturing Technology	545
4	Hong Kong Polytech U	93	Taiwan	484	Computers in Industry	207
5	Purdue U	93	France	442	Computers Industrial Engineering	204
6	Indian Institute Tech	87	Canada	336	J Intelligent Manufacturing	166
7	Beihang U	85	South Korea	310	Robotics and Computer Integrated Manufact	158
8	U Bath	82	India	282	Int J Production Economics	151
9	U Tehran	79	Turkey	281	Proc Inst Mechanical Eng Part B J Engin Manufact	140
10	Cranfield U	76	Iran	267	Production Planning Control	103
11	National Cheng Kung U	75	Spain	261	J Manufacturing Systems	97
12	Northwestern Polytech U	74	Italy	256	Expert Systems with Applications	89
13	Tsinghua U	73	Germany	222	European J Operational Research	86
14	Xi An Jiaotong U	71	Australia	144	Computer Aided Design	80
15	Penn State U	69	Singapore	139	CIRP Annals Manufacturing Technology	64
16	National Tsing Hua U	68	Japan	113	J Cleaner Production	63
17	U Auckland	64	Brazil	105	Concurrent Engineering Research and Applications	50
18	Zhejiang U	64	Greece	99	Engineering Applications of Artificial Intelligence	44
19	National U Singapore	63	Portugal	96	IIE Transactions	41
20	Nanyang Tech U	61	Netherlands	95	Advanced Engineering Informatics	40
21	U Polytech Valencia	59	Sweden	95	Applied Soft Computing	37
22	Polytechnic U Milan	58	Malaysia	92	Advances in Mechanical Engineering	36
23	City U Hong Kong	56	New Zealand	79	Computers Operations Research	36
24	U Lorraine	56	Finland	65	Industrial Management Data Systems	36
25	U Nottingham	51	Switzerland	63	Mathematical Problems in Engineering	36
26	U Patras	51	Mexico	60	J Engineering Design	34
27	U Toulouse	50	Belgium	52	J Manufacturing Science Engineering Trans ASME	33
28	Feng Chia U	47	Israel	51	J Materials Processing Technology	33
29	Southeast U China	46	Poland	47	Assembly Automation	32
30	National Chiao Tung U	45	Serbia	47	Computer Integrated Manufacturing Systems	31

Abbreviations are available in the previous tables.

Table 13. Publications and citations of 20 selected top international journals.

	TP	TC	C/P	H	>200	>100	>10	IF	5Y-IF	Q
Expert Systems with Applications	9596	182,348	19	115	25	165	5272	3.768	3.711	Q1
European J of Operational Research	6500	115,349	17.75	107	28	124	3065	3.428	3.96	Q1
IJ Advanced Manufacturing Technology	9802	83,692	8.54	65	3	18	2847	2.601	2.748	Q2
Int J Production Economics	3327	67,573	20.31	92	16	80	1866	4.407	4.976	Q1
Int J Production Research	4168	43,749	10.5	56	1	14	1542	2.623	2.78	Q2
Computers & Industrial Engineering	2801	36,422	13	66	2	22	1165	3.195	3.442	Q1
CIRP Annals – Manufacturing Technology	1519	29,460	19.39	74	10	40	732	3.333	4.074	Q1
Int J Machine Tools & Manufacture	1137	28,158	24.77	67	4	27	805	5.106	5.905	Q1
Computer Aided Design	1171	14,137	12.07	45	2	6	423	2.947	2.76	Q1
Robotics and Computer Integrated Manufacturing	885	12,834	14.5	45	1	9	420	3.464	4.031	Q1
Computers in Industry	866	11,963	13.81	44	2	10	366	2.85	2.712	Q2
J Intelligent Manufacturing	1029	10,582	10.28	37	0	3	368	3.667	3.383	Q1
Proc Inst Mechanical Eng Part B J Engin Manufact	1832	9800	5.35	29	1	2	287	1.445	1.587	Q3
J Manufacturing Science Eng Trans ASME	1399	7163	5.12	27	0	0	206	2.578	2.574	Q2
Production Planning Control	788	6529	8.29	32	0	1	219	2.33	2.933	Q2
Int J Computer Integrated Manufacturing	858	6379	7.43	29	0	1	209	1.995	2.016	Q2
J Manufacturing Systems	586	5936	10.13	30	0	4	199	3.699	3.621	Q1
AI EDAM – Art Intel Eng Design Analysis Manuf	331	2162	6.53	20	0	2	59	1.045	1.288	Q4
J Advanced Mechanical Design Syst Manuf	835	1708	2.05	14	0	0	34	0.503	0.54	Q4
Concurrent Engineering: Research and Applic	260	1214	4.67	15	0	0	40	1.456	1.252	Q3

Abbreviations are available in previous tables except for IF and 5Y-IF = Impact factor and 5-year impact factor, respectively, in the Journal Citation Reports (JCR) 2017; Q = Quartile in Web of Science category (closest to IJCIM) in JCR 2017.

The self-citations of IJCIM are the most relevant, followed by the citations of the International Journal of Product ion Research. The International Journal of Advanced Manufacturing Technology cited publications of IJCIM in its 545 articles. Ten journals have cited IJCIM in more than 100 documents available in WoS. At the country level, the top countries of Table 9 also lead this table but with a different order. China is the highest contributing nation by citing IJCIM in 1569 articles. The USA also cited more than one thousand articles from IJCIM. The top institutions of Table 9 are also leading this table.

Next, let us examine the current publication and citation numbers of IJCIM compared to the journals that have the closest connection. Table 13 considers the publications and citations between 2008 and 2017 of 20 selected international journals that have a scope similar to IJCIM.

According to the number of citations that the papers published between 2008 and 2017 have obtained, *Expert Systems with Applications* and the *European Journal of Operational Research* have the highest results. However, the *International Journal of Advanced Manufacturing*

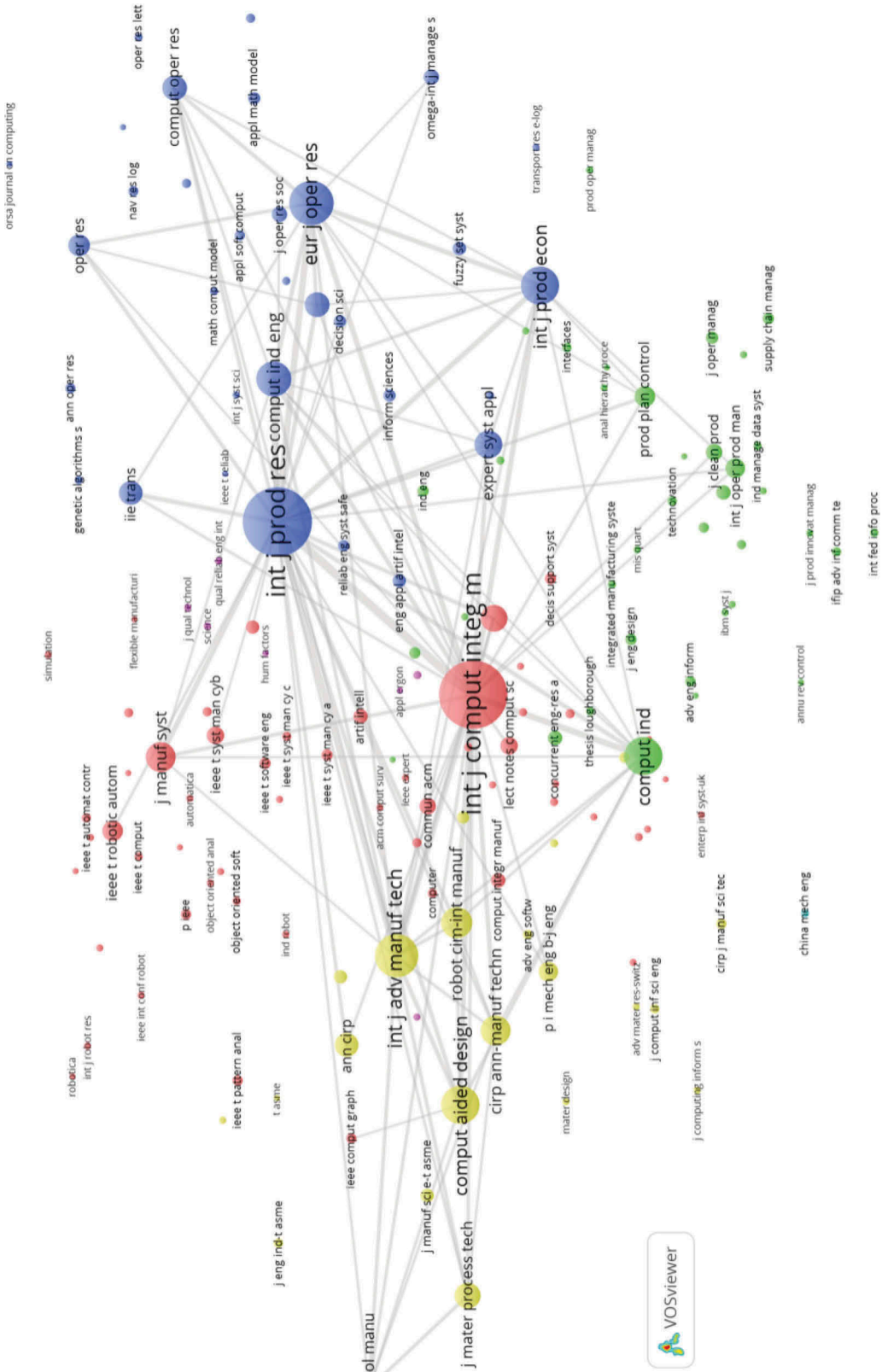

Figure 4. Co-citation of journals in IJCIM.

Table 14. Co-citation of journals in IJCIM: Global and geographical analysis.

	Global			Asia			Europe			America		
R	Journal	Cit	CLS	Journal	Cit	CLS	Journal	Cit	CLS	Journal	Cit	CLS
1	*Int J Prod Res*	2519	1909.85	*Int J Prod Res*	1310	1031.57	*Int J Prod Res*	834	611.04	*Int J Prod Res*	637	411.44
2	*Int J Comput Integ M*	2466	1962.56	*Int J Comput Integ M*	933	788.85	*Int J Comput Integ M*	674	551.64	*Int J Comput Integ M*	230	168.44
3	*Eur J Oper Res*	1057	903.57	*Eur J Oper Res*	697	596.68	*CIRP Ann-Manuf Techn*	342	287.65	*J Manuf Syst*	191	166.10
4	*Int J Adv Manuf Tech*	1017	904.49	*Int J Adv Manuf Tech*	627	556.30	*Comput Ind*	336	296.66	*Int J Comp Integ M*	160	125.64
5	*Int J Prod Econ*	778	702.50	*Comput Aided Design*	478	342.70	*Int J Adv Manuf Tech*	334	295.54	*Comput Aided Design*	158	112.46
6	*Comput Aided Design*	767	568.50	*Comput Ind Eng*	468	433.97	*Int J Comp Integ M*	319	264.21	*Int J AdvManuf Tech*	157	131.51
7	*Comput Ind*	767	686.33	*Int J Prod Econ*	466	421.47	*Int J Prod Econ*	287	254.26	*Eur J Oper Res*	131	109.66
8	*Comput Ind Eng*	675	629.95	*Int J Comp Integ M*	400	343.38	*Eur J Oper Res*	270	229.54	*Comput Ind*	122	108.43
9	*Robot CIM-Int Manuf*	517	483.74	*Comput Ind*	367	328.73	*Robot CIM-Int Manuf*	203	190.91	*Manage Sci*	110	95.47
10	*CIRP Ann-Manuf Techn*	493	428.22	*Expert Syst Appl*	339	295.81	*Comput Aided Design*	196	153.79	*Comput Ind Eng*	104	96.87
11	*J Manuf Syst*	478	434.09	*Comput Oper Res*	275	251.64	*J Mater Process Tech*	166	137.29	*Robot CIM-Int Manuf*	99	90.09
12	*Expert Syst Appl*	418	370.77	*Robot CIM-Int Manuf*	260	246.01	*Int J Mach Tool Manu*	158	125.47	*IEEE T Robotic Autom*	91	67.97
13	*J Intell Manuf*	392	366.95	*J Manuf Syst*	209	191.64	*J Intell Manuf*	157	146.16	*IEEE T Syst Man Cyb*	84	63.40
14	*J Mater Process Tech*	372	317.01	*J Intell Manuf*	205	192.01	*Comput Ind Eng*	151	142.06	*Oper Res*	79	71.63
15	*Int J Mach Tool Manu*	343	284.63	*J Mater Process Tech*	200	168.55	*Ann CIRP*	137	109.21	*IIE Trans*	72	67.24
16	*Manage Sci*	336	306.40	*IIE Trans*	199	187.16	*J Manuf Syst*	135	124.23	*Ann CIRP*	65	56.38
17	*Comput Oper Res*	331	303.85	*Manage Sci*	152	143.23	*Int J Oper Prod Man*	131	118.81	*Int J Prod Econ*	56	51.93
18	*IIE Trans*	306	289.70	*Int J Mach Tool Manu*	141	122.44	*P I Mech Eng B-J Eng*	118	110.78	*Int J Mach Tool Manu*	52	41.41
19	*Ann CIRP*	294	241.35	*Oper Res*	129	123.39	*Prod Plan Control*	105	98.81	*Artif Intell*	51	35.63
20	*Oper Res*	255	237.41	*Prod Plan Control*	126	119.98	*Manage Sci*	103	92.81	*CIRP Ann-Manuf Techn*	51	43.94
21	*Prod Plan Control*	235	223.43	*CIRP Ann-Manuf Techn*	118	113.64	*Expert Syst Appl*	85	79.21	*J Intell Manuf*	51	46.86
22	*IEEE T Robotic Autom*	221	187.67	*IEEE T Robotic Autom*	104	88.21	*Harvard Bus Rev*	71	60.78	*Computer Integrated*	50	42.05
23	*P I Mech Eng B-J Eng*	220	210.26	*Omega-Int J Manage S*	99	95.94	*Commun ACM*	69	57.46	*Commun ACM*	46	42.19
24	*Int J Oper Prod Man*	205	188.79	*Ann CIRP*	97	76.41	*J Clean Prod*	68	55.67	*Comput Oper Res*	40	35.36
25	*IEEE T Syst Man Cyb*	160	139.77	*Fuzzy Set Syst*	94	83.21	*IIE Trans*	64	61.30	*P I Mech Eng B-J Eng*	39	37.42
26	*J Clean Prod*	156	128.03	*J Clean Prod*	91	74.12	*IEEE T Robotic Autom*	56	49.33	*Prod Plan Control*	39	34.70
27	*Commun ACM*	144	130.92	*P I Mech Eng B-J Eng*	83	78.72	*Oper Res*	54	48.47	*Ind Eng*	35	27.85
28	*Omega-Int J Manage S*	138	133.21	*Computer Integrated*	78	73.63	*Comput Oper Res*	47	43.33	*J Mater Process Tech*	34	30.78
29	*Computer Integrated*	134	122.99	*J Oper Res Soc*	78	76.11	*Concurrent Eng-Res A*	46	43.47	*IEEE T Software Eng*	33	27.30
30	*J Oper Res Soc*	127	123.47	*Appl Math Model*	77	73.46	*Supply Chain Manag*	43	39.86	*Expert Syst Appl*	32	28.77

Abbreviations: Cit = Citations; CLS = Citation link strength.

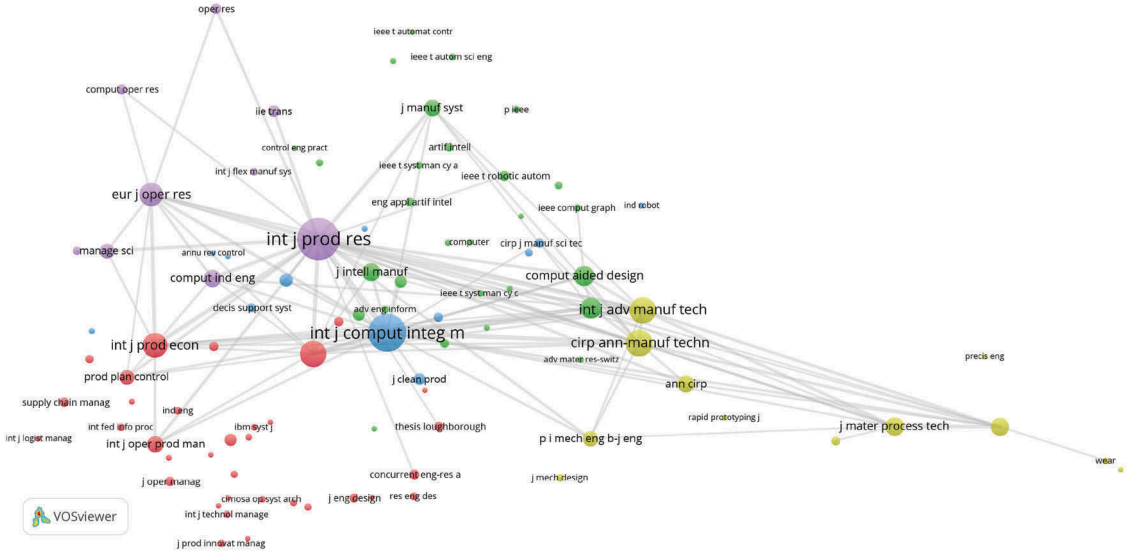

Figure 5. Co-citation of journals in IJCIM: Europe.

Technology is the journal with the highest number of papers published during this period. If the citations per paper are examined, then the *International Journal of Machine Tools and Manufacture* and the *International Journal of Production Economics* perform better. These two journals also obtain the highest impact factors. IJCIM performs quite well in this analysis, considering that these are the top journals in the field. The first six journals clearly published a higher number of papers. However, most of the other journals in the table have a publication and citation profile similar to IJCIM.

The focus is on the leading journals, and therefore, the position of IJCIM is not so remarkable. However, from a general point of view, IJCIM is currently a quartile 2 journal in the Journal Citation Reports (JCR) of the Web of Science. Thus, among the top international journals indexed in the Web of Science category of Engineering – Manufacturing, IJCIM ranks between the top 25% and 50%. In the 2017 JCR

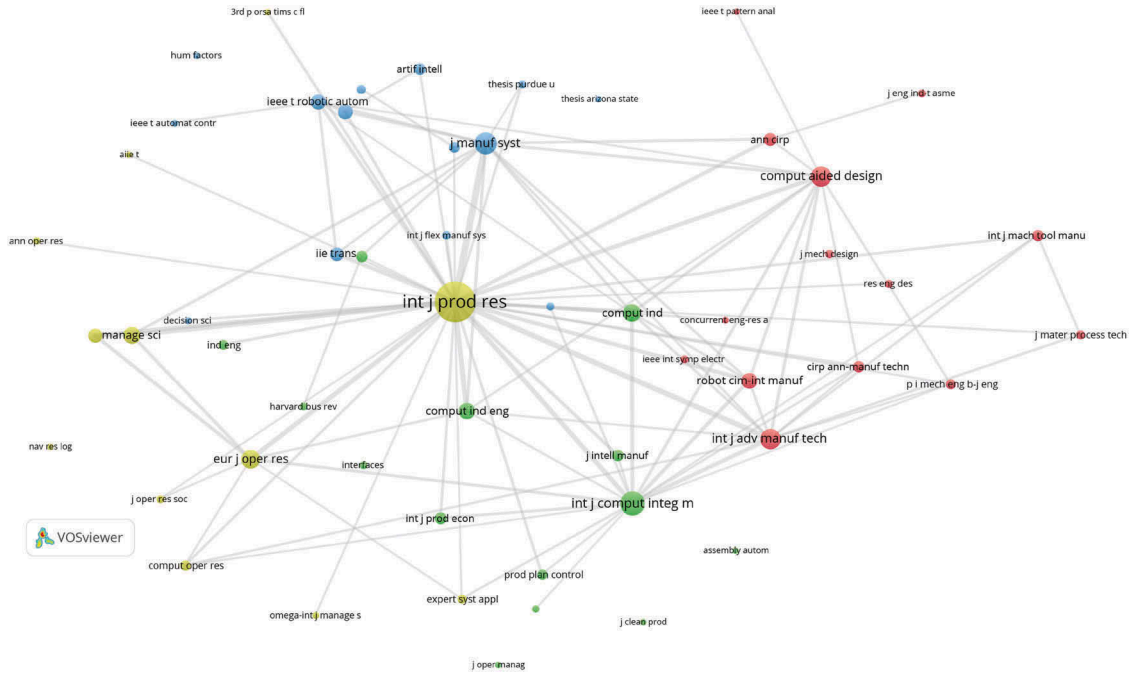

Figure 6. Co-citation of journals in IJCIM: America.

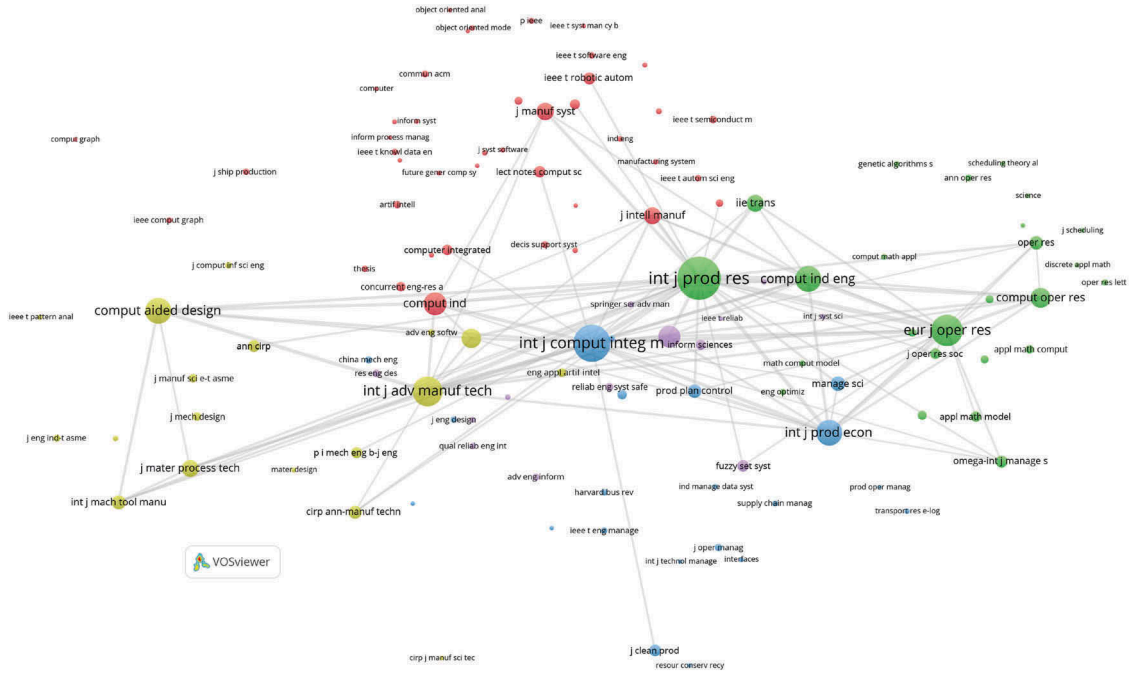

Figure 7. Co-citation of journals in IJCIM: Asia.

edition, IJCIM is ranked the 23rd journal of 46 and excluding journals recently indexed in the Emerging Sources Citation Index of the Web of Science. However, IJCIM obtains better results in the other two categories where it currently appears. In Computer Science – Interdisciplinary Applications, IJCIM ranks 50th of 105 journals, and in Operations Research and Management Science, IJCIM obtains the 30th position out of 83 journals.

4. Mapping IJCIM with VOS viewer software

To obtain an extensive view of the results, this section presents graphical visualisations of bibliographic coupling, co-authorship, co-citation and co-occurrence of keywords. Co-citation of journals occurs when two documents of two different journals receive a citation from the same third document of another journal (Mulet-Forteza et al. 2018). The VOS viewer software generates clusters based on citation links, and these

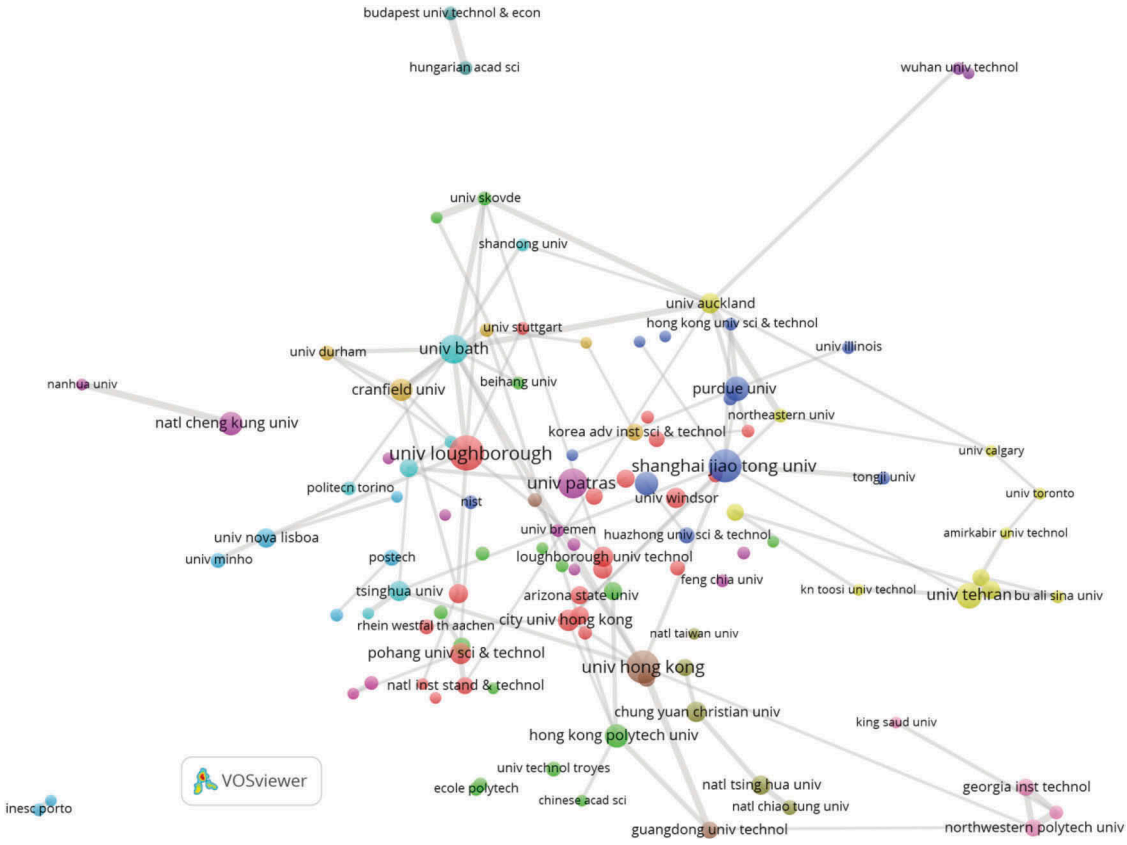

Figure 8. Bibliographic coupling of institutions publishing in IJCIM.

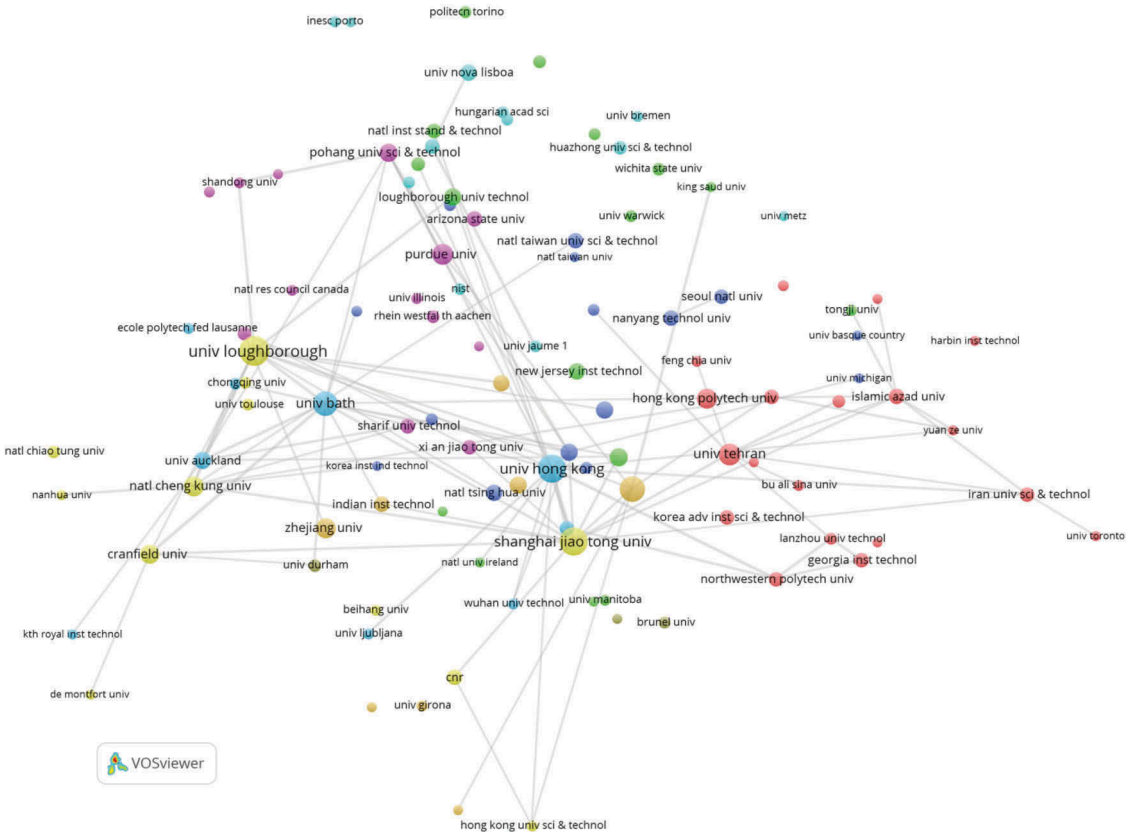

Figure 9. Citation analysis of institutions publishing in IJCIM.

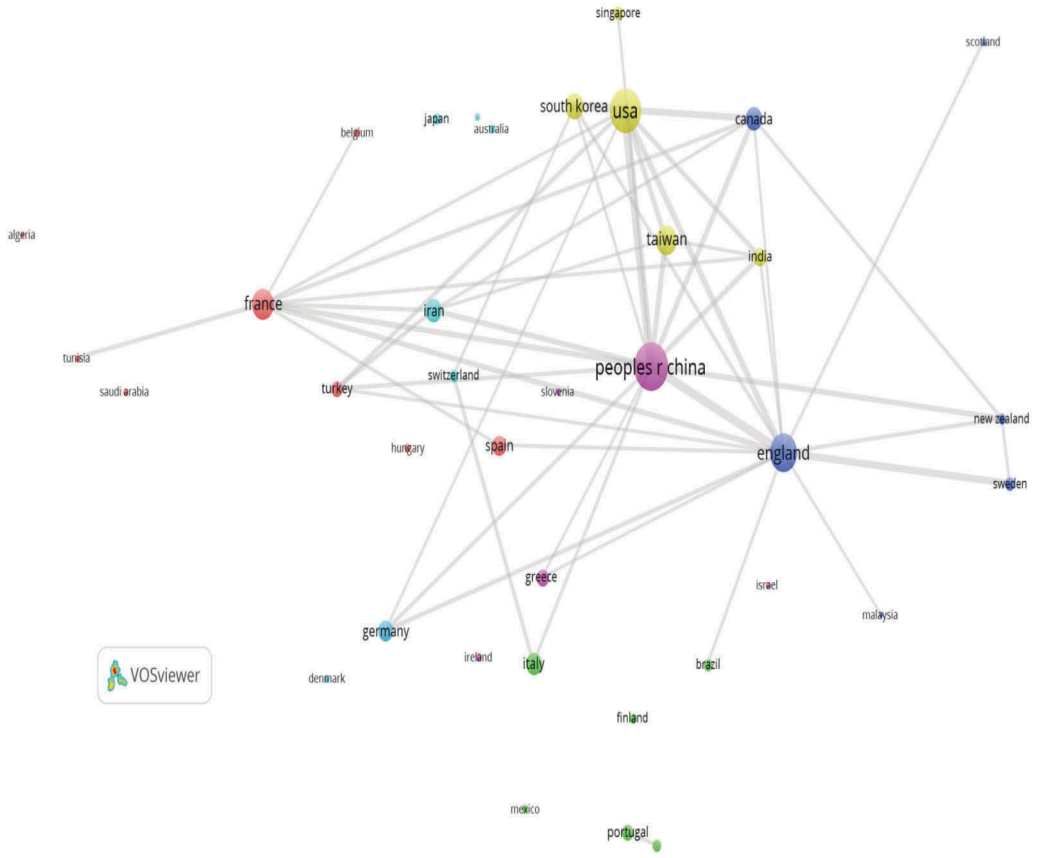

Figure 10. Bibliographic coupling of countries publishing in IJCIM.

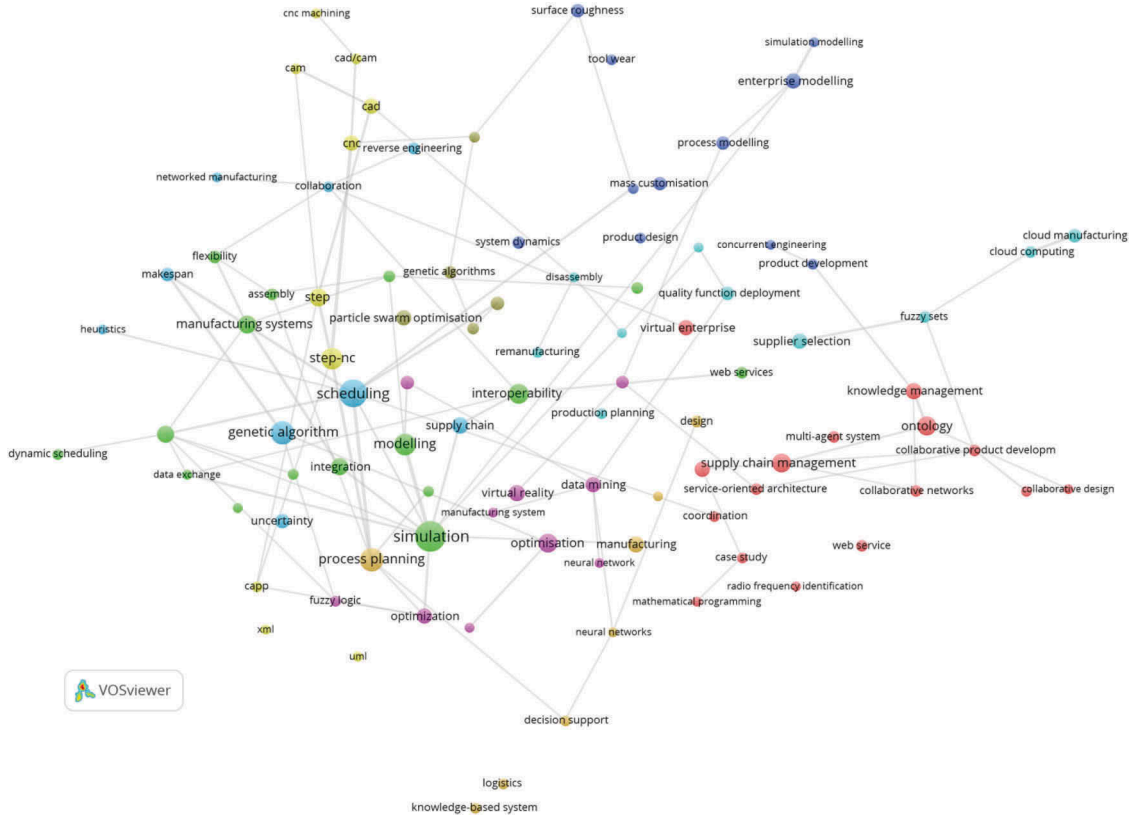

Figure 11. Co-occurrence of author keywords in IJCIM.

clusters are represented by different colours. Figure 4 presents the co-citation of journals in IJCIM.

Figure 4 shows that IJCIM has highest co-citation link with the *International Journal of Production Research*. IJCIM also has a higher co-citation link with the *European Journal of Operational Research* and *International Journal of Advanced Manufacturing Technology*. Table 14 provides details of co-citations and link strength of the top 30 journals with the IJCIM. Nine journals have more than 500-link strength with the IJCIM, including self-citation. To extend this analysis on a regional basis, Figures 5, 6 and 7 depict network visualisation of the co-citation of journals in IJCIM for Europe, America and Asia, respectively.

The International Journal of Production Research and IJCIM itself are in the first and second position, respectively, in all the three continents. Three continent-based studies provide a pattern of co-citation almost similar to the global pattern, proving the consistent influence of IJCIM all around the world.

The case of the *International Journal of Production Research* is also obvious since it is the main journal focussing on production research. For further information on the publication and citation structure of the *International Journal of Production Research*, see Fry et al. (2013). Additionally, for more information on the general citation structure of the production and operations management field, see Fry and Donohue (2013), Fry et al. (2015), Hsieh and Chang (2009) and Shang et al. (2015).

Another important issue to consider is the bibliographic coupling of institutions publishing in IJCIM (Tur-Porcar et al. 2018). Bibliographic coupling is defined as a measure that considers the number of times two different studies reference a common third work in their bibliographies (Kessler 1963). Applying this concept, Figure 8 presents the bibliographic coupling of the leading Universities publishing in IJCIM. This approach allows us to identify the bibliographic references that different institutions have in common and at the same time, see how relevant they are in the field of CIM. Moreover,

Table 15. Co-occurrence of author keywords in IJCIM: Global and geographical analysis.

	Global			Europe			America			Asia		
R	Keyword	Occ	Co-oc	Keyword	Occ	Co-oc	Keyword	Occ	Co-oc	Keyword	Occ	Co-oc
1	Simulation	43	30	Simulation	22	17	Simulation	24	18	Process Planning	9	8
2	Scheduling	37	22	Scheduling	21	15	Interoperability	14	8	Simulation	7	6
3	Process Planning	27	20	Genetic Algorithm	19	10	Modelling	14	9	Optimisation	5	2
4	Genetic Algorithm	26	13	Process Planning	14	11	Scheduling	14	13	Step	5	5
5	Step-NC	23	17	Supplier Selection	12	9	Discrete Event Simulation	13	7	Step-NC	5	3
6	Modelling	22	15	Ontology	11	8	Manufacturing	13	8	Machining	4	4
7	Interoperability	19	12	Step-NC	11	9	Manufacturing Systems	12	10	Optimization	4	4
8	Ontology	17	12	Optimisation	10	5	CNC	9	7	System Dynamics	4	0
9	Optimisation	17	10	Particle Swarm Optimisation	9	4	Knowledge Management	9	5	Virtual Reality	4	1
10	Supply Chain Management	17	12	CAD	8	4	Step-NC	9	7	Complexity	3	2
11	Manufacturing Systems	16	10	Makespan	8	8	Integration	8	8	Manufacturing Service	3	3
12	Step	16	13	Modelling	8	3	Enterprise Modelling	7	6	Manufacturing Systems	3	0
13	Discrete Event Simulation	14	11	RFID	8	3	Optimization	7	5	Mathematical Programming	3	2
14	Integration	14	11	Supply Chain Management	8	5	Process Planning	7	5	Modelling	3	3
15	Knowledge Management	13	9	Data Mining	7	3	Supply Chain	7	6	Ontology	3	3
16	Manufacturing	13	9	Interoperability	7	6	Supply Chain Management	7	4	Reconfigurable Manufacturing Systems	3	2
17	Supply Chain	13	11	Quality Function Deployment	7	6	Virtual Reality	7	5	Scheduling	3	2
18	Virtual Reality	13	4	Virtual Enterprise	7	4	Mass Customisation	6	3	2.5D Milling	2	0
19	CAD	12	8	Virtual Reality	7	2	Virtual Enterprise	6	5	Assembly	2	2
20	CNC	12	10	Web Services	7	6	Collaborative Networks	5	2	CAD	2	1
21	Data Mining	12	6	Mass Customization	6	4	Decision Support	5	3	Collaborative Engineering	2	2
22	Optimization	12	8	Service-Oriented Architecture	6	5	Decision Support Systems	5	5	Collaborative Manufacturing	2	2
23	Particle Swarm Optimisation	12	6	Step	6	5	Design	5	4	Collaborative Product Development	2	0
24	RFID	12	4	Supply Chain	6	5	Flexibility	5	4	Decomposition	2	1
25	Supplier Selection	12	7	Taguchi Method	6	1	Fuzzy Logic	5	4	Design of Experiments	2	1
26	Virtual Enterprise	12	7	Cloud Manufacturing	5	4	Genetic Algorithm	5	2	Disassembly	2	0
27	Enterprise Modelling	11	6	CNC	5	5	Ontology	5	4	Distributed Manufacturing	2	1
28	Uncertainty	10	3	Collaborative Manufacturing	5	4	Process Modelling	5	5	Engineering Design	2	0
29	Cloud Manufacturing	9	3	Fuzzy Sets	5	3	Product Design	5	4	Enterprise Engineering	2	1
30	Makespan	9	9	Heuristics	5	3	Production Planning	5	4	Error	2	1

Abbreviations: Occ = Occurrences; Co-oc = Co-occurrence link strength.

Figure 9 presents graphical visualisation of citations between institutions publishing in IJCIM.

Thus, most of the productive and influential universities appearing in Table 7 form the core in Figures 8 and 9. Loughborough University of the United Kingdom, the University of Hong Kong and Shanghai Jiao Tong University of China and Purdue University of the USA show an important presence in the figures. Now, consider the bibliographic coupling of countries publishing in IJCIM presented in Figure 10. Figure 10 also provides information about the collaboration among different countries. Collaborations can easily be recognised in graphical representation of the VOS viewer through different coloured clusters. Figure 10 depicts three major clusters with yellow-, blue- and purple-coloured nodes. USA, Taiwan, South Korea, India and Singapore form the yellow coloured cluster. China and England are leading the purple and blue coloured clusters, respectively. Most productive and influential countries provided in Table 9 are similarly present in Figure 10.

To illustrate the characteristics of publications in IJCIM, in this part of the study, VOS viewer software is used to draw up co-occurrence of authors keywords and is presented in Figure 11. Note that the keywords analysed here are the keywords used by authors in title, abstract and keywords of the papers. The co-occurrence means the frequency that a keyword appears with other keywords.

According to Figure 11, simulation, scheduling, genetic algorithm, process planning and modelling are keywords commonly used by the authors in their publications in IJCIM. These results clearly show the scope of IJCIM that connects with topics in manufacturing, engineering and computer science.

Table 15 provides the 30 most-used author keywords in IJCIM for a global as well as a continental basis. Simulation is a common keyword used by the authors all around the world. In addition to simulation, scheduling and genetic algorithm are the other two keywords mostly used by the European authors in IJCIM. Interoperability and modelling are special keywords used by American authors, while process planning is the keyword mostly used by Asian authors.

5. Conclusions

In 2017, IJCIM completed its first three decades of a notable journey. During those 30 years, IJCIM has published several outstanding research works related to CIM. These contributions have helped the growth of CIM significantly. To celebrate 30 years of a successful journey of IJCIM, this study analysed all the publications of the IJCIM from 1988 to 2017 through a bibliometric retrospective analysis. The WoS Core Collection database was used to gather all related data and depict the foremost trends of this journal in terms of impact, topics, authors, universities and countries. The results show that IJCIM has become a very popular journal in the scientific community in topics connected to manufacturing, engineering and computer science. Currently, IJCIM performs well among the top journals in the field, although its publication volume is lower than large journals such as the *European Journal of Operational Research* and the *International Journal of Production Research*.

The present study presents the following insights: First, the journal shows consistent growth in terms of the number of publications in each of the three decades. Each year from 2001 to 2013, the journal showed a consistent performance in its total citation index. According to the WoS database, 21 papers of IJCIM have more than 50 citations. More than 50% of the total documents have received more than 5 citations. Second, the top 4 among the 50 most influential documents of IJCIM have more than 100 citations. The article entitled 'Computer-aided process planning – A critical review of recent developments and future trends' published in 2011 is the most cited paper of IJCIM. This study reveals that review papers, state of art reviews and simulation-based studies have a higher chance of receiving more citations than the research articles. Third, Table 4 shows the diversity in the citation pattern of IJCIM. Fifty percent of the 30 most cited documents in IJCIM publications are journal articles. Fourth, the analysis of the most contributing authors shows that George Chryssolouris with 26 publications leads the list in total publications. George Chryssolouris has continuously contributed to the journal from the very first volume to the 30th volume.

Through this publication, we especially want to offer a tribute to his contributions throughout the journey of IJCIM. Loughborough University of United Kingdom is the most productive university of IJCIM in both the TP and TC categories. Two Chinese Universities, University of Hong Kong and Shanghai Jiao Tong University, occupy the second and third place, respectively, in the list of the top 50 productive universities. The temporal analysis clearly shows the dominance of Asian Universities in recent years because during last two decades, Asian countries such as China, Taiwan, Iran, Korea, and India have been growing rapidly. Numbers of research institutions are increasing significantly with high population growth. Governmental authorities, private financing firms and manufacturing organisations are providing incentives to researchers for development and new technology. Fifth, Western Europe leads in both quantity and quality contributions in IJCIM among the nine supranational regions. Finally, graphical visualisations of bibliographic coupling, co-authorship, co-citation and co-occurrence of keywords demonstrate collaboration among the authors, institutions and countries. Simulation, scheduling, genetic algorithm, process planning and modelling are keywords commonly used by the authors in their publications in IJCIM.

This work presents a wide outline of the publication and citation structure of IJCIM with the help of quantity and quality indicators such as total number of papers, total citations, *h*-index and citations per paper. This bibliometric study might be helpful for the researchers who intend to submit their research in IJCIM. These researchers might use the result of keyword analysis to understand the general direction of the journal, various subjects that have been published, and the gaps that can be addressed by new studies. This paper may also be used as a resource for the editors of the journal to assess the records of IJCIM in publishing studies of the field, which can be used as a guideline to determine future directions.

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