

Research in Production and Operations Management: A University-Based Bibliometric Analysis

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Abstract Universities across the world are contributing greatly to production and operations management (POM) research and playing significant roles in social and economic development. This article analyzes the performance of universities in POM research and development between 1990 and 2014. The Web of Science core collection database is used to collect all the necessary data. The results show a wide diversity among the countries of origin of the top universities, with some of them being in Asia, Europe, and North America. These results are quite different from many other management areas where English-speaking countries, especially the USA, tend to be dominant. Hong Kong Polytechnic University is the most productive university, while Michigan State University is the most influential one. Time-based evolution reveals that the USA previously had a more dominant position, while now there is more distribution of top universities around the world. The analysis of selected

journals indicates that many journals tend to be more influenced by their respective countries of origin. However, other journals show a more general profile by publishing papers from most of the countries around the world.

Keywords Bibliometrics · Production and operations management · University analysis · Web of science

Introduction

Universities have been idealistically viewed as sources of innovation that generate new ideas by conducting and publishing research. Universities are playing an important role as a primary source of knowledge creation and talent. New discoveries help to increase the eminence of universities. The pursuit of eminence is reflected in academic publications. During the last century, the number of universities has increased substantially, which has been especially motivated by economic improvements and high growth rates of the population. Especially, this increase in the number of universities has been very significant during the last decades. Universities across the world are contributing greatly toward social and economic development to strengthen their respective nations' roles in the global marketplace. Successful regional economies such as the region around Cambridge in the UK, the Boston area and Silicon Valley are providing examples of universities' contributions to regional economic growth. Companies such as Cisco, Google, and Yahoo also originated from university (Stanford University) research (Veugelers and Del Rey 2014). These success stories have helped to uphold the roles of universities in regional and national economic growth.

A number of techniques are used in the library and information science literature for measuring the

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Table 1 Most productive and influential universities in POM

<i>R</i>	University	Country	TP	TC	<i>H</i>	<i>C/P</i>	≥ 100	≥ 50
1	Hong Kong Polytechnic University	CHN	738	9941	43	13.47	9	33
2	Penn State University	USA	509	6394	35	12.56	10	17
3	Arizona State University	USA	509	11,865	53	23.31	21	55
4	National University of Singapore	SGP	475	6773	37	14.26	2	16
5	Michigan State University	USA	421	12,471	57	29.62	26	64
6	City University of Hong Kong	CHN	394	4954	33	12.57	4	15
7	Purdue University	USA	369	7159	41	19.40	11	33
8	University of Michigan	USA	361	6318	38	17.50	10	27
9	University of Manchester	UK	349	5853	39	16.77	6	29
10	Georgia Institute of Technology	USA	331	7534	44	22.76	18	36
11	University of Minnesota Twin Cities	USA	319	10,395	55	32.59	26	60
12	Cardiff University	UK	317	5712	37	18.02	7	27
13	Massachusetts Institute of Technology	USA	315	9931	49	31.53	20	47
14	Cranfield University	UK	313	4670	30	14.92	7	14
15	Erasmus University Rotterdam	NET	310	6733	41	21.72	12	31
16	Eindhoven University of Technology	NET	310	5020	37	16.19	5	24
17	University of Hong Kong	CHN	307	4674	33	15.22	5	14
18	Loughborough University	UK	307	3091	26	10.07	0	8
19	Texas A M University College Station	USA	305	5551	38	18.20	7	29
20	National Cheng Kung University	TWN	299	3039	29	10.16	0	4
21	University of Nottingham	UK	296	4388	32	14.82	4	16
22	Shanghai Jiao Tong University	CHN	294	2177	21	7.40	2	5
23	Nanyang Technological University	SGP	292	4303	32	14.74	7	20
24	University of Montreal	CAN	288	4168	32	14.47	5	18
25	National Chiao Tung University	TWN	288	3918	29	13.60	6	14
26	Ohio State University	USA	277	8228	43	29.70	18	33
27	University of Maryland College Park	USA	273	5921	39	21.69	11	28
28	University of Warwick	UK	257	3601	30	14.01	3	15
29	Polytechnic University of Milan	ITA	249	3135	28	12.59	0	13
30	Virginia Polytechnic Institute	USA	248	4885	38	19.70	10	23
31	Iowa State University	USA	246	4297	31	17.47	4	15
32	University of Groningen	NET	243	2350	23	9.67	2	8
33	University of California Berkeley	USA	242	5027	34	20.77	8	21
34	Hong Kong University of Science Technology	CHN	242	4742	35	19.60	7	20
35	National Taiwan U of Science and Technology	TWN	226	2431	23	10.76	2	10
36	Monash University	AUS	223	2647	29	11.87	0	9
37	Linkoping University	SWE	223	2953	30	13.24	2	9
38	Tsinghua University	CHN	221	2026	23	9.17	1	6
39	National Tsing Hua University	TWN	219	2233	25	10.20	2	4
40	Chinese University of Hong Kong	CHN	214	3612	34	16.88	3	18
41	University of Texas Austin	USA	212	4795	39	22.62	4	23
42	University of Cambridge	UK	208	4569	37	21.97	6	22
43	University of Arkansas Fayetteville	USA	208	2524	25	12.13	3	10
44	Rutgers State University	USA	206	3118	28	15.14	4	16
45	University of Florida	USA	205	3486	29	17.00	4	12
46	Korea Advanced Institute of Science Tech.	KOR	204	2915	26	14.29	2	7
47	University of Tennessee Knoxville	USA	195	3334	29	17.10	8	17
48	KU Leuven	BEL	195	3442	30	17.65	6	13

Table 1 continued

<i>R</i>	University	Country	<i>TP</i>	<i>TC</i>	<i>H</i>	<i>C/P</i>	≥ 100	≥ 50
49	Stanford University	USA	194	6909	38	35.61	15	30
50	North Carolina State University	USA	194	4679	35	24.21	11	23

R Rank, *TP* total papers, *TC* total cites, *H* H-index, *C/P* cites per paper; ≥ 100 , ≥ 50 = Articles with more than 100 and 50 cites, respectively

Table 2 Ranking of the Top 50 universities in POM according to the Total Citations, the H-index and the Citations per paper

<i>R</i>	Total citation	H-index	Citation per paper
1	Michigan State U	Michigan State U	U Pennsylvania
2	Arizona State U	U Minnesota Twin Cities	Harvard U
3	U Pennsylvania	Arizona State U	U North Carolina Chapel Hill
4	U Minnesota Twin Cities	MIT	INSEAD Business School
5	Hong Kong Polytechnic U	U Pennsylvania	Stanford U
6	MIT	Georgia Institute of Tech.	Carnegie Mellon U
7	Ohio State U	Hong Kong Polytechnic U	U Western Ontario
8	Georgia Institute of Tech.	Ohio State U	Columbia U
9	Purdue U	Purdue U	U Minnesota Twin Cities
10	Harvard U	Erasmus U Rotterdam	MIT
11	Stanford U	U North Carolina Chapel Hill	Ohio State U
12	U North Carolina Chapel Hill	U Manchester	U California Los Angeles
13	National U Singapore	U Maryland College Park	Michigan State U
14	Erasmus U Rotterdam	U Texas Austin	Northwestern U
15	Penn State U	U Michigan	North Carolina State U
16	U Michigan	Texas A M U College Station	Arizona State U
17	U Maryland College Park	Virginia Polytechnic Institute	Georgia Institute of Tech.
18	U Manchester	Stanford U	U Texas Austin
19	Cardiff U	Harvard U	U Cambridge
20	Texas A M U College Station	National U Singapore	Erasmus U Rotterdam
21	INSEAD Business School	Cardiff U	U Maryland College Park
22	U California Berkeley	Eindhoven U Technology	U Southern California
23	Eindhoven U Technology	U Cambridge	Northeastern U
24	City U Hong Kong	INSEAD Business School	U California Berkeley
25	Virginia Polytechnic Ins.	Penn State U	SUNY Buffalo
26	U Western Ontario	Hong Kong U Science Tech.	Virginia Polytechnic Ins.
27	U Texas Austin	North Carolina State U	Hong Kong U Science Tech.
28	Hong Kong U Sci. Tech.	U California Berkeley	Purdue U
29	North Carolina State U	Chinese U Hong Kong	Auburn U
30	U Hong Kong	City U Hong Kong	U Illinois Urbana Champaign
31	Cranfield U	U Hong Kong	Texas A M U College Station
32	Carnegie Mellon U	U Western Ontario	Clemson U
33	U Cambridge	Carnegie Mellon U	Cardiff U
34	Columbia U	U Nottingham	U Texas Dallas
35	U Nottingham	Nanyang Technological U	KU Leuven
36	Nanyang Technological U	U Montreal	U Michigan
37	Iowa State U	Clemson U	Iowa State U
38	Northwestern U	Cornell U	Cornell U
39	U Montreal	U Southern California	U Tennessee Knoxville
40	U California Los Angeles	Iowa State U	U Florida
41	National Chiao Tung U	Rensselaer Polytechnic Ins.	Chinese U Hong Kong



Table 2 continued

<i>R</i>	Total citation	H-index	Citation per paper
42	U Southern California	Columbia U	U Manchester
43	Auburn U	Cranfield U	U Toronto
44	Chinese U Hong Kong	U Warwick	Kansas State U
45	U Warwick	Linkoping U	Eindhoven U Technology
46	U Florida	KU Leuven	U Wisconsin Madison
47	Clemson U	Auburn U	U Melbourne
48	KU Leuven	U Illinois Urbana Champaign	Rensselaer Polytechnic Ins.
49	U Tennessee Knoxville	Lancaster U	U Waterloo
50	U Illinois Urbana Champaign	U California Los Angeles	U Pittsburgh

Table 3 Leading universities in production and operations management between 1990 and 1994

<i>R</i>	University	TP	TC	<i>H</i>	<i>C/P</i>
1	Purdue University	56	1670	23	29.82
2	University of North Carolina	55	1244	18	22.62
3	Penn State University	54	1054	16	19.52
4	Ohio State University	40	1283	14	32.08
5	United States Department of Defense	38	139	7	3.66
6	Texas A M University College Station	36	733	14	20.36
7	University of Michigan	32	952	15	29.75
8	National University of Singapore	32	390	12	12.19
9	Massachusetts Institute of Technology	32	1957	15	61.16
10	Korea Advanced Institute of Science Technology	32	459	13	14.34
11	University of Minnesota Twin Cities	31	1105	17	35.65
12	University of Manchester	31	407	9	13.13
13	AT&T	31	191	6	6.16
14	University of Maryland College Park	29	934	14	32.21
15	Louisiana State University	29	388	12	13.38
16	Eindhoven University of Technology	29	387	10	13.34
17	North Carolina State University	28	720	14	25.71
18	Arizona State University	28	1808	14	64.57
19	University of Wisconsin Madison	27	483	13	17.89
20	University of Iowa	27	998	17	36.96
21	Tel Aviv University	27	311	11	11.52
22	New Jersey Institute of Technology	26	239	10	9.19
23	Loughborough University	26	311	11	11.96
24	International Business Machines(IBM)	26	426	8	16.38
25	Nanyang Technological University	25	312	9	12.48
26	Iowa State University	25	838	12	33.52
27	Concordia University Canada	25	347	9	13.88
28	Rensselaer Polytechnic Institute	23	437	9	19.00
29	University of Texas Austin	22	595	11	27.05
30	Indian Institute of Technology Madras	22	867	15	39.41

performance of universities/institutions in the production of scientific research. Bibliometrics is one of them, and it is defined as the science that quantitatively studies bibliographic materials (Broadus 1987). Bibliometric studies

initiated in the field of library and information sciences. Since its inception, it has been applied in different fields (Podsakoff et al. 2008). Bibliometrics has been applied to analyze different research areas, including supply chain

Table 4 Leading universities in production and operations management between 1995 and 1999

<i>R</i>	University	TP	TC	<i>H</i>	<i>C/P</i>
1	University of North Carolina	97	3395	28	35.00
2	Purdue University	88	2308	27	26.23
3	Penn State University	81	1168	18	14.42
4	University of Manchester	78	1335	19	17.12
5	Arizona State University	67	1851	25	27.63
6	City University of Hong Kong	54	886	16	16.41
7	University of Nottingham	52	1313	19	25.25
8	University of Michigan	50	1682	20	33.64
9	University of Warwick	48	938	17	19.54
10	Korea Advanced Institute of Science Technology	48	693	15	14.44
11	National University of Singapore	47	739	18	15.72
12	Monash University	46	603	15	13.11
13	University of Wisconsin Madison	45	648	13	14.40
14	Nanyang Technological University	45	693	15	15.40
15	Massachusetts Institute of Technology	45	2473	21	54.96
16	Iowa State University	45	1148	16	25.51
17	Texas A M University College Station	43	1126	19	26.19
18	Eindhoven University of Technology	43	951	18	22.12
19	University of California Berkeley	41	1596	20	38.93
20	University of Texas Austin	39	1426	15	36.56
21	University of Maryland College Park	39	1337	16	34.28
22	Rensselaer Polytechnic Institute	39	572	14	14.67
23	Loughborough University	39	284	9	7.28
24	University of Southern California	38	1129	15	29.71
25	Erasmus University Rotterdam	38	1856	14	48.84
26	Rutgers State University	37	1279	18	34.57
27	Polytechnic University of Milan	37	896	18	24.22
28	Michigan State University	37	1717	22	46.41
29	Brunel University	37	546	11	14.76
30	Virginia Polytechnic Institute	36	1173	17	32.58

management (González-Benito et al. 2013; Boehmke and Hazen 2017), operations research and management science (Shang et al. 2015; Merigó and Yang 2017; Laengle et al. 2017, 2018a), economics (Bonilla et al. 2015), health economics (Wagstaff and Culyer 2012), fuzzy research (Blanco-Mesa et al. 2017; Merigó et al. 2015a), innovation (Merigó et al. 2016; Haleem et al. 2018), manufacturing strategy (Kulkarni et al. 2016), sustainability (Franceschini et al. 2016), radio frequency identification (Musa and Dabo 2016), entrepreneurship (Landström et al. 2012), natural resources (Zhong et al. 2016), and closed-loop supply chain and reverse logistics (Kazemi et al. 2018).

POM is considered an important tool for economic growth. POM addresses planning, organizing, directing and controlling production and services to achieve higher efficiency and cost-effectiveness. Since 1940, production management has drawn significant attention from the

managers/researchers focused on economic efficiency in manufacturing. In the 1970s, a shift in the service and manufacturing sectors emerged through the new name operations management. Economists, mathematicians, social scientists and computer scientists contributed newer, more sophisticated analytical approaches in the field of POM to achieve firms' objectives, increase goodwill, optimize the utilization of resources, minimize production costs, generate employment and boost the economy. There are many bibliometric studies in production and operations management. Some of them focused on the most significant journals in the field, including Goh et al. (1997) and Barman et al. (2001). They extended the analysis developed previously by other studies (Barman et al. 1991). More recently, Holsapple and Lee-Post (2010) developed a behavioral-based analysis of journals in this discipline, and Stonebraker et al. (2012) focused on the impact factor as a

Table 5 Leading universities in production and operations management between 2000 and 2004

<i>R</i>	University	TP	TC	<i>H</i>	<i>C/P</i>
1	University of North Carolina	128	4849	33	37.88
2	Arizona State University	104	4145	34	39.86
3	CNRS France	101	1709	21	16.92
4	Penn State University	100	1254	19	12.54
5	Hong Kong Polytechnic University	97	2297	29	23.68
6	Michigan State University	93	5129	37	55.15
7	National University of Singapore	92	2577	26	28.01
8	City University of Hong Kong	85	1365	22	16.06
9	University of Manchester	78	2110	27	27.05
10	Eindhoven University of Technology	76	2070	25	27.24
11	Purdue University	72	2122	21	29.47
12	Loughborough University	72	1057	18	14.68
13	University of Minnesota Twin Cities	68	4050	36	59.56
14	University of Hong Kong	67	1832	24	27.34
15	Virginia Polytechnic Institute	62	1696	21	27.35
16	University of Michigan	61	1613	22	26.44
17	Massachusetts Institute of Technology	61	3574	27	58.59
18	University of Maryland College Park	60	1692	23	28.20
19	Nanyang Technological University	59	1495	21	25.34
20	Cardiff University	59	2367	26	40.12
21	Cranfield University	58	1899	20	32.74
22	Iowa State University	57	988	17	17.33
23	University of Warwick	56	1160	20	20.71
24	New Jersey Institute of Technology	54	695	14	12.87
25	Rensselaer Polytechnic Institute	53	1225	21	23.11
26	Polytechnic University of Milan	53	1037	18	19.57
27	Hong Kong University of Science Technology	53	2043	27	38.55
28	University of Cambridge	52	1771	26	34.06
29	Korea Advanced Institute of Science Technology	52	1065	19	20.48
30	University of Nottingham	51	1183	18	23.20

tool for measuring the quality of journals. Malaviya and Wadhwa (2005) executed an empirical study on organizational innovation management. Garg and Singh (2006) presented an exhaustive review of the literature concerning change in organizational management. Grover and Kar (2017) analyzed the research on big data published in high-quality business management journals. Ketchen and Hult (2007) showed the application potential of organizational theory to the field of supply chain management and highlighted the research gaps in these fields in order to improve the understanding of why some supply chains are better than others. Wong and Lai (2011) studied the best publication outlets of POM research under different categories between 1998 and 2009. Some other authors focused on other issues, including the work of Pilkington and Meredith (2009) that developed a citation analysis in order to study

the evolution of operations management between 1980 and 2006. Hsieh and Chang (2009) presented a general overview of production and operations management by studying the publications of twenty leading journals in this field. This work developed a university ranking between 1973 and 2008 and found that Massachusetts Institute of Technology and Georgia Institute of Technology were at the top. Only three institutions in the Top 20 were from outside the USA. Although this study represents an important contribution to the field, it needs improvements because the twenty journals that were considered may not strictly represent the discipline. The main reason for this is because many journals have a broader perspective by publishing papers outside the core of production and operations management. Therefore, the results may be conditioned by this issue. From a general perspective, the results clearly

Table 6 Leading universities in production and operations management between 2005 and 2009

<i>R</i>	University	TP	TC	<i>H</i>	<i>C/P</i>
1	Hong Kong Polytechnic University	203	4781	36	23.55
2	CNRS France	188	2226	21	11.84
3	University of North Carolina	161	4249	32	26.39
4	Arizona State University	161	3045	29	18.91
5	National University of Singapore	126	2003	25	15.90
6	Michigan State University	122	4089	38	33.52
7	Penn State University	113	2287	26	20.24
8	University of Hong Kong	106	1936	24	18.26
9	Georgia Institute of Technology	105	2991	31	28.49
10	City University of Hong Kong	103	1617	22	15.70
11	National Cheng Kung University	101	1401	20	13.87
12	Cranfield University	96	1474	21	15.35
13	University of Manchester	95	1755	24	18.47
14	Erasmus University Rotterdam	91	2086	25	22.92
15	University of Montreal	90	1711	25	19.01
16	University of Minnesota Twin Cities	90	3245	31	36.06
17	University of Michigan	90	1462	22	16.24
18	Cardiff University	90	1359	22	15.10
19	National Chiao Tung University	83	1666	21	20.07
20	Texas A M University College Station	81	1518	22	18.74
21	Loughborough University	80	1096	18	13.70
22	Nanyang Technological University	78	1474	19	18.90
23	Shanghai Jiao Tong University	76	1062	16	13.97
24	Massachusetts Institute of Technology	73	1505	22	20.62
25	University of California Berkeley	69	1655	20	23.99
26	Ohio State University	69	1713	23	24.83
27	University of Nottingham	68	1032	17	15.18
28	University of Bath	68	1000	19	14.71
29	Eindhoven University of Technology	66	1205	18	18.26
30	Purdue University	65	761	15	11.71

overestimated the prominence of the USA because older journals such as *Management Science* and *Operations Research* are totally dominated by this country. However, the problem is that these journals do not only publish papers in production and operations management, and so the results are affected by this issue. An example of this can be seen in the ranking of authors, where many authors that are more oriented to the general field of operations research rather than to production and operations management do appear in the list.

To solve this issue, this paper aims to present a more general approach that can clearly represent the field of production and operations management in a more complete way. Particularly, this study provides a general overview of the leading universities in this field between 1990 and 2014. To do so, we present a ranking of the fifty most productive and influential universities. We identify the 50

best universities according to the total citations, H-index and citations per paper. We also consider an evolution in order to see how their influence and productivity has changed throughout time. The article also considers the most productive institutions in twenty-two selected journals. Finally, the paper demonstrates a graphical visualization of bibliographic coupling using the visualization of similarities (VOS) viewer software (Van Eck and Waltman 2010). This mapping analysis is carried out with bibliographic coupling (Kessler 1963) and co-author and co-citation analysis (Small 1973). The next section discusses the methodology of the present bibliometric study. “Results” section demonstrates the results of the bibliometric exploration. Using quantitative and qualitative indicators, this section depicts the leading universities in POM. Moreover, the section depicted the top institutions in twenty-two well-established POM journals. Finally, “Conclusions”

Table 7 Leading universities in production and operations management between 2010 and 2014

<i>R</i>	University	TP	TC	<i>H</i>	<i>CIP</i>
1	Hong Kong Polytechnic University	401	2617	24	6.53
2	CNRS France	359	1477	17	4.11
3	Shanghai Jiao Tong University	193	781	13	4.05
4	University of North Carolina	186	955	15	5.13
5	National University of Singapore	178	1087	17	6.11
6	Penn State University	161	653	12	4.06
7	Michigan State University	151	1173	19	7.77
8	Arizona State University	149	1045	14	7.01
9	City University of Hong Kong	144	1006	17	6.99
10	National Cheng Kung University	131	641	13	4.89
11	Georgia Institute of Technology	129	641	12	4.97
12	University of Michigan	128	622	12	4.86
13	University of Montreal	125	608	13	4.86
14	Tsinghua University	124	566	10	4.56
15	Erasmus University Rotterdam	123	559	11	4.54
16	University of Groningen	120	436	10	3.63
17	Cranfield University	119	676	14	5.68
18	University of Arkansas Fayetteville	116	395	12	3.41
19	Cardiff University	113	517	11	4.58
20	National Chiao Tung University	110	502	11	4.56
21	University of Tehran	107	503	12	4.70
22	University of Nottingham	106	579	11	5.46
23	Massachusetts Institute of Technology	104	449	12	4.32
24	University of Hong Kong	102	541	12	5.30
25	National Tsing Hua University	101	497	9	4.92
26	Xi An Jiaotong University	98	740	12	7.55
27	Texas A M University College Station	98	478	12	4.88
28	University of Minnesota Twin Cities	97	639	14	6.59
29	National Taiwan U Science tech.	96	380	11	3.96
30	Eindhoven University of Technology	96	413	10	4.30

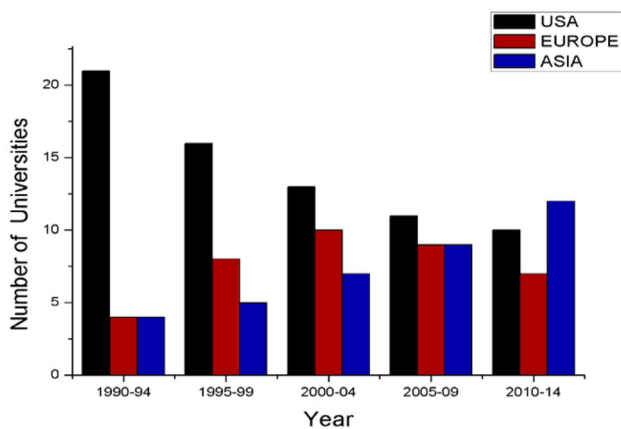
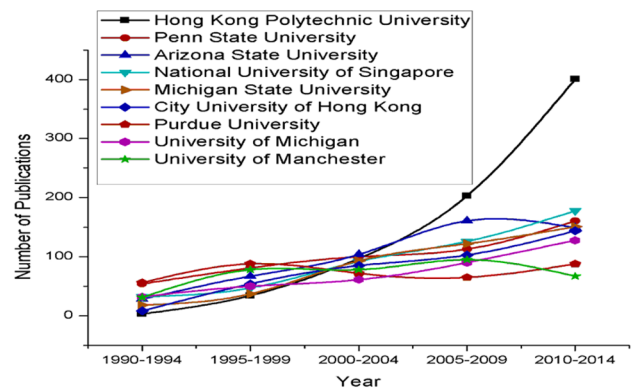
**Fig. 1** Temporal analysis of the universities of the USA, Europe and Asia in the Top 30 positions**Fig. 2** Temporal Performance of the Top 9 universities

Table 8 Leading universities in the International Journal of Production Research

<i>R</i>	University	TP	TC	<i>H</i>	<i>C/P</i>
1	CNRS France	152	1022	15	6.72
2	Purdue University	118	2545	28	21.57
3	Shanghai Jiao Tong University	112	593	12	5.29
4	Penn State University	112	1142	18	10.20
5	Hong Kong Polytechnic University	106	866	16	8.17
6	Nanyang Technological University	105	1366	20	13.01
7	National University of Singapore	100	1561	24	15.61
8	Loughborough University	95	1089	18	11.46
9	University of Hong Kong	86	1380	21	16.05
10	University of North Carolina	80	1156	19	14.45
11	National Chiao Tung University	73	719	15	9.85
12	Arizona State University	71	1021	17	14.38
13	University of Groningen	62	444	11	7.16
14	National Tsing Hua University	61	631	13	10.34
15	University of Calgary	60	996	19	16.60
16	City University of Hong Kong	59	918	15	15.56
17	Texas A M University College Station	57	836	15	14.67
18	Korea Advanced Institute of Science Technology	57	841	18	14.75
19	Tel Aviv University	55	546	14	9.93
20	Indian Institute of Technology Delhi	54	661	14	12.24
21	National Taiwan University of Science and Technology	52	797	13	15.33
22	Yuan Ze University	51	525	11	10.29
23	University of Nottingham	50	590	13	11.80
24	Tsinghua University	50	389	10	7.78
25	Michigan State University	50	737	16	14.74
26	Rensselaer Polytechnic Institute	48	583	16	12.15
27	University of Michigan	47	491	13	10.45
28	National Cheng Kung University	47	352	11	7.49
29	Indian Institute of Technology Madras	45	1137	19	25.27
30	Hanyang University	45	360	11	8.00

Section sums up the major findings and conclusions of the paper.

Methods

This study uses the Web of Science (WoS) database in order to collect the information for the bibliometric analysis. The Institute for Scientific Information (ISI) is produced the WoS database. Currently, it is maintained by Clarivate Analytics. Previously, it was owned by the intellectual property and science business of Thomson and Reuters. The database includes more than 15,000 journals and 50,000,000 papers classified in 251 subject categories and 151 subject areas. The data for the present bibliometric study were collected between April and May 2015. To search for the material, we used a double search process

between keywords and journals. The keywords selected are as follows: operations management, production management, supply chain management, total quality management, TQM, logistics, MRP, and JIT. The journals that were selected for the analysis were complimentary to the keywords by using the Boolean “OR” so that all the materials that were found with the keywords or the journals were considered. The search process finds 51,015 articles in this field.

The study considers a time period of twenty-five years between 1990 and 2014. The present study considers different types of bibliometric indicators in order to present a comprehensive representation of the bibliographic information. It uses the quantitative indicator of the total number of publications to provide information about the productivity of the universities. On the other hand, it uses qualitative indicators such as the total numbers of citations,

Table 9 Leading universities in the International Journal of Production Economics

<i>R</i>	University	TP	TC	<i>H</i>	<i>C/P</i>
1	Hong Kong Polytechnic University	170	2647	29	15.57
2	CNRS France	122	1717	22	14.07
3	Eindhoven University of Technology	90	1076	19	11.96
4	Linköping University	87	1537	24	17.67
5	University of Nottingham	76	1735	20	22.83
6	Lappeenranta University of Technology	66	1009	19	15.29
7	University of Groningen	64	909	16	14.20
8	University of North Carolina	55	784	16	14.25
9	Cardiff University	55	1650	21	30.00
10	City University of Hong Kong	48	607	14	12.65
11	Corvinus University of Budapest	45	257	7	5.71
12	National University of Singapore	44	470	13	10.68
13	Concordia University Canada	42	829	14	19.74
14	Polytechnic University of Milan	41	653	18	15.93
15	National Chiao Tung University	38	891	14	23.45
16	Erasmus University Rotterdam	38	607	13	15.97
17	Nanyang Technological University	37	375	13	10.14
18	Louisiana State University	37	567	12	15.32
19	University of Montreal	36	562	12	15.61
20	Ryerson University	36	640	16	17.78
21	Chung Yuan Christian University	36	640	13	17.78
22	Lancaster University	34	485	14	14.26
23	Cranfield University	34	434	12	12.76
24	National Taiwan University of Science and Technology	33	447	11	13.55
25	Aarhus University	33	258	10	7.82
26	Korea Advanced Institute of Science Technology	32	414	12	12.94
27	Penn State University	31	210	8	6.77
28	University of Twente	30	300	10	10.00
29	Tsinghua University	30	425	11	14.17
30	Ku Leuven	30	424	12	14.13

the citations per paper, the H-index (Hirsch 2005), and some citation thresholds to measure the eminence of the research works of universities. The H-index reflects both the number of publications and citations simultaneously (Hirsch 2005). A university will get an H-index of P if it has P papers that have received P citations or more. The H-index is one of the most common and accepted indicators to assess the performance of a university or a journal (Laengle et al. 2018b, c; Mas-Tur et al. 2018).

Five thousand of the most cited papers are used to map the bibliographic material of the leading universities. Graphical visualizations of the bibliographic coupling, co-citations and co-authors of the leading universities are prepared through the VOS viewer software (Van Eck and Waltman 2010). Two documents are bibliographically coupled if both documents cite one or more documents in

common (Valenzuela et al. 2017). Bibliographic coupling helps researchers come across related research done in the past. If two documents receive a citation from a third document, then both documents get a co-citation (Small 1973) index. On the other hand, the indicator co-authorship represents the connectivity of the authors from different universities. The maps are prepared based on the two standardized weights of each item. One weight is the number of links of an item. The other weight is the total strength of the links of an item (Cancino et al. 2017; Martínez-López et al. 2018). The size of a circle in the network of the graphical representations denotes its relevance. The size of a circle increases (or decreases) according to the superior (or inferior) performance of the university representing that circle. On the other hand,

Table 10 Leading universities in the Journal of Operations Management

<i>R</i>	University	TP	TC	<i>H</i>	<i>C/P</i>
1	Michigan State University	69	3951	37	57.26
2	University of Minnesota Twin Cities	52	2823	28	54.29
3	Arizona State University	48	2355	25	49.06
4	Ohio State University	37	2102	18	56.81
5	University of North Carolina	34	1864	22	54.82
6	University of South Carolina	23	1327	16	57.70
7	IU Kelley School of Business	22	1063	17	48.32
8	Emory University	20	728	13	36.40
9	Clemson University	19	787	14	41.42
10	University of Western Ontario	18	1430	16	79.44
11	University of North Carolina Chapel Hill	17	924	13	54.35
12	University of Arkansas Fayetteville	16	423	8	26.44
13	Georgia Institute of Technology	16	892	11	55.75
14	Wake Forest University	14	377	8	26.93
15	University of Toledo	13	762	11	58.62
16	University of Notre Dame	13	329	7	25.31
17	Texas Christian University	13	234	9	18.00
18	Texas A M University College Station	13	673	9	51.77
19	Rensselaer Polytechnic Institute	13	571	11	43.92
20	Indiana University Bloomington	13	321	9	24.69
21	London Business School	12	1270	10	105.83
22	Xi An Jiaotong University	11	606	9	55.09
23	University of Maryland College Park	11	267	7	24.27
24	Penn State University	11	429	7	39.00
25	North Carolina State University	11	800	8	72.73
26	DePaul University	11	391	10	35.55
27	University of Utah	10	194	8	19.40
28	Indiana University Purdue University Indianapolis	10	750	10	75.00
29	Hong Kong Polytechnic University	10	471	8	47.10
30	Cornell University	10	222	6	22.20

linked universities are identified through network connections.

There are some limitations of this study that are mainly due to the use of WoS data. The limitations due to WoS data are as follows. First, there are many people that work in one country that have different nationalities. The WoS only considers the working institutions as their affiliation. Second, the WoS gives one unit to each participating institution and country. This procedure provides an advantage to the papers written by many authors rather than a single-authored paper. Third, the WoS does not consider the different weights for a publication based on the number of co-authors, and the number of pages for other related issues can be a condition of the analysis. Other limitations of the study are as follows: (1) the results represent the current picture but, obviously, the results are dynamic and may change in the future and (2) the methods

and the indicators that are used follow the general standards. However, sometimes, some exceptional research may not be identified correctly under this approach.

Results

The following subsection depicts the top 50 POM research institutions of the world based on indicators such as the total number of publications, the total citations, the H-index, and the citations per paper.

Leading Universities in Production and Operations Management Between 1990 and 2014

Table 1 presents the 50 most productive universities in POM research during 1990 to 2014. Additionally, two



Table 11 Leading universities in the Int. Journal of Operations and Production Management

<i>R</i>	University	TP	TC	<i>H</i>	<i>C/P</i>
1	Cranfield University	67	1731	20	25.84
2	University of Manchester	50	795	18	15.90
3	University of Warwick	48	731	16	15.23
4	University of Cambridge	43	1917	21	44.58
5	University of Bath	33	828	15	25.09
6	Polytechnic University of Milan	32	678	15	21.19
7	Monash University	32	373	13	11.66
8	University of London	30	1414	18	47.13
9	University of Padua	28	671	14	23.96
10	University of North Carolina	24	473	14	19.71
11	University of Groningen	24	146	9	6.08
12	Cardiff University	24	717	13	29.88
13	Aston University	24	260	10	10.83
14	University of Strathclyde	23	511	12	22.22
15	Chalmers University of Technology	23	329	13	14.30
16	University of Exeter	22	319	9	14.50
17	London Business School	22	1260	14	57.27
18	Michigan State University	21	506	11	24.10
19	Arizona State University	20	467	10	23.35
20	University of Nottingham	19	199	6	10.47
21	Eindhoven University of Technology	18	377	10	20.94
22	University of Bradford	17	157	7	9.24
23	Tilburg University	17	233	8	13.71
24	Loughborough University	16	255	8	15.94
25	Stockholm School of Economics	15	289	9	19.27
26	Hong Kong Polytechnic University	14	117	7	8.36
27	Aalborg University	14	178	8	12.71
28	University of Liverpool	13	267	8	20.54
29	Lancaster University	13	257	6	19.77
30	DePaul University	13	175	6	13.46

threshold indicators, which are greater than or equal to one hundred and fifty citations, respectively, are used to get a more general perspective of POM research.

Hong Kong Polytechnic University is the most productive university in production and operations management. However, it is still less influential than some American universities such as Arizona State University, Michigan State University and the University of Minnesota Twin Cities. An interesting result seen in this list is that the USA is not as dominant as in other management fields (Podsakoff et al. 2008). In this case, only twenty universities appear in the Top 50, which is quite low compared to other management fields. The main reason is because production and operations management lies at the intersection of management and operations research. Therefore, from the operations side, the results are closer to the results seen in engineering and computer science (Merigó et al. 2015b). It

is worth noting that Asia and Europe get fifteen and thirteen universities, respectively, in the ranking. Table 2 presents a ranking of the top 50 universities based on the indicators of the total citation, the H-index and the citations per paper.

Table 2 depicts that Michigan State University holds best position with respect to both the TC and H-index. The University of Pennsylvania shows the best performance for the number of category cites per paper. Although the University of Pennsylvania is among the top five universities with respect to the TC, for the H-index and the *C/P*, it is 59th in the total publications. The USA again dominates significantly in all three categories (TC, H-index and *C/P*). Twenty eight universities in the USA appear among the top 50 universities in total citations and the H-index and thirty nine appear among the top 50 in citations per paper. Note that the USA captures 80% of the top twenty universities in the

Table 12 Journal of Quality Technology

<i>R</i>	Institution	TP	TC	<i>H</i>	TC/TP
1	Arizona State University	87	2596	26	29.84
2	Virginia Polytechnic Institute	72	2785	29	38.68
3	United States Department of Energy	41	623	15	15.20
4	University of Waterloo	26	635	10	24.42
5	University of Minnesota Twin Cities	26	674	13	25.92
6	University of Alabama Tuscaloosa	24	988	14	41.17
7	National University of Singapore	23	417	12	18.13
8	Los Alamos National Laboratory	23	277	9	12.04
9	University of North Carolina	20	979	12	48.95
10	Penn State University	20	261	9	13.05
11	University of Michigan	19	342	11	18.00
12	Georgia Institute of Technology	18	224	8	12.44
13	University of Florida	17	591	9	34.76
14	Rutgers State University	16	731	12	45.69
15	Hong Kong University of Science Technology	16	262	9	16.38
16	University of Tennessee Knoxville	15	309	7	20.60
17	University of Wisconsin Madison	14	357	9	25.50
18	North Carolina State University	14	526	9	37.57
19	University of Amsterdam	13	132	7	10.15
20	SAS Institute Inc.	13	327	8	25.15
21	General Electric Company	13	192	5	14.77
22	United States Department of Defense	12	157	6	13.08
23	Southwest Research Institute	12	757	11	63.08
24	Southern Illinois University Edwardsville	12	224	9	18.67
25	McMaster University	12	627	8	52.25
26	University of Antwerp	11	85	5	7.73
27	University of Maryland College Park	10	469	8	46.90
28	University of Iowa	10	424	7	42.40
29	Pacific Northwest Laboratory	10	157	6	15.70
30	Georgia Southern University	10	384	7	38.40

H-index, which is the most accepted category to measure the performance of a journal or a university. Hong Kong Polytechnic University in the People's Republic of China and Erasmus University Rotterdam in the Netherlands are the only two universities able to secure a place in the top 10 of the H-index. USA-based universities performed remarkably in production and operations management research. Arizona State University, the University of Minnesota Twin Cities, Massachusetts Institute of Technology, Hong Kong Polytechnic University, and Purdue University perform appreciably in each of the four indicators.

Temporal Analysis of the Most Productive Universities

This subsection is dedicated for the time-based evaluation of the leading universities. For doing this, the 25 years

from 1990 to 2014 are sectioned into five intervals of five years in duration/each. Tables 3, 4, 5, 6 and 7 present the Top 30 universities in production and operations management between 1990–1994, 1995–1999, 2000–2004, 2005–2009 and 2010–2014, respectively.

As we can see, in the nineties, the USA was more influential than it is now. This is in accordance with the general evolution of research worldwide since previously the majority of international research was carried out by English-speaking countries. However, now increasingly more institutions all over the World are starting to develop research with an international impact. Particularly, Purdue University and the University of North Carolina show the most remarkable results in the nineties. North Carolina still holds his influence during the rest of the periods, although Hong Kong Polytechnic University has become more relevant by achieving the top ranking.



Table 13 Leading universities in Production and Operations Management

<i>R</i>	Institution	TP	TC	<i>H</i>	TC/TP
1	University of Texas Dallas	52	633	13	12.17
2	University of North Carolina	41	730	13	17.80
3	Georgia Institute of Technology	40	817	14	20.43
4	INSEAD Business School	37	1045	14	28.24
5	University of California Los Angeles	31	430	11	13.87
6	University of Texas Austin	30	409	11	13.63
7	University of Minnesota Twin Cities	29	512	13	17.66
8	Penn State University	26	376	9	14.46
9	Michigan State University	26	544	12	20.92
10	University of Michigan	24	341	9	14.21
11	University of California Berkeley	23	241	8	10.48
12	Indiana U Kelley School of Business	23	301	9	13.09
13	University of Maryland College Park	22	570	12	25.91
14	Columbia University	22	306	8	13.91
15	Massachusetts Institute of Technology	21	419	9	19.95
16	Indiana University Bloomington	21	233	7	11.10
17	Cornell University	20	125	6	6.25
18	Chinese University of Hong Kong	20	240	7	12.00
19	Stanford University	19	564	10	29.68
20	Washington University St Louis	17	225	6	13.24
21	Texas AM University College Station	17	184	7	10.82
22	University of Pennsylvania	16	853	11	53.31
23	Ohio State University	16	191	6	11.94
24	Hong Kong Polytechnic University	16	241	6	15.06
25	University of Southern California	15	136	5	9.07
26	New York University	15	472	8	31.47
27	Purdue University	14	74	5	5.29
28	Emory University	14	328	8	23.43
29	University of Notre Dame	13	121	7	9.31
30	McGill University	13	164	7	12.62

Figure 1 presents a comparative temporal study among the universities of the USA, Europe and Asia from 1990 to 2014 by depicting the number of universities among the Top 30 most productive universities. American universities are losing their majority in the Top 30 as the years progress. On the other hand, the number of Asian universities among the Top 30 most productive universities has increased as time has progressed. Table 6 shows that the USA and Asia have 10 and 12 universities, respectively, among the Top 30 universities in the last five years (2010–14). Hong Kong, China and Taiwan are emerging as sources of POM research in Asia. The CNRS of France has a great impact in advanced POM research and held the second position during 2005–2014. UK universities have better performances than other European universities. Figure 2 presents the temporal analysis of the top 9 most productive universities.

Figure 2 depicts that Hong Kong Polytechnic University shows remarkable improvement in POM research. Purdue University failed to increase its research activities, and it is ranked 38th during 2010–14. The National University of Singapore and Penn State University show steady and remarkable performance throughout the 25 years (1990–2014).

Analysis of the Most Productive Universities in Some Selected Journals

To deepen the analysis, we examine the universities that publish the most in twenty-two representative journals in production and operations management (See Table 21 in the appendix). Table 8 presents the thirty most productive universities in the International Journal of Production Research. Note that some additional bibliometric indicators

Table 14 IEEE Transactions on Engineering Management

<i>R</i>	Institution	TP	TC	<i>H</i>	TC/TP
1	National University of Singapore	44	423	12	9.61
2	New Jersey Institute of Technology	39	383	12	9.82
3	Massachusetts Institute of Technology	31	890	14	28.71
4	Michigan State University	30	632	16	21.07
5	Rensselaer Polytechnic Institute	28	344	11	12.29
6	City University of Hong Kong	28	348	12	12.43
7	Rutgers State University	27	181	7	6.70
8	University of North Carolina	26	477	11	18.35
9	Penn State University	26	172	8	6.62
10	Georgia State University	24	615	13	25.63
11	Rutgers State University Newark	23	127	6	5.52
12	University of Arkansas Fayetteville	21	201	5	9.57
13	Portland State University	21	82	4	3.90
14	University of Michigan	20	468	11	23.40
15	Northeastern University	19	531	11	27.95
16	Arizona State University	19	299	9	15.74
17	University of Illinois Urbana Champaign	18	395	10	21.94
18	University of Texas Austin	17	169	6	9.94
19	University of Southern California	17	330	8	19.41
20	George Washington University	16	80	5	5.00
21	University of Wisconsin Milwaukee	14	167	7	11.93
22	University of Manchester	14	125	6	8.93
23	Texas AM University College Station	14	74	5	5.29
24	University of Waterloo	13	226	7	17.38
25	University of Maryland College Park	13	245	7	18.85
26	United States Department of Defense	13	289	7	22.23
27	Iowa State University	12	167	6	13.92
28	Drexel University	12	337	8	28.08
29	Carleton University	12	184	5	15.33
30	Virginia Polytechnic Institute	11	193	7	17.55

are presented including the total citations, the H-index and the citations per paper.

CNRS France is the most productive and influential institution in this journal between 1990 and 2014. Purdue University also presents remarkable results with highest H-index. Sixteen Asian universities appear in the list. Only nine universities are from the USA, and one is from the UK.

Next, let us look into the International Journal of Production Economics. The results are shown in Table 9. Hong Kong Polytechnic University leads this ranking, which is far greater than the second position obtained by the Centre National De La Recherche Scientifique (CNRS). This journal is mainly led by European institutions, thirteen of which are in the Top 30. Ten Asian universities appear in the list, and only three are from the USA.

Table 10 presents the results for the Journal of Operations Management. Note that this journal and the next one have a closer orientation to the management field, while the previous two are closer to engineering and operations research.

Michigan State University is the leading university in this journal. It is worth noting that the first nine universities are from the USA, while the tenth one is from Canada. This journal is totally led by USA institutions with twenty-five in the Top 30. Two UK universities appear in the list, and only two are from Asia. These results clearly prove the dominant position that American universities have in the field of management.

Finally, let us look into the International Journal of Operations and Production Management. The results appear in Table 11. Note that this journal is from Europe.

Table 15 Production, Planning and Control

<i>R</i>	Institution	TP	TC	<i>H</i>	TC/TP
1	CNRS France	54	340	10	6.30
2	Polytechnic University of Milan	46	369	12	8.02
3	Eindhoven University of Technology	25	295	10	11.80
4	National Taiwan University of Science and Technology	22	152	7	6.91
5	Hong Kong Polytechnic University	21	148	6	7.05
6	Aalborg University	20	91	6	4.55
7	University of Strathclyde	19	126	7	6.63
8	National University of Ireland Galway	18	279	8	15.50
9	Indian Institute of Technology Delhi	18	129	8	7.17
10	Cardiff University	18	205	8	11.39
11	Aalto University	17	164	6	9.65
12	Polytechnic University of Valencia	16	84	6	5.25
13	King Fahd University of Petroleum Minerals	16	110	7	6.88
14	City University of Hong Kong	16	147	6	9.19
15	University of Trondheim	15	8	2	0.53
16	Pohang University of Science Technology	15	141	8	9.40
17	Monash University	15	132	6	8.80
18	University of Nottingham	14	107	6	7.64
19	University of Manchester	14	307	8	21.93
20	PRES University of Toulouse	14	84	6	6.00
21	Linköping University	14	124	6	8.86
22	Chung Yuan Christian University	14	233	8	16.64
23	Aston University	14	32	4	2.29
24	National Cheng Kung University	13	57	6	4.38
25	University of Groningen	12	88	6	7.33
26	Purdue University	12	91	6	7.58
27	Louisiana State University	12	193	7	16.08
28	Cranfield University	12	102	6	8.50
29	Concordia University Canada	12	68	5	5.67
30	Wageningen University Research Center	11	76	6	6.91

Cranfield University is the most productive university in this journal between 1990 and 2014, although the University of Cambridge is more influential. The Top 5 is constituted only by British universities, while the Top 30 has twenty-four European universities (including sixteen UK universities), four from the USA, one from Asia and one from Australia.

Table 12 depicts the performance of the Top 30 universities in the Journal of Quality Technology. This journal is dominated by American institutions with twenty-four in the Top 30. The Top 30 has only two from Canada and one each from Hong Kong, Singapore, Belgium, and Netherlands.

Table 13 lists Top 30 universities in POM. The top 30 has twenty-seven universities from the USA, two from

Hong Kong and one from Canada. Note that there is no European university in the Top 30.

Table 14 displays the Top 30 universities in the IEEE Transactions on Engineering Management. The National University of Singapore is most productive university followed by four American universities. The Top 30 has 25 universities from the USA, two from Canada, and one each from the UK and Hong Kong.

The Top 30 most productive universities in Production Planning and Control are listed in Table 15. The Top 30 has seventeen European universities and only two American universities. Two Asian universities, the National Taiwan University of Science and Technology and Hong Kong Polytechnic University, perform remarkably in the fourth and fifth positions in the table.

Table 16 Total Quality Management & Business Excellence

<i>R</i>	Institution	TP	TC	<i>H</i>	TC/TP
1	Chung Hua University	22	151	7	6.86
2	National Cheng Kung University	21	201	9	9.57
3	Linkoping University	18	89	5	4.94
4	University of Piraeus	16	82	6	5.13
5	National Taiwan University of Science and Technology	16	75	5	4.69
6	Aarhus University	15	47	4	3.13
7	Lulea University of Technology	14	58	5	4.14
8	Indian Statistical Institute	14	69	4	4.93
9	University of Girona	13	108	7	8.31
10	National Central University	13	108	7	8.31
11	University of Coimbra	12	69	6	5.75
12	National Taiwan University	12	83	5	6.92
13	Chung Yuan Christian University	12	118	5	9.83
14	University of Kent	11	65	5	5.91
15	Stockholm School of Economics	11	39	4	3.55
16	National Chin Yi University of Technology	11	46	5	4.18
17	National Chiao Tung University	11	47	4	4.27
18	Massey University	11	32	4	2.91
19	Lund University	11	111	5	10.09
20	City University of Hong Kong	11	55	5	5.00
21	Yuan Ze University	10	66	5	6.60
22	Hong Kong Polytechnic University	10	50	4	5.00
23	Chalmers University of Technology	10	14	3	1.40
24	University of Granada	9	55	6	6.11
25	University of Bradford	9	80	5	8.89
26	National Yunlin University Science Technology	9	89	7	9.89
27	National Sun Yat Sen University	9	78	5	8.67
28	National Chung Cheng University	9	41	4	4.56
29	University of Manchester	8	24	3	3
30	University of Birmingham	8	50	4	6.25

Table 16 shows that sixteen Asian universities dominate the journal Total Quality Management and Business Excellence. Twelve Taiwanese universities performed notably to get ranked in the Top 30. There is no American university in the Top 30.

Table 17 depicts the Top 30 most productive universities in the International Journal of Computer Integrated Manufacturing. CNRS France leads in this journal. The Top 30 has fifteen universities from Asia, six universities from the USA and seven universities from Europe.

Table 18 shows the Top 30 most productive universities in the Journal of Manufacturing Systems. The University of Michigan leads this ranking, which is far greater than the second position obtained by Penn State University. The USA again leads this journal. The Top 30 has twenty-two universities from the USA. The journals that have been

discussed so far published 100% POM articles. Table 19 presents the Top 10 most productive universities in the 11 selected top ranked journals. These journals published POM articles but did not only publish them.

American universities completely dominate the Top 10 positions of the following journals: Management Science, Decision Sciences, and the Journal of Business Logistics and Manufacturing Service Operations Management. Universities from the UK dominate Supply Chain Management: An International Journal. Asian universities are dominant in Expert Systems with Applications, the Omega International Journal of Management Science, and Computers and Industrial Engineering. On the other hand, a wider range is seen in the European Journal of Operational Research, Transportation Research Part E Logistics and Transportation Review and in the International Journal of

Table 17 International Journal of Computer Integrated Manufacturing

<i>R</i>	Institution	TP	TC	<i>H</i>	TC/TP
1	CNRS France	73	470	12	6.44
2	Loughborough University	64	524	12	8.19
3	University of Hong Kong	46	441	12	9.59
4	Shanghai Jiao Tong University	29	146	7	5.03
5	University of Bath	28	248	7	8.86
6	Purdue University	28	356	10	12.71
7	Pohang University of Science Technology	23	188	8	8.17
8	National Institute of Standards Technology USA	21	259	8	12.33
9	National Cheng Kung University	19	191	7	10.05
10	City University of Hong Kong	18	113	7	6.28
11	New Jersey Institute of Technology	17	66	5	3.88
12	Nanyang Technological University	17	106	6	6.24
13	Hong Kong Polytechnic University	17	97	5	5.71
14	University of Patras	16	155	8	9.69
15	Tsinghua University	16	82	7	5.13
16	National Tsing Hua University	16	79	6	4.94
17	National Taiwan University of Science and Technology	15	69	4	4.60
18	National Chiao Tung University	15	84	6	5.60
19	Korea Advanced Institute of Science Technology	15	100	6	6.67
20	Cranfield University	15	102	5	6.80
21	University of Auckland	14	143	7	10.21
22	University of Nottingham	13	60	5	4.62
23	Guangdong University of Technology	13	42	4	3.23
24	Chung Yuan Christian University	13	73	6	5.62
25	Arizona State University	13	116	5	8.92
26	Wichita State University	12	70	5	5.83
27	University of Windsor	12	82	7	6.83
28	University of North Carolina	12	68	5	5.67
29	University of Lorraine	12	135	6	11.25
30	Penn State University	12	142	8	11.83

Physical Distribution Logistics Management. The next table presents the information of the twenty-five most cited research papers in other research works.

Table 20 provides information about the mostly relevant topics in POM, which will in turn help young researchers to choose research topics and plan future research agendas. The article entitled “Toward a knowledge-based theory of the firm” written by R.M. Grant of Georgetown University is leading the table by a wide margin. Grant (1996) recognized the most important role of the firm as integrating the specialist knowledge resident in individuals into goods and services. This work suggested that the primary task of firm management is establishing the coordination necessary for this knowledge integration. The article entitled “the capabilities of market-driven organizations” written by George S. Day of the University of Pennsylvania is

ranked second. Stanford University is the origin of the research article, which is ranked third. Note that the top three have more than one thousand citations and the USA is the country of origin of all these articles. During the 25 years, researchers highly focused on topics such as knowledge-sharing management, information sharing management, and supply chain management.

Mapping the Leading Universities with VOS Viewer

Another important issue to consider is the bibliographic influence that each university has and the bibliographic network formed around its publications and citations. A tool for doing so is bibliographic coupling. It is defined as a measure that considers the number of times two different studies reference a common third work in their

Table 18 Journal of Manufacturing Systems

<i>R</i>	Institution	TP	TC	<i>H</i>	TC/TP
1	University of Michigan	39	356	10	9.13
2	Penn State University	24	182	9	7.58
3	University of California Berkeley	19	291	9	15.32
4	Korea Advanced Institute of Science Technology	19	299	9	15.74
5	General Motors Company	18	149	8	8.28
6	Auburn University	18	419	9	23.28
7	University of Windsor	17	106	6	6.24
8	Purdue University	17	301	10	17.71
9	University of Tehran	14	116	6	8.29
10	Texas AM University College Station	14	92	4	6.57
11	University of Wisconsin Madison	13	198	5	15.23
12	University of North Carolina	12	145	7	12.08
13	Massachusetts Institute of Technology	12	187	7	15.58
14	Islamic Azad University	12	78	6	6.50
15	Bradley University	11	34	3	3.09
16	University of Pittsburgh	9	77	4	8.56
17	University of Maryland College Park	9	142	7	15.78
18	National University of Singapore	9	47	3	5.22
19	Iran University Science Technology	9	42	4	4.67
20	Arizona State University	9	50	4	5.56
21	University of Wisconsin Milwaukee	8	107	6	13.38
22	University of Texas Austin	8	100	4	12.50
23	University of Iowa	8	104	6	13.00
24	University of Cincinnati	8	199	6	24.88
25	Ohio State University	8	70	4	8.75
26	Iowa State University	8	101	6	12.63
27	Virginia Polytechnic Institute	7	19	3	2.71
28	University of Skovde	7	27	4	3.86
29	University of Illinois Urbana Champaign	7	35	4	5.00
30	University of Connecticut	7	43	4	6.14

bibliographies (Kessler 1963; Martyn 1964). If we apply this concept to universities, we consider the number of times that two documents from different institutions cite a common third article. This approach allows us to simultaneously identify the bibliographic references that different institutions have in common and see how relevant they are in this field. Figure 3 presents the bibliographic coupling of the leading universities in the five thousand most cited papers in production and operations management between 1990 and 2014.

As we can see, American universities form the core of the field. Most of these universities appear in Table 1. However, Asian institutions also have an important presence in the field. Hong Kong Polytechnic University and the National University of Singapore also form an important core in this area. British universities are less

significant, although they also form some important cores around the University of Cambridge, the University of Warwick, and the University of Manchester. Note that Fig. 3 is presented using a density visualization of the results. Figure 4 presents the network visualization of bibliographic coupling.

Figures 5 and 6, respectively, present the network visualization of the citation and co-authorship analyses of universities with a minimum threshold of twenty documents and the one hundred most representative connections. The performances of Michigan State University, Hong Kong Polytechnic University, Arizona State University, and the University of Minnesota Twin Cities are significant in both the co-citation and co-author indicators. American universities again perform notably in these fields.



Table 19 Top 10 universities in the eleven selected journals

Journal	<i>R</i>	Institution	Country	TP	TC	<i>H</i>	TC/TP
Supply Chain Management An International Journal	1	Cranfield University	UK	22	190	8	8.64
	2	Cardiff University	UK	20	251	10	12.55
	3	University of Melbourne	AUS	12	298	7	24.83
	4	Aalto University	FIN	11	64	6	5.82
	5	University of Birmingham	UK	10	202	7	20.20
	6	University of Warwick	UK	9	129	6	14.33
	7	University of Kent	UK	9	99	6	11.00
	8	University of Hull	UK	9	114	6	12.67
	9	University of Bath	UK	9	77	5	8.56
	10	Hong Kong Polytechnic Uni.	CHN	9	145	6	16.11
Manufacturing Service Operations Management	1	Columbia University	USA	27	393	12	14.56
	2	Univ North Carolina Chapel Hill	USA	24	379	11	15.79
	3	University of Pennsylvania	USA	23	352	11	15.30
	4	Stanford University	USA	20	185	7	9.25
	5	University of Michigan	USA	19	203	6	10.68
	6	Northwestern University	USA	18	126	6	7.00
	7	Georgia Institute of Technology	USA	17	211	8	12.41
	8	Univ California Los Angeles	USA	16	262	8	16.38
	9	Duke University	USA	16	174	6	10.88
	10	INSEAD Business School	USA	14	103	7	7.36
International Journal of Physical Distribution Logistics Management	1	University of Tennessee Knoxville	USA	16	255	7	15.94
	2	Cranfield University	UK	16	142	7	8.88
	3	Lund University	SWE	14	48	5	3.43
	4	Chalmers University of Technology	SWE	12	56	5	4.67
	5	Auburn University	USA	11	98	5	8.91
	6	Whu-Otto Beisheim School of Management	GER	9	43	5	4.78
	7	University of Southern Denmark	DEN	9	71	6	7.89
	8	University of North Texas Denton	USA	9	148	4	16.44
	9	University of North Carolina	USA	8	100	5	12.50
	10	University of Alabama Tuscaloosa	USA	8	76	4	9.50
Journal of Business Logistics	1	University of Arkansas Fayetteville	USA	33	154	6	4.67
	2	Ohio State University	USA	28	278	10	9.93
	3	University of Tennessee Knoxville	USA	27	343	9	12.70
	4	Michigan State University	USA	18	109	6	6.06
	5	Weber State University	USA	12	36	3	3.00
	6	University of North Carolina	USA	9	140	5	15.56
	7	University of Oklahoma	USA	8	166	7	20.75
	8	University of Alabama Tuscaloosa	USA	8	72	4	9.00
	9	Copenhagen Business School	DEN	8	62	4	7.75
	10	Colorado State University	USA	8	47	3	5.88
Transportation Research Part E Logistics and Transportation Review	1	Univ Maryland College Park	USA	42	813	15	19.36
	2	National University of Singapore	SGP	34	599	16	17.62
	3	University of British Columbia	UK	32	269	10	8.41
	4	University of Sydney	AUS	27	427	11	15.81
	5	University of California Berkeley	USA	26	436	11	16.77
	6	National Chiao Tung University	TWN	23	533	10	23.17

Table 19 continued

Journal	<i>R</i>	Institution	Country	TP	TC	<i>H</i>	TC/TP
European Journal of Operational Research	7	Hong Kong Polytechnic Univ	CHN	23	548	11	23.83
	8	Iowa State University	USA	21	185	9	8.81
	9	National Cheng Kung Univ	TWN	17	217	8	12.76
	10	Hong Kong Univ Sci. Tech.	CHN	17	196	9	11.53
	1	CNRS France	FRA	40	582	13	14.55
	2	Erasmus University Rotterdam	NET	29	2128	21	73.38
	3	Hong Kong Polytechnic University	CHN	27	1201	16	44.48
	4	Eindhoven University of Technology	NET	26	742	17	28.54
	5	KU Leuven	BEL	23	949	13	41.26
	6	University of Florida	USA	22	640	10	29.09
Management Science	7	National University of Singapore	SGP	20	332	11	16.60
	8	City University of Hong Kong	HK	20	640	12	32.00
	9	University of Montreal	CAN	17	429	9	25.24
	10	National Cheng Kung University	TWN	17	424	13	24.94
	1	University of Pennsylvania	USA	37	3200	25	86.49
	2	Stanford University	USA	29	3404	21	117.38
	3	INSEAD Business School	USA	26	1711	18	65.81
	4	Carnegie Mellon University	USA	18	1043	14	57.94
	5	Northwestern University	USA	17	1402	12	82.47
	6	Columbia University	USA	17	1149	14	67.59
Expert Systems with Applications	7	University of Michigan	USA	16	837	12	52.31
	8	Univ California Los Angeles	USA	15	1387	12	92.47
	9	Massachusetts Institute Technology	USA	15	1467	12	97.80
	10	Harvard University	USA	14	647	11	46.21
	1	Hong Kong Polytechnic University	CHN	47	680	14	14.47
	2	National Chiao Tung University	TWN	22	426	11	19.36
	3	City University of Hong Kong	CHN	17	224	7	13.18
	4	National Taipei University Tech.	TWN	16	160	7	10.00
	5	National Taiwan Univ Sci. Tech.	TWN	15	307	7	20.47
	6	National Cheng Kung University	TWN	13	144	7	11.08
Decision Sciences	7	National Tsing Hua University	TWN	12	98	5	8.17
	8	Yonsei University	KOR	11	80	5	7.27
	9	University of Hong Kong	CHN	11	225	8	20.45
	10	Tamkang University	TWN	10	125	7	12.50
	1	Michigan State University	USA	28	1174	16	41.93
	2	Ohio State University	USA	20	497	12	24.85
	3	University of South Carolina	USA	16	424	12	26.50
	4	Clemson University	USA	16	496	12	31.00
	5	Univ Minnesota Twin Cities	USA	15	710	11	47.33
	6	Texas AM Uni. College Station	USA	13	311	8	23.92
Omega International Journal of Management Science	7	University of North Carolina	USA	12	682	11	56.83
	8	Indiana University Bloomington	USA	12	254	8	21.17
	9	IU Kelley School of Business	USA	9	285	7	31.67
	10	Arizona State University	USA	8	332	6	41.5
	1	Hong Kong Polytechnic Univ	CHN	12	484	11	40.33
	2	Cardiff University	UK	8	118	6	14.75
	3	National University of Singapore	SGP	6	124	6	20.67
	4	Chinese University of Hong Kong	CHN	6	154	5	25.67



Table 19 continued

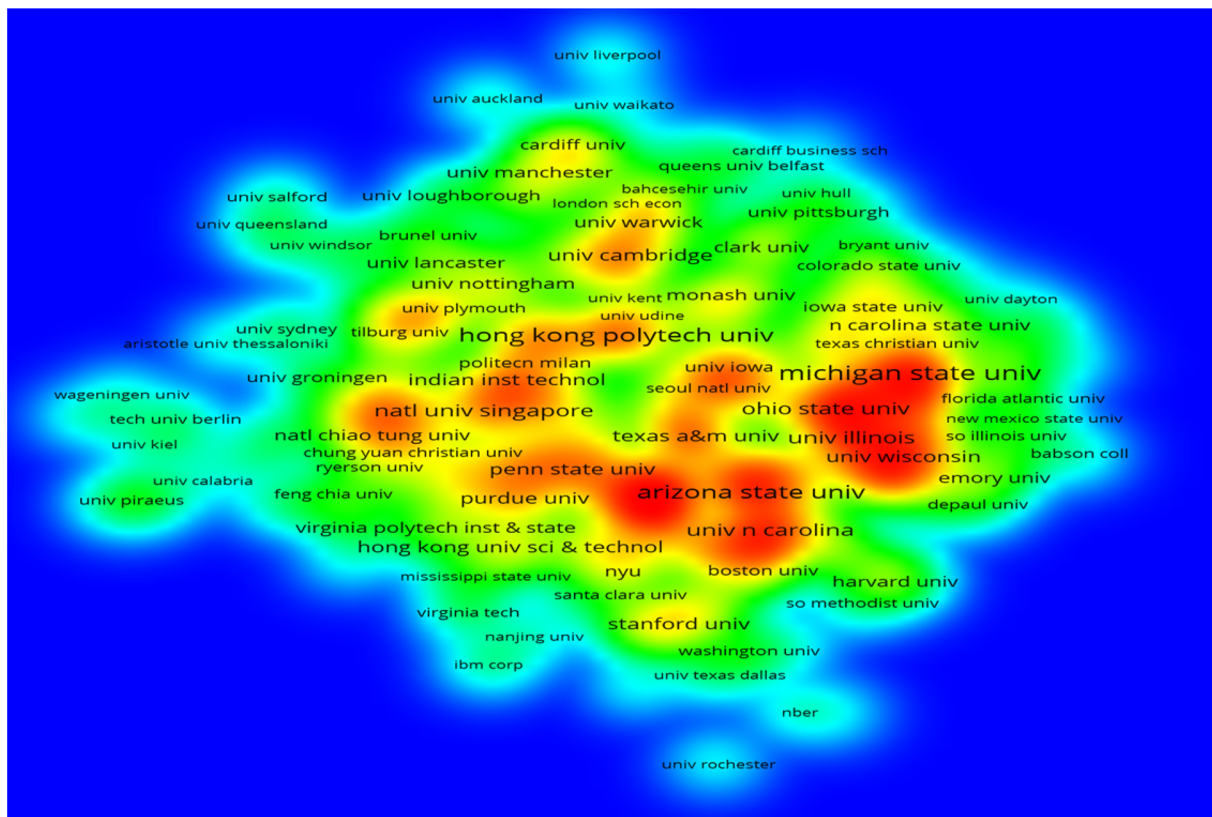
Journal	R	Institution	Country	TP	TC	H	TC/TP
	5	University of Bradford	UK	5	92	4	18.40
	6	Tsinghua University	CHN	5	77	3	15.40
	7	National Cheng Kung University	TWN	5	73	4	14.60
	8	Indian Institute of Technology Delhi	IND	5	203	4	40.60
	9	Drexel University	USA	5	103	4	20.60
	10	CNRS France	FRA	5	37	3	7.40
	1	Hong Kong Polytechnic Univ	CHN	12	484	11	40.33
Computers & Industrial Engineering							
	1	City University of Hong Kong	CHN	12	126	6	10.5
	2	CNRS France	FRA	12	66	6	5.5
	3	Ryerson University	CAN	10	145	5	14.5
	4	National Taiwan U Sci. Tech.	TWN	10	129	5	12.9
	5	Waseda University	JAP	9	307	7	34.11
	6	University of North Carolina	USA	9	59	3	6.56
	7	National Tsing Hua University	TWN	9	39	4	4.33
	8	University of Tehran	IRA	8	113	5	14.12
	9	Hong Kong Polytechnic Uni.	CHN	8	101	5	12.62
	10	Hanyang University	KOR	8	216	6	27

Table 20 The 25 most cited documents in POM from 1990 to 2014

1	Strategic Management Journal	2938	Toward a knowledge-based theory of the firm	Grant, RM	1996	163.2
2	Journal of Marketing	1424	The capabilities of market-driven organizations	Day, GS	1994	71.2
3	Management Science	1336	Information distortion in a supply chain: the bullwhip effect	Lee, HL; Padmanabhan, V; Whang, SJ	1997	78.6
4	Harvard Business Review	990	What is strategy?	Porter, ME	1996	55.0
5	Strategic Management Journal	883	Creating and managing a high-performance knowledge-sharing network: The Toyota case	Dyer, JH; Nobeoka, K	2000	63.1
6	American Economic Review	767	The effects of human resource management practices on productivity: A study of steel finishing lines	Ichniowski, C; Shaw, K; Prennushi, G	1997	45.1
7	Research Policy	740	The role of product architecture in the manufacturing firm	Ulrich, K	1995	38.9
8	Harvard Business Review	670	What is the right supply chain for your product?	Fisher, ML	1997	39.4
9	Academy of Management Review	665	Exploitation, exploration, and process management: The productivity dilemma revisited	Benner, MJ; Tushman, ML	2003	60.5
10	Management Science	645	The value of information sharing in a two-level supply chain	Lee, HL; So, KC; Tang, CS	2000	46.1
11	Industrial & Labor Relations Review	637	How common is workplace transformation and who adopts it	Osterman, P	1994	31.9
12	Academy of Management Journal	635	International expansion by new venture firms: International diversity, mode of market entry, technological learning, and performance	Zahra, SA; Ireland, RD; Hitt, MA	2000	45.4
13	Management Science	624	Quantifying the bullwhip effect in a simple supply chain: The impact of forecasting, lead times, and information	Chen, F; Drezner, Z; Ryan, JK; et al.	2000	44.6
14	Strategic Management Journal	613	Total quality management as competitive advantage—a review and empirical study	Powell, TC	1995	32.3
15	Organization Science	602	A pragmatic view of knowledge and boundaries: Boundary objects in new product development	Carlile, PR	2002	50.2
16	Administrative Science Quarterly	597	Reconceptualizing organizational routines as a source of flexibility and change	Feldman, MS; Pentland, BT	2003	54.3
17	European Journal of Operational Research	595	Quantitative models for reverse logistics: A review	Fleischmann, M; Bloemhof Ruwaard, JM; Dekker, R; et al.	1997	35.0

Table 20 continued

18	European Journal of Operational Research	555	Vendor Selection Criteria And Methods	Weber, CA; Current, JR; Benton, WC	1991	24.1
19	Journal of Management Information Systems	552	Knowledge management: An organizational capabilities perspective	Gold, AH; Malhotra, A; Segars, AH	2001	42.5
20	Journal of Applied Psychology	549	Task versus relationship conflict, team performance, and team member satisfaction: a meta-analysis	De Dreu, CKW; Weingart, LR	2003	49.9
21	International Journal of Operations & Production Management	541	Case research in operations management	Voss, C; Tsikriktsis, N; Frohlich, M	2002	45.1
22	Management Science	534	Supply chain inventory management and the value of shared information	Cachon, GP; Fisher, M	2000	38.1
23	Journal of Operations Management	512	Arcs of integration: an international study of supply chain strategies	Frohlich, MT; Westbrook, R	2001	39.4
24	International Journal of Production Economics	511	Supply chain design and analysis: Models and methods	Beamon, BM	1998	31.9
25	Management Science	501	The impact of environmental management on firm performance	Klassen, RD; McLaughlin, CP	1996	27.8

**Fig. 3** Bibliographic coupling of the leading universities in production and operations management

Conclusions

This study has presented a general overview of the most productive and influential universities between 1990 and 2014 in production and operations management. The results are extracted from the WoS database, which is

usually regarded as the most influential for scientific research. The findings of the article indicate that production and operations management has more distribution than other management fields because universities from all over the world are leading the discipline. In management and social sciences, this is quite uncommon, and usually

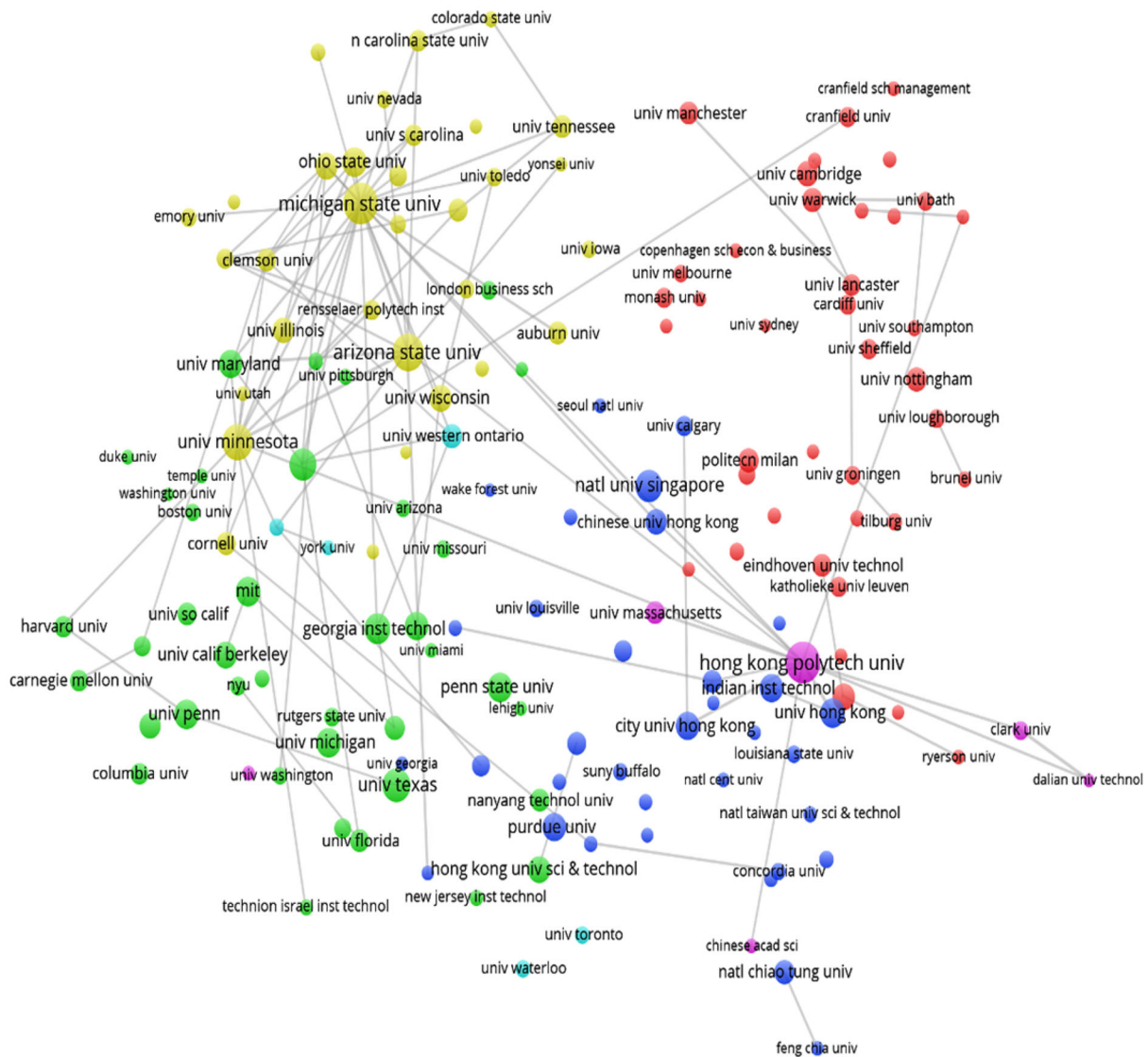


Fig. 4 Network visualization of the bibliographic coupling of leading universities in POM

English-speaking countries hold a dominant position. The main explanation for this is that production and operations management are close to more technical fields such as engineering and operations research where the current research is led by institutions from a wide range of countries and not only by English-speaking countries. This work provides a snapshot of the most productive universities in POM. This is very useful for PhD students and newcomers in order to identify places where there is strong activity in POM. For example, this could be useful for planning a potential research visit at one of the most productive institutions in the field. From Table 20, one can easily see the high impact research topics of POM. For instance, one may consider the following research topics for future research: knowledge-based theory, the capabilities of market-driven organizations, the bullwhip effect in supply

chain, the knowledge-sharing network, human resource management, product architecture, supply chain selection, information sharing, total quality management, reverse logistics, vendor selection, inventory management, supply chain strategies, environmental management, Big Data and Predictive Analytics, and other technological innovations.

Focusing on the results, Hong Kong Polytechnic University is the most productive university, although Michigan State University is the most influential one according to the total number of citations. Currently, North America, Europe and East Asia have a similar level of significant research in this area as seen from the number of institutions that appear in the ranking. Temporal analysis reveals that Asian universities are developing rapidly and capturing increasingly more positions in the list of top universities. Another interesting result is that the

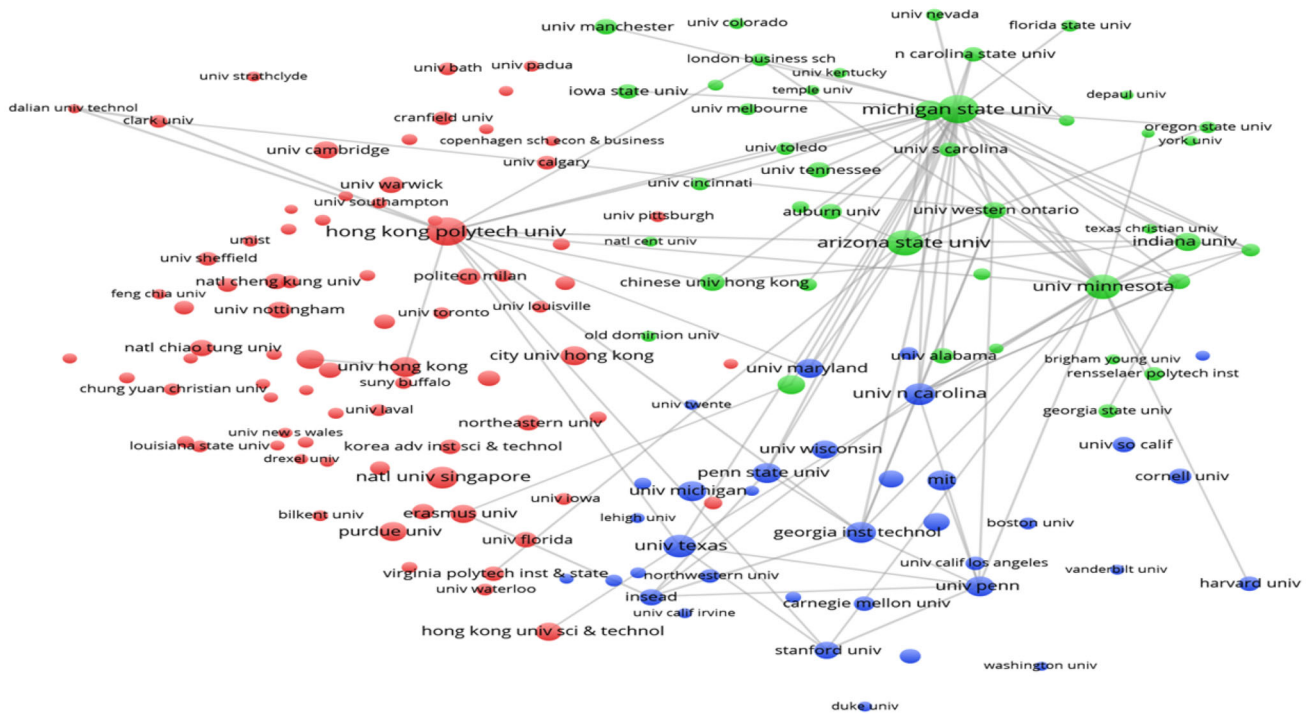


Fig. 5 Network visualization of the citations of leading universities in POM

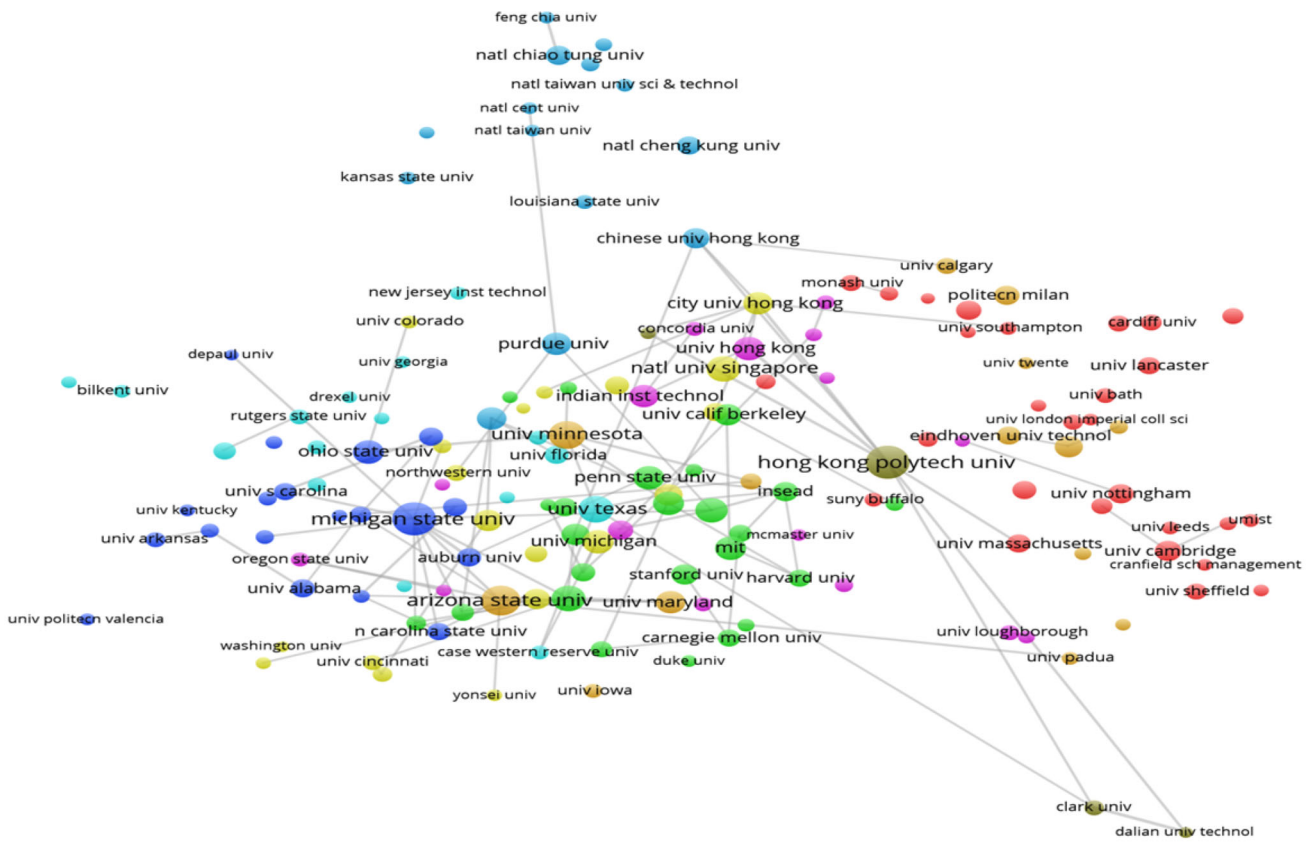


Fig. 6 Network visualization of co-author of leading universities in POM

universities tend to publish more in their local top journals with the USA being the dominant leader in the Journal of Operations Management, the Journal of Quality Technology, Production and Operations Management, IEEE Transactions on Engineering Management, and the Journal of Manufacturing Systems; Europe in the International Journal of Operations and Production Management and Production Planning and Control; Asia in Total Quality Management and Business Excellence and the International Journal of Computer Integrated Manufacturing; and a wider dispersion is seen in the International Journal of Production Research and in the International Journal of Production Economics.

The trends for the future indicate that the dispersion will continue with the appearance of more universities from developing countries. A first indication of this is that some Indian Institutes of Technologies have already entered the lists. Note that these institutes has several locations in different Indian cities. Nevertheless, it is remarkable that

IIT Delhi and Madras entered several rankings. In the future, we will deepen the analysis by expanding the rankings to a bigger list of universities and including more journals in the analysis. Some other bibliometric techniques will also be considered, such as the co-occurrence of author keywords and citation networks.

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Compliance with Ethical Standards

Conflict of interest No potential conflict of interest was reported by the authors.

Appendix

See Table 21.

Table 21 Most influential POM Journals

R	Journal	TP	TC	H	TC/TP	> 200	> 100	> 50
1	International Journal of Production Research	6816	78,383	78	11.5	1	37	232
2	International Journal of Production Economics	5018	69,061	79	13.76	10	43	240
3	Journal of Operations Management	662	27,966	90	42.24	14	72	178
4	International Journal of Operations and Production Management	1528	25,463	68	16.66	5	25	101
5	Journal of Quality Technology	955	18,688	70	19.57	8	37	97
6	IEEE Transactions on Engineering Management	1270	16,645	51	13.11	1	14	52
7	Production and Operations Management	894	13,554	56	15.16	3	26	63
8	Production Planning and Control	1583	11,279	40	7.13	0	2	22
9	Total Quality Management and Business Excellence	1789	9446	32	5.28	0	0	8
10	International Journal of Computer Integrated Manufacturing	1401	8715	32	6.22	0	0	10
11	Journal of Manufacturing Systems	925	8001	37	8.65	0	5	19
12	Supply Chain Management An International Journal	561	6601	36	11.77	0	2	21
13	Manufacturing Service Operations Management	357	3599	29	10.08	0	1	9
14	International Journal of Physical Distribution Logistics Management	332	2222	21	6.69	1	2	3
15	Journal of Business Logistics	201	1641	21	8.16	0	0	2
Most influencing other POM Journals (not 100%)								
16	European Journal of Operational Research	1229	29,618	77	24.1	12	52	140
17	Management Science	291	19,412	74	66.71	17	57	105
18	Transportation Research Part E Logistics And Transportation Review	1143	14,412	51	12.61	1	11	54
19	Expert Systems With Applications	630	7603	39	12.07	0	5	27
20	Decision Sciences	234	6863	43	29.33	4	15	39
21	Omega International Journal of Management Science	299	6454	41	21.59	2	9	29
22	Computers & Industrial Engineering	522	5157	35	9.88	2	4	20

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Key Questions

1. Which universities are the most productive and influential in POM research?
2. How have the influence and productivity of universities changed throughout time?
3. Which universities are leading in the most influential POM Journals?
4. How have universities from different continents and countries contributed to POM research?
5. How have leading universities formed the bibliographic network around its publications and citations?



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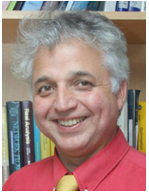
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