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Bibliometrics in operations research and management science: a university analysis

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Abstract
Many universities around the World have made important contributions in the field of operations research and management science. This article presents the most productive and influential universities between 1991 and 2015. For doing so, we use the Web of Science database in order to search for the information which is usually regarded as the most relevant for scientific research. The results show the country of origin of the leading universities being mainly from North America and Asia and especially from USA and China. The Centre National de la Recherche Scientifique (CNRS) of France is the most productive university while the Massachusetts Institute of Technology (MIT) of USA is the most influential one. The temporal evolution shows that USA is trailing its dominancy while China progressing quickly. The evaluation also reveals that Asian universities outperform North American universities during the last 5 years.

Keywords Operations research and management science · Bibliometrics · Web of Science · University analysis

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1 Introduction

Operations research and management science (OR–MS) is originated from the three fields: military operations, computer science and economics. Success of OR–MS in military operations influenced others to develop and apply it in industrial problems since late 1940s. Since the 1950s OR–MS has developed rapidly in universities and also in industries. Now, the OR–MS community has developed well in application, modeling and solution procedure. Researchers/practitioners are using OR–MS to enhance the quality of decisions and processes in different areas like finance, manufacturing, marketing and telecommunications. It now becomes a foremost part of the global modern movement towards the exercise of advanced analytics in industry and scientific research.

Wysocki (1979) presented a bibliographic study of 300 papers written on OR–MS aiming at classifying these works to create a research tradition. Corbett and Van Wassenhove (1993) presented a temporal analysis from 1956 to 1991 on OR–MS publications in Harvard Business Review (HBR), Operations Research and Journal of the Operational Research Society (JORS). They depicted a significant drifting of OR–MS publications from HBR to Operations Research and JORS. Motivated from the Corbett and Van Wassenhove (1993) work, Reisman and Kirschnick (1994) analyzed OR–MS research in three flagships journals: Operations Research, Management Science and Interfaces for three decades and provided some punctual research directions. Ormerod and Kiossis (1997) observed high proportion of publications of authors from US institutions in the leading European OR–MS journals and Mingers and Xu (2011) studied the drivers of citations in OR–MS. Since its early days, OR–MS not only has been used in different fields, different disciplines also contributed in its innovations and creativity (Evans 1997; Tsoukas and Papoulias 1996; Brans and Gallo 2007). Pidd (2004) demonstrated some enormous contributions of OR–MS in strategy development and policy-making. Besides its industrial contributions the OR–MS research significantly contributed in disaster operations management also. Altay and Green (2006) first reviewed the contribution of the OR–MS community in disaster operations management and demonstrated some research directions for future advancement. Motivated from the Altay and Green's (2006) work Galindo and Batta (2013) further examined how the community response to fill the gaps mentioned by Altay and Green (2006). Snyder et al. (2016)reviewed importance of OR–MS research in supply chain disruptions, which are caused by both natural disasters and human actions. Considering a heavy sample of OR–MS articles published during 2001–2008, Avkiran and Alpert (2015) investigated the influence of co-authorship on article impact. Zhang and Wilhelm (2011) provided variety of decision support OR–MS models to resolve problems and promote growth for the specialty crops industry.

The universities and other related institutions are playing important role for developing research and knowledge creation in OR–MS (Daraio et al. 2015). Performance and contribution of universities can be measured through academic publications. Thousands of universities are contributing in social and economic development research around the world. During the last decades the number of universities has increased significantly due to the growth of the population and the development of the economies. University research helps in regional economic growth, for example, Silicon Valley and the Boston area. Cisco, Google, and Yahoo are also some classical examples of university originated giants. Today, there are many thousands of universities around the World. How these universities perform in OR–MS is one of the main objectives of the present study.

In the literature, there are many methods for measuring the scientific production of the universities. Among others, bibliometric analysis is receiving increasing attention by the

scientific community (Laengle et al. 2017). Bibliometrics is originated from the field of library and information science (Broadus 1987; Pritchard 1969) and is strongly connected to scientometrics (Mingers and Leydesdorff 2015). Van Raan (1996) discussed procedures to manage methodological and technical problems which arise in bibliometric studies. In the pioneering work of the Leiden group, Van Raan (2004) extensively and minutely discussed the importance of indicator standardization for the measurement of research performance. The most vital parameter in the measurement of performance of scientific research should be based on citations because citation related indicators provide information about international impact and influence (Narin 1976; Rinia et al. 1998). Hicks et al. (2015) proposed ten principles to guide evaluation of research outcomes and said "Simplicity is a virtue in an indicator because it enhances transparency". With the help of fast development of computers and the internet it is increasingly spreading its wings in a wide range of fields (Podsakoff et al. 2008). Several bibliometric research articles are presented in the literature on different research areas, including supply chain management (Fahimnia et al. 2015; González-Benito et al. 2013), economics (Bonilla et al. 2015; Wang et al. 2018), health economics (Wagstaff and Culyer 2012), fuzzy research (Merigó et al. 2015a), innovation (Merigó et al. 2016), radio frequency identification (Lim et al. 2013), data envelopment analysis (Lampe and Hilgers 2015; Liu et al. 2013), psychology (Tur-Porcar et al. 2018), marketing (Martínez-López et al. 2018; Valenzuela et al. 2017), entrepreneurship (Landström et al. 2012), big data and supply chain management (Mishra et al. 2016) and pricing research (Leone et al. 2012).

The aim of this paper is to provide a general overview of research performed in OR–MS over the last decades using bibliometric methods. We use the Web of Science (WoS) Core Collection as the database for collecting information. Differing from Merigó and Yang (2017), the objective of this work is to identify the most productive and influential research institutions in OR–MS and see the current evolution of the field by taking into account the most influential journals. The present study tries to highlight performance of the universities from different continents as well as countries on overall and temporal basis. This analysis also considers performance of the universities in 30 most influential journals to depict profile of publishing papers whether from diverse countries around the World or influenced by some specific country or region.

The rest of the paper is structured as follows. Section 2 briefly demonstrates the methodology of the bibliometric study. Section 3 presents the outcomes of the bibliometric analysis including the presentation of leading universities in OR–MS, temporal analysis of the most productive universities and most productive institutions in thirty significant journals. Finally, Sect. 4 summarizes the main findings and conclusions of the paper.

2 Methods

To prepare the bibliometric analysis about performance of universities on OR–MS this study collects data from the Web of Science (WoS) Core Collection. The WoS database includes more than 15,000 journals and 50,000,000 papers classified in 251 subject categories and 151 subject areas. Clarivate Analytics now maintains this database. It was formed by the Institute for Scientific Information (ISI) and then it was maintained by the intellectual property and science business of Thomson and Reuters. The study considers a time period of 25 years between 1991 and 2015. During this time interval our search depicts 127,840 research papers in this field. The search process has been developed between August and November 2016.

The work also considers a wide range of bibliometric indicators in order to provide a complete representation of the bibliographic information including the total number of papers, citations, citations per paper, the *H-index* (Hirsch 2005; Mingers 2009), and some other related indicators regarding the number of articles that overcome a citation threshold (Merigó et al. 2015b). Total number of paper publications provides information about productivity of the universities while citations and citations per paper help to measure quality of research works of the universities (Cancino et al. 2017). Present bibliometric study considers the field OR–MS. There are several sub-fields within OR–MS and citation densities between research fields may be different. To overcome these issues, beside the H-index the present study provides information of two basic indicators total number of publications ans total citations. It also depicts several citation thresholds such that more than or equal to 5, 50 and 100 citations, which help to determine citation density.

H-index measures both the quality and the quantity of publications simultaneously (Hirsch 2005). If a university has an *H-index* of *n*, it means that it has *n* papers that have received *n* citations or more. H-index is the most popular and accepted indicator to evaluate performance of an institution or a journal (Merigó and Yang 2017). Initially, the scientific community widely accepted the indicator, H-index for measuring research performance (Bornmann and Daniel 2005). Later, in 2006 A.F.J Van Raan depicted high chance of estimation error in H-index (Van Raan 2006). Because H-index '*n*' of a university provides an estimation of total n^2 number of citations received by the university. Moreover, H-index ignores the citations of those publications which have less than *n* citations. Through a large evolutionary study on all publications of 147 chemistry research groups, Van Raan (2006) presented the statistical correlation between the H-index and regular and advanced bibliometric indicators (TP = Total Papers; TC = Total Cites, CPP = citations per paper and CPP/FCSm = 'crown indicator'), as well as with the results of peer review judgment. Waltman and Van Eck (2012) provided three examples to show that inconsistency affects not only the H-index but also all kinds of variants, extensions, and generalizations of this index. Instead of H-index, they provide more attention to citation data and proposed cumulative citation index. In their manifesto, Hicks et al. (2015) also criticized evaluation of scientific publications of a researcher/group only through a number of H-index.

Influenced by the advanced indicators of Leiden group, we incorporate an indicator Average citation per publication per year (ACPY) to analyze growth of the field. The procedure of the calculation is as follows. Suppose, a year has P publications and C citations and we have considered the evaluation period of 25 years from 2001 to 2015, then ACPY of 2001, 2002, 2003, … will be C/25P; C/24P; C/23P,… respectively. We have provided individual rankings based on publications, citations and H-index. To prepare a general ranking, we first normalize TP and TC score of the universities and then giving equal importance (50% + 50%), we prepare the ranking score. For example consider CNRS, it has 1774 publications 20,390 citations. Our search reveals total 127,858 publication having 1,954,499 citations in OR–MS during 25 years. So, ranking score of CNRS, France is calculated as (1774/127,858) * 50% + (20,390/1,954,499) * 50% = 0.012153554. Similarly, ranking score of MIT will be 0.036911456. In this way, we prepare ranking of the universities. Instead of equal weight on TP and TC, we also consider different weight such as 30% of TP + 70% of TC.

Table 1 Annual citation structure of OR–MS research

Year	TP	TC	ACPY	>100	>50	>25	>5
1991	2714	43,094	0.63513633	53	130	236	801
1992	2936	50,289	0.71368358	50	149	275	895
1993	2997	54,918	0.79670975	60	186	301	976
1994	3493	56,792	0.73903651	57	159	324	1115
1995	3765	66,511	0.84121925	78	196	375	1273
1996	3737	69,476	0.92956917	64	222	372	1385
1997	3791	81,442	1.13068347	73	233	447	1405
1998	3765	77,378	1.14177365	77	248	439	1435
1999	3861	90,045	1.37186343	101	272	493	1496
2000	3960	93,595	1.47719381	102	272	507	1567
2001	3958	90,081	1.51728146	100	300	537	1500
2002	3904	91,611	1.67613803	110	294	565	1574
2003	3843	96,070	1.92297684	118	292	568	1583
2004	4132	102,297	2.06310503	101	358	642	1779
2005	4449	99,067	2.02429555	101	307	637	2044
2006	5014	108,395	2.16184683	103	301	750	2305
2007	5638	113,988	2.24642308	105	346	776	2551
2008	6453	110,135	2.13340694	78	320	758	2946
2009	7622	114,615	2.14819882	54	304	893	3526
2010	7003	92,538	2.20234185	48	193	632	3193
2011	7763	83,881	2.16104599	21	146	530	3432
2012	8337	71,615	2.1475051	10	76	372	3428
2013	7910	48,025	2.02380952	5	33	148	2525
2014	8154	33,263	2.03967378	0	9	54	1679
2015	8659	15,378	1.77595565	0	2	4	497
Total	127,858	1,954,499		1669	5348	11,635	46,910
Percentage (%)	100.00			1.31	4.18	9.10	36.69

3 Results

Increasingly competitive environment in the ever changing World generates more and more issues/problems/spaces for OR–MS research. OR–MS community is spreading its wings in different disciplines. As a result, the number of research works is increasing day by day. Influenced by the advanced indicators of Leiden group, we incorporate an indicator Average citation per publication per year (ACPY) in Table 1 to access year wise advancement of OR–MS from 1991 to 2015.

Publications of 2007 are leading the Table 1 with respect to ACPY index followed by publications of 2010. Publications of 2015 and 2009 are leading in the TP and TC index respectively. Year wise pattern in ACPY index clearly states regular growth of OR–MS research. Table 1 also depicts that 1669 papers receive huge attention from researchers having more than one hundred citations. 4.18% of total papers have more than fifty citations and more than one-third documents have more than five citations. Figure 1 demonstrates number
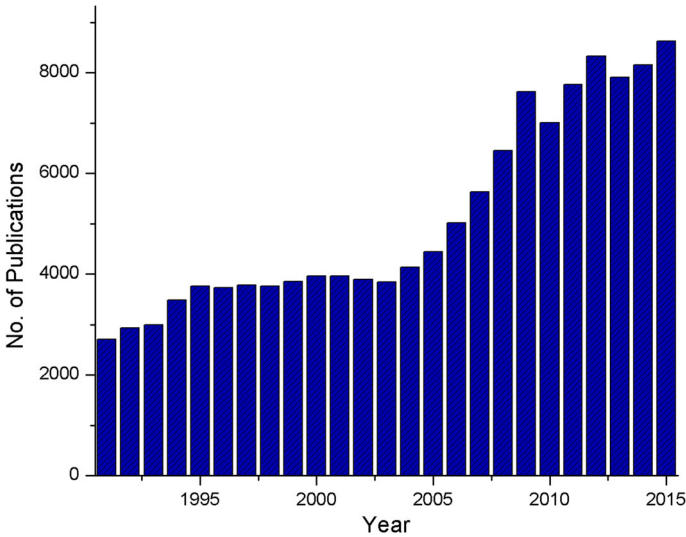
Fig. 1 Number of OR–MS publications from 1991 to 2015

of OR–MS papers published yearly from 1991 to 2015. Figure 1 shows that the yearly publication numbers is increasing on a regular basis.

This Section presents the results of the paper. First, we consider the global ranking between 1991 and 2015. Next, the article considers the temporal evolution of the most productive and influential universities. Third, the leading universities in some selected journals. Finally, the study presents the co-citation, co-author and bibliographic coupling of the most significant institutions in OR–MS.

3.1 Leading universities in OR–MS

A lot of universities around the world are strongly involved in production and operations management research. In order to identify the leading ones, let us look into the results obtained between 1991 and 2015 according to some well-known bibliometric indicators. Table 2 presents the 100 most productive institutions in this field. Additionally, some other indicators are presented in order to obtain a more general perspective of each of the 100 universities. The ranking is according to the number of publications and in the case of a tie, according to the number of citations.

Massachusetts Institute of Technology (MIT) is the most influential university in OR–MS research during 1991–2015 followed by the University of Montreal of Canada. The CNRS France is the most productive university with 1774 publications followed by the Hong Kong Polytechnic University of China and University of Montreal of Canada. Forty-three universities of USA appear in the Top 100. Asia has twenty-three universities while Europe has twenty universities in the Top 100 ranking. China is showing dominancy among Asian countries with 11 universities followed by Taiwan. Some universities from European counties like France and Netherlands are showing excellent performance in OR–MS. Although six universities from UK come out in Top 100 but none of them are in first 50. It is worth noting that nine Canadian universities are highlighting their position in world's Top 100 productive and influential universities in OR–MS. Five universities: University of Montreal; Georgia Institute of Technology; Massachusetts Institute of Technology (MIT); Columbia University

Table 2 100 most influential universities in OR–MS

R	University	COUN	TP	TC	H	TC/TP	>100	>50	>10	ARWU	QS
1	Massachusetts Institute of Technology MIT	US	1316	38,717	88	29.42	78	196	657	–	1
2	U Montreal	CAN	1466	35,673	82	24.33	63	181	683	101–150	115
3	Georgia Institute of Technology	US	1408	31,033	77	22.04	52	149	648	101–150	84
4	U Pennsylvania	US	588	27,681	82	47.08	64	141	385	17	18
5	Hong Kong Polytechnic U	CHN	1492	25,250	64	16.92	24	107	647	–	116
6	Columbia U	US	766	23,844	77	31.13	53	135	417	8	22
7	U California Berkeley	US	900	22,849	65	25.39	29	102	449	4	26
8	Carnegie Mellon U	US	793	22,471	74	28.34	42	108	379	61	62
9	National U Singapore	SGP	1241	22,410	62	18.06	25	89	534	101–150	12
10	Stanford U	US	697	20,665	67	29.65	38	103	339	2	3

R	University	COUN	TP	TC	H	TC/TP	>100	>50	>10	>5	ARWU	QS
11	U Maryland College Park	US	798	20,563	62	25.77	32	85	375	499	43	126
12	U Texas Austin	US	833	20,446	64	24.55	28	102	413	545	37	77
13	CNRS	FRA	1774	20,390	57	11.49	17	63	507	792	–	–
14	Northwestern U	US	686	19,633	66	28.62	39	88	327	438	–	32
15	U Michigan	US	999	19,056	61	19.08	31	91	427	596	99	30
16	Purdue U	US	892	17,848	62	20.01	24	76	378	536	61	89
17	Rutgers State U	US	801	17,785	60	22.20	27	76	351	468	64	601–650
18	Arizona State U	US	804	17,720	59	22.04	28	75	369	512	93	249
19	U Minnesota Twin Cities	US	557	17,375	69	31.19	38	98	298	373	–	–
20	Hec Montreal	CAN	606	17,257	66	28.48	33	88	301	404	–	–
21	Hong Kong U Science Tech	CHN	780	16,568	64	21.24	27	90	374	494	201–300	28
22	U Florida	US	907	16,520	58	18.21	23	70	363	511	83	180

Table 2 continued

R	University	COUN	TP	TC	H	TC/TP	>100	>50	>10	>5	ARWU	QS
23	Erasmus U Rotterdam	NET	699	15,654	58	22.39	25	71	319	438	151–200	126
24	City U Hong Kong	CHN	1024	15,371	57	15.01	15	68	399	577	201–300	57
25	Indian Institute of Technology Iit	IND	1080	14,246	52	13.19	15	53	369	581	–	179
26	Eindhoven U Technology	NET	903	13,781	52	15.26	17	53	340	508	301–400	117
27	Penn State U	US	877	13,581	52	15.49	17	55	346	508	–	–
28	Ku Leuven	BEL	687	13,541	52	19.71	21	56	296	403	90	82
29	U Illinois Urbana Champaign	US	673	13,259	54	19.70	18	62	287	398	29	59
30	National Chiao Tung U	TWN	835	12,984	47	15.55	17	39	316	487	301–400	182
31	Technion Israel Institute of Technology	ISR	675	12,871	52	19.07	18	55	254	348	77	198
32	Ohio State U	US	512	12,838	53	25.07	23	58	253	327	67	99
33	Korea Advanced Institute of Science Technology KAIST	S. KOR	813	12,669	50	15.58	15	49	323	474	–	43
34	Virginia Polytechnic Institute State U	US	742	12,049	50	16.24	13	50	297	420	201–300	338
35	Mcmaster U	CAN	495	12,049	50	24.34	14	50	206	296	96	149
36	Cornell U	US	589	12,042	54	20.44	17	60	273	358	13	17
37	New York U	US	442	12,024	56	27.20	23	62	211	284	27	53
38	U Wisconsin Madison	US	540	11,753	54	21.76	22	57	261	359	24	54
39	Chinese Academy of Sciences	CHN	848	11,709	50	13.81	8	47	268	411	–	–
40	Nanyang Technological U	SGP	731	11,692	50	15.99	16	49	274	409	151–200	–
41	Texas A M U College Station	US	698	11,601	52	16.62	13	53	286	408	100	159
42	At T	US	489	11,570	51	23.66	19	53	229	306	–	–
43	U California Los Angeles	US	393	11,397	51	29.00	26	51	192	257	12	27
44	Duke U	US	398	11,368	54	28.56	21	65	233	290	31	29
45	International Business Machines Ibm	US	607	11,221	54	18.49	18	56	215	320	–	–

Table 2 continued

R	University	COUN	TP	TC	H	TC/TP	>100	>50	>10	>5	ARWU	QS
46	U Hong Kong	CHN	623	10,849	49	17.41	12	48	270	394	151–200	30
47	Chinese U Hong Kong	CHN	644	10,722	51	16.65	10	53	268	384	151–200	51
48	National Cheng Kung U	TWN	821	10,709	44	13.04	7	33	305	463	301–400	224
49	National Taiwan U Science Technology	TWN	648	10,146	47	15.66	10	41	283	385	–	260
50	U Washington	US	458	9869	48	21.55	15	46	203	278	15	65
51	United States Department of Energy Doe	US	570	9841	44	17.26	14	33	206	307	–	–
52	U Washington Seattle	US	435	9542	48	21.94	15	45	194	263	–	–
53	U Bologna	Italy	490	9306	47	18.99	16	44	194	287	201–300	204
54	Tel Aviv U	Israel	628	9183	42	14.62	8	27	239	344	151–200	203
55	U Waterloo	CAN	621	9131	43	14.70	7	37	217	316	201–300	152
56	Polytechnique Montreal	CAN	558	8872	44	15.90	8	39	212	304	–	–
57	U Arizona	US	449	8712	45	19.40	9	35	203	267	90	216
58	United States Department of Defense	US	749	8596	42	11.48	9	32	203	320	–	–
59	Tsinghua U	CHN	808	8565	42	10.60	5	33	205	364	101–150	25
60	Delft U Technology	NET	546	8366	42	15.32	10	33	207	291	201–300	64
61	U Nottingham	UK	402	8340	45	20.75	13	34	182	236	101–150	70
62	U Southampton	UK	535	8291	42	15.50	9	31	206	305	101–150	81
63	Universite Paris Saclay Comue	FRA	681	8112	42	11.91	9	31	207	321	–	–
64	U Iowa	US	463	8025	45	17.33	10	38	204	287	151–200	–
65	U Pittsburgh	US	394	7951	41	20.18	20	36	164	219	70	133
66	U Southern California	US	489	7851	44	16.06	8	35	197	264	49	130
67	U Warwick	UK	441	7692	43	17.44	9	32	189	275	92	48

Table 2 continued

R	University	COUN	TP	TC	H	TC/TP	>100	>50	>10	>5	ARWU	QS
68	Cardiff U	UK	360	7534	45	20.93	13	37	163	221	151–200	122
69	Imperial College London	UK	437	7389	43	16.91	6	31	188	251	–	8
70	Polytechnic U Milan	ITA	522	7383	41	14.14	4	29	206	311	201–300	–
71	U Manchester	US	473	7361	40	15.56	10	33	184	259	41	33
72	Rensselaer Polytechnic Institute	US	388	7150	44	18.43	11	40	158	232	301–400	–
73	Inria	FRA	601	7130	36	11.86	8	21	174	270	–	–
74	U New South Wales	AUS	368	7087	40	19.26	8	23	147	215	101–150	46
75	State U New York Suny Buffalo	US	382	7082	40	18.54	7	31	182	247	201–300	–
76	U Texas Dallas	US	459	7069	42	15.40	12	30	168	257	301–400	–
77	U British Columbia	CAN	449	6729	39	14.99	7	27	188	251	40	50
78	Shanghai Jiao Tong U	CHN	681	6587	36	9.67	4	21	182	297	–	70
79	Tilburg U	NET	511	6541	36	12.80	9	21	167	254	–	293
80	U Twente	NET	460	6475	38	14.08	10	25	164	244	301–400	188
81	U Alberta	CAN	364	6460	39	17.75	9	30	150	227	101–150	96
82	National Tsing Hua U	TWN	484	6455	37	13.34	5	19	178	269	101–150	155
83	Laval U	CAN	400	6417	38	16.04	7	22	171	234	201–300	324
84	Kyoto U	JAP	426	6405	41	15.04	5	29	164	226	–	38
85	Universidade de Lisboa	POR	452	6392	39	14.14	2	20	170	246	201–300	–
86	Universite de Recherche Paris Sciences Et Lettres Comue	FRA	436	6225	36	14.28	9	25	159	217	–	–
87	Bilkent U	TUR	420	6120	38	14.57	2	23	165	236	–	–
88	National Central U	TWN	375	5869	37	15.65	3	23	148	211	–	397
89	Lancaster U	UK	397	5770	39	14.53	3	23	157	221	301–400	121
90	Clemson U	US	366	5724	39	15.64	7	29	139	200	401–500	651–700

Table 2 continued

R	University	COUN	TP	TC	H	TC/TP	>100	>50	>10	>5	ARWU	QS
91	Sapienza U Rome	ITA	416	5513	37	13.25	6	22	137	218	151–200	213
92	Huazhong U Science Technology	US	454	5448	36	12.00	5	18	149	237	201–300	401–410
93	U Melbourne	AUS	355	5316	35	14.97	7	21	123	175	44	42
94	U Padua	ITA	360	5181	35	14.39	7	22	130	189	151–200	–
95	U Quebec	CAN	357	5154	36	14.44	5	21	136	190	401–500	–
96	National Taiwan U	TWN	380	5065	33	13.33	7	18	128	194	151–200	70
97	Loughborough U	UK	423	4916	32	11.62	4	14	143	231	–	228
98	Xi An Jiaotong U	CHN	362	4818	33	13.31	7	21	102	167	201–300	331.00
99	United States Navy	US	380	4772	33	12.56	6	18	116	169	–	–
100	U Sevilla	ESP	461	4752	31	10.31	2	13	133	232	401–500	501–550

R rank, *TP* total papers, *TC* total cites, *H* H-index, *C/P* cites per paper, ≥ 100, ≥ 50, ≥ 10 Articles with more than 100, 50 and 10 cites

Table 3 Ranking of the Top 50 universities in OR–MS according to total publication, H-index and Citation per paper

R	Total publication	H-index	Citation per paper
1	CNRS France	MIT	U Pennsylvania
2	Hong Kong Polytechnic U	U Montreal	Columbia U
3	U Montreal	U Pennsylvania	Stanford U
4	Georgia Institute of Tech.	Georgia Institute of Tech.	MIT
5	Massachusetts Ins. of Tech.	Columbia U	U California Los Angeles
6	National U Singapore	Carnegie Mellon U	Northwestern U
7	Indian Institute of Tech.	Stanford U	Duke U
8	City U Hong Kong	Northwestern U	Carnegie Mellon U
9	U Michigan	U California Berkeley	New York U
10	U Florida	Hong Kong Polytechnic U	U Maryland College Park
11	Eindhoven U Tech.	U Texas Austin	U California Berkeley
12	U California Berkeley	Hong Kong U Science Tech.	Ohio State U
13	Purdue U	National U Singapore	U Texas Austin
14	Penn State U	U Maryland College Park	McMaster U
15	Chinese Academy of Sciences	Purdue U	U Montreal
16	National Chiao Tung U	U Michigan	ATT
17	U Texas Austin	Rutgers State U	Erasmus U Rotterdam
18	National Cheng Kung U	Arizona State U	Rutgers State U
19	KAIST	U Florida	Georgia Institute of Tech.
20	Tsinghua U	Erasmus U Rotterdam	Arizona State U
21	Arizona State U	CNRS France	U Washington Seattle
22	Rutgers State U	City U Hong Kong	U Wisconsin Madison
23	U Maryland College Park	New York U	Hong Kong U Sci Tech.
24	Carnegie Mellon U	U Illinois Urbana Champaign	Cardiff U
25	Hong Kong U Science Tech.	Cornell U	U Nottingham
26	Columbia U	U Wisconsin Madison	Cornell U
27	US Department of Defense	Duke U	U Pittsburgh
28	Virginia Polytechnic Ins State U	IBM	Purdue U
29	U Toronto	Ohio State U	KU Leuven
30	Nanyang Technological U	Indian Institute of Tech.	U Illinois Urbana Champaign
31	Erasmus U Rotterdam	Eindhoven U Tech.	U Arizona
32	Texas A M U College Station	Penn State U	U New South Wales
33	Stanford U	KU Leuven	U Michigan
34	KU Leuven	Technion	Technion
35	Northwestern U	U Toronto	U Bologna
36	Universite Paris Saclay Comue	Texas AM U College Station	SUNY Buffalo
37	Shanghai Jiao Tong U	ATT	IBM
38	Technion Israel Institute of Tech.	U California Los Angeles	Rensselaer Polytech Inst

Table 3 continued

R	Total publication	H-index	Citation per paper
39	U Illinois Urbana Champaign	Chinese U Hong Kong	U Florida
40	National Taiwan U Science Tech.	KAIST	National U Singapore
41	Chinese U Hong Kong	Virginia Polytech Inst State U	U Alberta
42	Tel Aviv U	McMaster U	U Warwick
43	U Hong Kong	Chinese Academy Sci	U Hong Kong
44	U Waterloo	Nanyang Technological U	U Iowa
45	Int. Business Machines (IBM)	U Hong Kong	US Department of Energy
46	INRIA	U Washington Seattle	Hong Kong Polytechnic U
47	Cornell U	National Chiao Tung U	Imperial College London
48	U Pennsylvania	National Taiwan U Sci Tech.	Chinese U Hong Kong
49	US Department of Energy	U Bologna	U Toronto
50	Delft U Tech.	U Arizona	Texas AM U College Station

Temporal evolution of the most productive institutions in OR–MS

and University of Pennsylvania have at least 50 publications having more than 100 citations. On the other hand, ten universities from Top 100 productive universities have at least 100 publications having more than 50 citations. We now want to measure performance of world's universities from other perspectives also. Table 3 presents a ranking of 50 universities based on the indicators total publication, H-index and citation per paper. Tables 2 and 3 depict that MIT holds best position in both the TC and H-index category followed by the University of Montreal. University of Pennsylvania shows best performance in the category cites per paper. It is worth noting that University of Pennsylvania also gets fourth and third position respectively in the TC and H-index category but it appears in only 49th position in the table of most productive universities. CNRS France the most productive university gets 13th, 22nd and 98th position respectively in total citation, H-index and citation per paper categories. This shows the importance of measuring performance on the basis of total citation, H-index and citation per paper. Thirteen universities have more than 20,000 total citations and nine among them are from US. Six universities: MIT (88), University of Montreal (82), University of Pennsylvania (82), Georgia Institute of Technology (77), Columbia University (77) and Carnegie Mellon University (72) have H-index more than 70. Eight of top ten H-index universities are from US and other two from Canada. Thirteen universities have more than 25 citations per paper and twelve among them are from US and other one from Canada. North America shows absolute dominancy in apex positions all the three total citation, H-index and citation per paper categories. So far we have discussed individual rankings based on publications, citations and H-index. In Table 4 we prepared a ranking of the universities by normalizing publication and citation data and adding them providing equal and different weight.

Top three influential universities again lead in the combined ranking. Hong Kong Polytechnic University gets fourth position and most productive university, Centre National De La Recherche Scientifique gets fifth position in overall ranking. University of Pennsylvania with only 588 publications gets seventh position because its publications have high citation rate. USA has 6 universities in top 10 while it has 15 universities in top 20. Clearly, American universities highly dominating in top positions of overall ranking. Note that, in Table 4 we

Table 4 Top 50 universities in OR–MS research during 1991–2015

Rank	Name of the university	Score (50% of normalized value of TP + 50% of normalized value of TC)
1	Massachusetts Institute of Technology MIT	0.015050918
2	U Montreal	0.014858791
3	Georgia Institute of Technology	0.013444971
4	Hong Kong Polytechnic U	0.012294054
5	Centre National De La Recherche Scientifique CNRS	0.012153554
6	National U Singapore	0.010585967
7	U Pennsylvania	0.00938078
8	U California Berkeley	0.009364761
9	Columbia U	0.009095284
10	Carnegie Mellon U	0.008849629
11	U Michigan	0.008781584
12	U Texas Austin	0.008488016
13	U Maryland College Park	0.008381077
14	Stanford U	0.008012201
15	Purdue U	0.008054121
16	Northwestern U	0.007705178
17	City U Hong Kong	0.007936652
18	Rutgers State U	0.007682141
19	Arizona State U	0.007677244
20	U Florida	0.007773051
21	Indian Institute of Technology Iit	0.007867848
22	Hong Kong U Science Technology	0.007288685
23	Hec Montreal	0.006784503
24	Eindhoven U Technology	0.007056717
25	U Minnesota Twin Cities	0.006623071
26	Erasmus U Rotterdam	0.006738108
27	Penn State U	0.006903878
28	National Chiao Tung U	0.006586909
29	Korea Advanced Institute of Science Technology	0.006420292
30	Ku Leuven	0.006150633
31	Chinese Academy of Sciences	0.006311576
32	U Illinois Urbana Champaign	0.006023744
33	U Toronto	0.006042468
34	Technion Israel Institute of Technology	0.005932307
35	Virginia Polytechnic Institute State U	0.005984032
36	National Cheng Kung U	0.00595017
37	Nanyang Technological U NIE Singapore	0.005849688
38	Texas A M U College Station	0.005697359
39	Cornell U	0.005383921
40	Ohio State U	0.005286439

Table 4 continued

Rank	Name of the university	Score (50% of normalized value of TP + 50% of normalized value of TC)
41	International Business Machines Ibm	0.005244284
42	Chinese U Hong Kong	0.005261321
43	U Hong Kong	0.005211688
44	U Wisconsin Madison	0.005118371
45	Tsinghua U	0.005350854
46	Mcmaster U	0.005018117
47	National Taiwan U Science Technology	0.005129611
48	At T	0.004872115
49	United States Department Of Defense	0.00512806
50	New York U	0.00480446

considered equal weight on TP and TC. Moreover, we provide a list of top 50 universities in table (see Table 22 in Appendix) by assuming more weight on TC than TP. Now look at the spearman's rho correlation coefficient to examine correlation among the different rankings based on publications, citation, H-index and our combined index. We considered ranking of top 10 universities of Table 4 under different the bibliometric measures to determine the spearman's rho correlation coefficient and results are presented in Table 5.

From Table 5, one may note that our combined index is positively correlated with all the three indexes TP, TC and H index. Ranking of the universities under the total publication and H-index are negatively correlated while total citation and H-index are almost perfectly correlated.

3.2 Temporal analysis of the most productive universities

Next, let us look into the evolution throughout time of the leading universities. For doing so, we consider periods of 5 years between 1991 and 2015 in order to see the leaders in the nineties and during the last years. Tables 16, 17, 18, 19 and 20 present the Top 50 universities in OR–MS between 1991–1995, 1996–2000, 2001–2005, 2006–2010 and 2011–2015, respectively.

Table 16 depicts that MIT is the most productive university with more than 200 publications during the period 1991–1995. The MIT also comes out first in total citation and H-index category with 8750 citation and 49 H-index. University of California Berkeley with 50.6 cites per paper appears first in cites per paper category. During this time period a university having more than or equal to 70 publications can qualify in Top 50 productive universities. Six universities have more than 5000 total citation and only two of them have more than 50 cites per paper during these 5 years.

Table 17 provides list of Top fifty productive universities in OR–MS from 1996 to 2000. University of Montreal emerges in the first position with 228 publications followed by Korea Advanced Institute of Science Technology with 215 publications. Although MIT gets only fourth position but it comes out first in TC category and second in H-index. During this time period a university having more than or equal to 85 publications can qualify in the table, which is 21% more than the last 5 years. Eleven universities have more than 5000 total citation and

Table 5 The spearman's rho correlation coefficient under different the bibliometric measures

Indexes	Combined and TP	Combined and TC	Combined and H	TP and H	TP and TC	TC and H
Spearman's rho correlation coefficient	$\frac{113}{165} = 0.6848$	$\frac{107}{165} = 0.6484$	$\frac{13}{33} = 0.3939$	$-\frac{47}{165} = -0.2848$	$\frac{1}{55} = 0.0182$	$\frac{149}{165} = 0.9030$

only five have more than 50 cites per paper during these 5 years. University of Pennsylvania shows best result in cites per paper category with a remarkable average of 69.50 cites per paper.

Table 18 demonstrates leading universities in OR–MS from 2001 to 2005. Hong Kong Polytechnic University shows huge improvement and appears as most productive university in this time period with 298 publications. Academic research in China and specially in Hong Kong is growing a lot during the last years thanks to the strong economic development of China. National University of Singapore, Georgia Institute of Technology, University of Montreal, CNRS, MIT and KAIST also perform significantly with more than 200 publications. MIT again shows its dominancy in total citation and H-index category with 12,057 citations and 57 H-index. University of Pennsylvania performs best in cites per paper category with a huge average 72.74 citations per paper. During this time period Top 50 universities have a minimum 92 publications.

Table 19 provides list of Top fifty productive universities in OR–MS from 2006 to 2010. CNRS France emerges in the first position with more than 100% improvement from the previous 5 years performance. Eight universities have more than 300 publications and only two of them are from USA. Hong Kong Polytechnic University emerges as the best university in both total citation and H-index categories. During this time period a university having more than or equal to 145 publications can qualify in the table, which is 70% more than the previous 5 years. This shows great deal of increment in OR–MS research during 2006–2010.

Table 20 depicts best fifty productive universities in OR–MS from 2011 to 2015. CNRS France is again in the first position with 783 publications followed by Hong Kong Polytechnic University having 635 publications. For this special improvement, CNRS is following approaches of consolidation of various research programs and maintaining the cooperative actions to ensure its fame at the international level aimed at increasing the visibility of French research worldwide. It is involved in 498 international programs for scientific cooperation and joint research projects, 183 international associated laboratories, 101 international research networks, 36 international joint units, 26 joint units with a French research institute abroad. Six universities have more than 400 publications. Three of them are from China and only one from USA. Hong Kong Polytechnic University again appears as the best university in all total citation, H-index and citation per paper categories. During this time period a university having more than or equal to 194 publications can qualify in the table. From the beginning of 21st century, economical growth of Asian countries like China, India, Singapore, South Korea, Taiwan, Hong Kong increasingly shifted the center of gravity of the global economy towards Asia.[1] They main reason behind it is more than 4.5 billion (more than 60% of total population of Earth) population in this region. Note that, research on OR–MS in a country/region is closely related with economic development that country/region. We now want to analyze performance of universities based on country and continent.

Figure 2 depicts temporal analysis of leading countries in Top 50 universities. USA, China, Taiwan, Canada, France, Netherlands and Singapore are worth noting countries of university research in OR–MS. USA is showing dominancy in OR–MS research from 1991 to 2010. During the last 5 years China shows great improvement and is now giving tough competition to USA. Figure 2 is clearly showing that USA universities are losing their dominancy in Top 50 with the progress of years. On the other hand, number of Chinese universities increasing in the Top 50 productive universities with the progress of years. The economic growth is producing a huge growth in research and development (R&D) in developing economies. This is the main factor why now these countries are producing more. Additionally, technical

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[1] https://en.wikipedia.org/wiki/Economy_of_Asia.
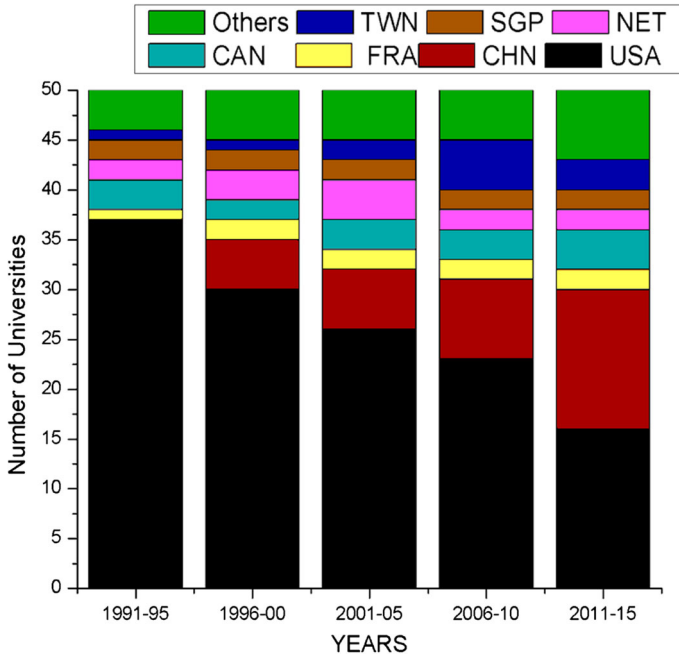
Fig. 2 Country based temporal analysis of universities in Top 50 positions
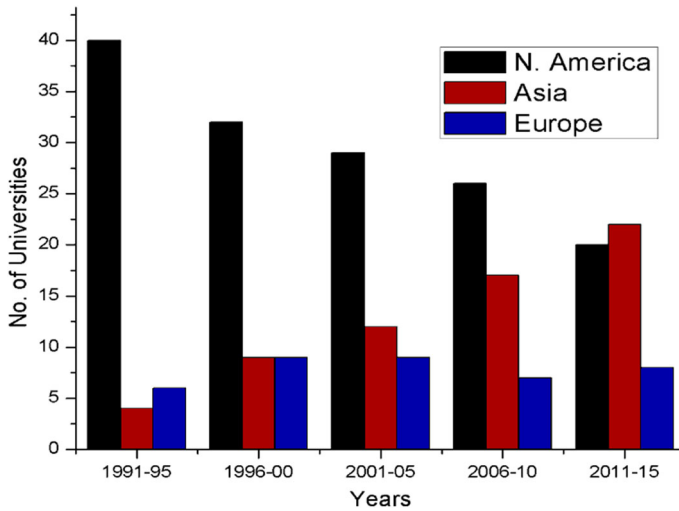
Fig. 3 Continent based temporal analysis of universities in Top 50 positions

fields seem to be more affordable for researchers in developing countries, probably because mathematical issues are universal and easier to handle for non-English speaking countries.

Figure 3 depicts performance of Asian, European and North American universities in Top 50 positions during 1991–2015. The graphical representation clearly depicts that number of
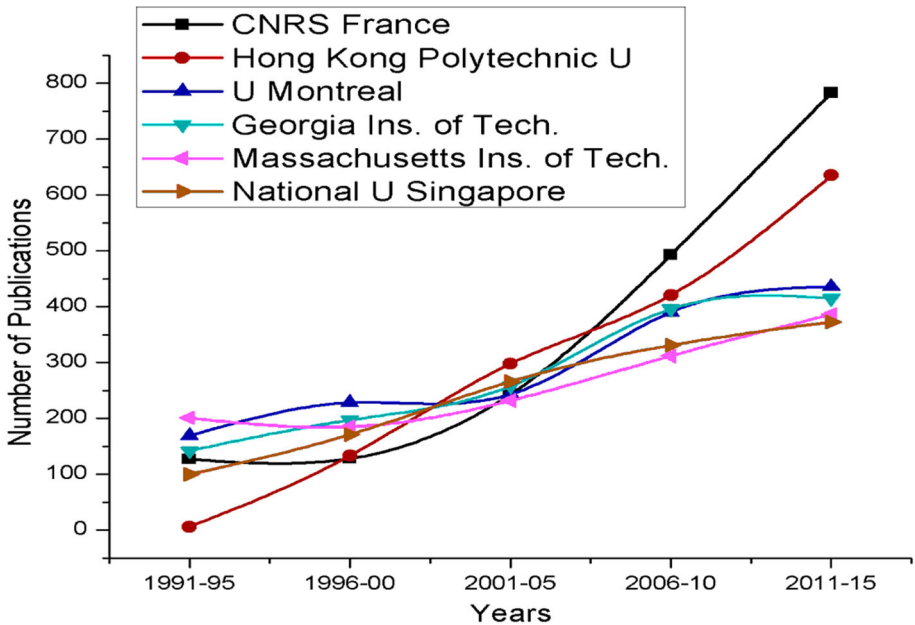
Fig. 4 Temporal analysis of top six productive universities

American (Asian) universities are decreasing (increasing) in Top 50 list with the progress of time. European universities show steady performance during these 25 years.

Figure 4 presents temporal analysis of six universities having more than 1200 publications. CNRS France and Hong Kong Polytechnic University show huge improvement during 2006–2015. Although MIT is showing improvement with the time progress but rate of progress is not as good as CNRS France, Hong Kong Polytechnic University, University of Montreal and Georgia Institute of Technology.

3.3 Analysis of the most productive universities in top 30 OR–MS journals

In order to extend the analysis, let us look into the performance of the universities in Top 30 OR–MS journals demonstrated in Table 21 in Appendix. Tables 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 present the twenty-five most productive universities in thirty selected influential OR–MS journals between 1991 and 2015.

University of Montreal and Islamic Azad University obtain the first two positions in the ranking in Computers Operations Research. Asian universities dominate Top 25 positions of this journal. Hong Kong Polytechnic University is the most productive university in JORS followed by the University of Montreal. Asian and European universities are leading this journal. On the other hand, USA universities largely dominate the most influential journal Management Science. University of North Carolina and University of Pennsylvania get hold of the first two positions in this journal with more than 1000 publications.

Table 7 depicts that University of Montreal is the most productive university of Operations Research followed by the MIT. Fifteen universities of USA get position in Top 25 productive

Table 6 Leading universities in COR, JORS and MS

R	Computers Oper Res	TP	J Oper Res Society	TP	Management Science	TP
1	U Montreal	174	U Warwick	120	U Pennsylvania	227
2	CNRS	65	U Southampton	102	Columbia U	175
3	KAIST	61	Lancaster U	97	Duke U	153
4	Hong Kong Polytechnic U	49	U Montreal	74	Carnegie Mellon U	153
5	U Maryland College Park	45	U Salford	57	Stanford U	148
6	U Sevilla	42	City U Hong Kong	48	MIT	146
7	U Lisboa	41	U Strathclyde	45	New York U	124
8	Polytech U Catalonia	39	U Manchester	44	U Michigan	123
9	National Chiao Tung U	37	U Edinburgh	44	Harvard U	122
10	City U Hong Kong	37	Hong Kong Polytechnic U	42	INSEAD Business School	120
11	Bilkent U	37	KAIST	41	Northwestern U	109
12	Tsinghua U	35	U Toronto	38	U Texas Austin	95
13	National Taiwan U Science Technology	35	U Nottingham	36	U California Berkeley	94
14	Indian Institute of Technology	35	Imperial College London	35	U California Los Angeles	93
15	Virginia Polytechnic Institute State U	34	Brunel U	34	U Maryland College Park	86
16	U Valencia	34	National Chiao Tung U	33	U Southern California	80
17	U Florida	34	London School Econ	33	Georgia Institute of Technology	78
18	U Coimbra	34	Aston U	32	U Texas Dallas	69
19	SUNY Buffalo	34	Ku Leuven	30	U Toronto	68
20	U Toronto	33	Loughborough U	29	U North Carolina	68
21	U North Carolina	33	Orta Dogu Teknik U	28	U Minnesota Twin Cities	68
22	Northeastern U China	31	U Hull	27	U Chicago	65
23	Pennsylvania State U	29	U Sheffield	26	Purdue U	65
24	KU Leuven	29	Laval U	26	Penn State U	64
25	U Quebec	28	U Kent	25	Hong Kong U Science Technology	61

Table 7 Leading universities in OR, Omega and MOR

R	Operations Research	TP	Omega	TP	Mathematics Oper Res	TP
1	MIT	179	National U Singapore	30	MIT	84
2	Columbia U	178	U Warwick	29	Technion Israel	74
3	Stanford U	106	Cardiff U	28	Columbia U	51
4	Georgia Institute of Technology	95	Hong Kong Polytechnic U	27	Georgia Institute of Technology	44
5	Northwestern U	84	U System of Georgia	22	Cornell U	41
6	U Michigan	81	U Bath	21	Stanford U	39
7	Duke U	78	National Cheng Kung U	21	CNRS France	38
8	Carnegie Mellon U	70	Drexel U	20	Tel Aviv U	37
9	U Montreal	69	U Toledo	19	IBM	37
10	U California Berkeley	63	U North Carolina	19	Northwestern U	31
11	U Pennsylvania	61	City U Hong Kong	18	Carnegie Mellon U	30
12	Cornell U	61	U Lisboa	17	AT T	29
13	U Texas Austin	55	U Southampton	16	U Michigan	27
14	U British Columbia	51	U Science Tech China	16	PSL Research U Paris	27
15	National U Singapore	49	U Manchester	16	Hebrew U Jerusalem	26
16	AT T	46	Virginia Polytechnic Institute State U	15	U British Columbia	25
17	U Illinois Urbana Champaign	45	U Michigan	14	Rutgers State U	25
18	New York U	43	Tsinghua U	14	INRIA	23
19	IBM	43	Chinese U Hong Kong	14	Princeton U	22
20	U California Los Angeles	42	US Dep. Defense	13	U Paris Saclay Comue	21
21	Hong Kong U Science Technology	42	Kent State U	13	Maastricht U	21
22	U Toronto	40	Inst Sup Tec	13	U Waterloo	19
23	U North Carolina	40	Imperial College London	13	U California Berkeley	19
24	US Dep. Defense	39	U Toronto	12	National U Singapore	19
25	Purdue U	36	U Pittsburgh	12	Chinese U Hong Kong	19

Table 8 Leading universities in MP, EJOR and SCL

R	Mathematical Programming	TP	European J Oper Res	TP	Systems and Control Letters	TP
1	MIT	96	U Montreal	202	CNRS France	145
2	Georgia Institute of Technology	92	CNRS France	191	U Paris Saclay Comue	63
3	Carnegie Mellon U	70	Erasmus U Rotterdam	175	U Melbourne	59
4	IBM	68	City U Hong Kong	137	INRIA	56
5	U Waterloo	56	National U Singapore	136	U Groningen	55
6	U Iowa	56	KU Leuven	130	Sapienza U Rome	54
7	CNRS France	55	Hong Kong Polytechnic U	129	U California Santa Barbara	51
8	Cornell U	54	Tilburg U	123	U Illinois Urbana Champaign	50
9	U Wisconsin Madison	51	Eindhoven U Technology	114	Chinese Academy Sci	50
10	U Washington Seattle	51	U North Carolina	113	Australian National U	50
11	Rutgers State U	48	U Lisboa	111	U Twente	47
12	Technion Israel	46	U Florida	102	Nanyang Technological U	44
13	Columbia U	43	Georgia Institute of Technology	100	Imperial College London	44
14	Northwestern U	41	PSL Research U Paris	99	Kyoto U	40
15	Kyoto U	41	National Cheng Kung U	96	Polytech U Turin	39
16	INRIA	40	U Texas Austin	95	U Padua	38
17	U Montreal	39	Indian Institute of Technology	95	U Lorraine	37
18	U California Berkeley	38	U Toronto	91	U California San Diego	36
19	U Cath Louvain	35	Texas AM U College Station	90	Peking U	36
20	Stanford U	33	U Sevilla	89	National U Singapore	35
21	U Padua	32	Aalto U	88	U Virginia	33
22	U Bologna	31	U Southampton	85	Rutgers State U	33
23	U Illinois Urbana Champaign	30	Purdue U	84	U Alberta	32
24	U Florida	30	Bilkent U	80	MIT	32
25	Sapienza U Rome	30	Laval U	79	U California Los Angeles	31

Table 9 Leading universities in JOM, IJPE and ESWA

R	Journal of Operations Management	TP	International Journal of Production Economics	TP	Expert Systems with Applications	TP
1	Michigan State U	67	Hong Kong Polytechnic U	171	National Cheng Kung U	216
2	U Minnesota Twin Cities	54	Eindhoven U Technology	92	National Taiwan U Science Technology	193
3	Arizona State U	46	U Nottingham	73	National Chiao Tung U	185
4	Ohio State U	37	Linkoping U	72	Hong Kong Polytechnic U	181
5	U North Carolina	31	U Groningen	69	KAIST	134
6	U South Carolina	23	Lappeenranta U Technology	65	Yonsei U	119
7	U Western Ontario	20	CNRS France	65	City U Hong Kong	115
8	Emory U	19	Cardiff U	58	Indian Institute of Technology	111
9	Clemson U	18	U North Carolina	57	Islamic Azad U	103
10	Georgia Institute of Technology	16	City U Hong Kong	52	U Granada	101
11	U Arkansas Fayetteville	15	Indian Institute of Tech.	50	National Central U	100
12	Texas A M U College Station	15	Polytechnic U Milan	46	Nanyang Technological U	95
13	U Toledo	14	National U Singapore	44	Firat U	92
14	U Notre Dame	13	Concordia U Canada	42	Seoul National U	89
15	Texas Christian U	13	National Chiao Tung U	39	Chinese Academy of Sciences	88
16	Xi An Jiaotong U	12	Erasmus U Rotterdam	38	U Tehran	87
17	Rensselaer Polytechnic Institute	12	Ryerson U	37	Yuan Ze U	85
18	Penn State U	12	Nanyang Technological U	37	Pohang U Science Technology Postech	85
19	Oregon State U	12	Tsinghua U	36	Istanbul Teknik U	85
20	London Business School	12	Penn State U	36	Nan Kai U Technology	82
21	Indiana U Bloomington	12	Louisiana State U	35	Tsinghua U	75
22	U Cambridge	11	Cranfield U	34	Shanghai Jiao Tong U	75
23	Wake Forest U	10	Corvinus U Budapest	34	National Sun Yat Sen U	73

Table 9 continued

R	Journal of Operations Management	TP	International Journal of Production Economics	TP	Expert Systems with Applications	TP
24	U Maryland College Park	10	Chung Yuan Christian U	34	Selcuk U	71
25	Hong Kong Polytech U	10	U Montreal	33	National Taipei U Technology	70

universities of Operations Research. Asian universities are highly dominating the journal Omega by occupying each of first ten positions of Top 25. The American university MIT leads the journal Mathematics of Operations Research followed by the European university CNRS. This journal shows diversity in its list of Top 25 productive universities.

Table 8 depicts that CNRS of France leads highly from its followers in both Mathematical Programming and Systems and Control Letters. Although American universities are showing dominancy but universities from distinct areas of the world are also contributing in Mathematical Programming. EJOR contributes huge number of publications in OR–MS. Nine universities published more than one thousand articles in EJOR. Sixteen Asian universities appear in Top 25 list of EJOR. On the other hand, European universities are showing their major contributions in Systems and Control Letters. Note that, numbers of publications in Systems and Control Letters are quite lower than the other two journals.

Table 9 portrays performance of Top 25 universities in JOM, IJPE and ESWA. Universities from USA are heavily dominating the Journal of Operations Management. First fifteen productive universities of JOM are from USA. Chinese university the Xi An Jiaotong University is the only one which contributing in this journal from Asia. The Hong Kong Polytechnic University leads in the IJPE far away from the second position which is obtained by the CNRS of France. Eleven European, eight Asian and six American Universities are in the Top 25 positions in IJPE. This result shows universities are contributing in this journal from wider dispersion areas. On the other hand, Asian universities are heavily dominating the Journal Expert Systems with Applications. Twenty-two Asian and three European universities are in the Top 25 positions in ESWA.

University of California Berkeley is the most productive university in Transportation Research Part B-Methodological followed by the Hong Kong University Science Technology. Indian Institute of Technology leads in the IJPR far away from the second position which is obtained by the Shanghai Jiao Tong University. City University of Hong Kong dominates the journal Decision Support Systems with 83 publications followed by University of Arizona. Seventeen universities from USA are in the Top 25 of this journal.

Sandia National Laboratory of USA having a close competition with the University of Stavanger of Norway gets the first position in the journal Reliability Engineering and System Safety. Universities from different countries of Europe are showing contribution for this journal. University of Montreal leads the journal Transportation Science far away from the second position which is obtained by the Georgia Institute of Technology. North American universities are extremely dominating this journal with 22 universities in Top 25. Virginia Polytechnic Institute State University and Arizona State University are contributing equally for the Journal of Quality Technology with 78 publications each. USA universities are showing majority in the Top 25 positions of this journal.

Table 10 Leading universities in TRPB, IJPR and DSS

R	Transportation Research Part B-Methodological	TP	International Journal of Production Research	TP	Decision Support Systems	TP
1	U California Berkeley	112	Indian Institute of Tech.	192	City U Hong Kong	83
2	Hong Kong U Science Tech.	89	Shanghai Jiao Tong U	128	U Arizona	77
3	U Texas Austin	75	Purdue U	115	U Florida	56
4	U Hong Kong	48	Nanyang Technological U	108	U Connecticut	50
5	U California Irvine	48	Hong Kong Polytechnic U	108	KAIST	47
6	U California Davis	47	Penn State U	108	Arizona State U	42
7	Hong Kong Polytechnic U	43	National U Singapore	106	Erasmus U Rotterdam	41
8	Northwestern U	40	Loughborough U	100	U North Carolina	37
9	U Montreal	38	U Hong Kong	91	Virginia Polytechnic Institute State U	36
10	Penn State U	35	U North Carolina	89	SUNY Buffalo	36
11	U Sydney	34	CNRS France	81	Penn State U	36
12	U Leeds	33	National Chiao Tung U	78	Oklahoma State U Stillwater	36
13	U Illinois Urbana Champaign	33	Arizona State U	76	Chinese U Hong Kong	36
14	Purdue U	31	U Groningen	66	U Texas Austin	34
15	Ecole Polytech Fed Lausanne	31	National Tsing Hua U	64	Hong Kong Polytechnic U	33
16	Georgia Institute of Technology	26	City U Hong Kong	64	Georgia State U	33
17	U Minnesota Twin Cities	25	Texas A M U College Station	64	U Hong Kong	32
18	U Florida	25	National Taiwan U Science Technology	58	National Sun Yat Sen U	32
19	Tongji U	25	KAIST Korea	58	Hong Kong U Science Tech.	32
20	U Maryland College Park	24	U Calgary	57	U Kentucky	31
21	Pontifical Cath U Chile	24	Tsinghua U	56	Purdue U	31
22	Delft U Technology	24	Yuan Ze U	56	National U Singapore	31
23	Beijing Jiaotong U	24	Michigan State U	53	Carnegie Mellon U	31

Table 10 continued

R	Transportation Research Part B-Methodological	TP	International Journal of Production Research	TP	Decision Support Systems	TP
24	U College London	23	Tel Aviv U	52	Texas Tech U	28
25	National U Singapore	22	U Nottingham	51	U Michigan	27

Rutgers State University leads the journal Annals of Operations Research followed by the CNRS of France. Georgia Institute of Technology is in the first position in the journal IIE Transactions followed by the Texas AM U College Station. USA universities are showing majority in this journal. Chinese Academy of Sciences and CNRS are contributing equally for the Journal of Optimization Theory and Applications with 71 publications each.

Table 13 depicts that George Washington University leads the journal Technovation with 36 publications followed by the Tokyo Institute of Technology of Japan. University of Florida leads the Journal of Global Optimization followed by the Hong Kong Polytechnic University. Universities from different countries are showing contribution in both Technovation and JGO. On the other hand, University of Texas Dallas is the highest contributing university for the journal Production and Operations Management. Importantly, Top 25 have twenty-two universities of USA and three from China.

Table 14 demonstrates Top 25 productive universities for the journals Transportation Research Part E, Operations Research Letters and Naval Research Logistics. University of Maryland College Park, Eindhoven U Technology and United States Department of Defense respectively lead the journal TRE, ORL and NRL. USA based universities again show its majority in both ORL and NRL.

Finally, Table 15 depicts that University of Montreal leads the journal Networks and also gets the second position in Informs Journal on Computing. CNRS France leads the journal Computational Optimization and Applications with 28 publications. Delft U Technology with 94 publications holds the first place among the productive universities in Safety Science. So far we have discussed Top 25 productive universities in thirty most influential journals of OR–MS. Note that, each of the University of Montreal and Hong Kong Polytechnic University leads in four journals while CNRS France leads in three journals.

4 Conclusions

This study has presented a general overview of the most productive and influential universities between 1991 and 2015 in OR–MS. The main advantage of this approach is that it identifies the most productive and influential institutions in OR–MS considering the evolution through time and some selected journals. By doing so, the reader can clearly identify where is the leading research taking place and which universities are leading each of the key journals in OR–MS. In this context, it is interesting to verify the evolution through time and see the current position held by institutions from North America, Europe and Asia. As it is well-known by previous studies (Martínez-López et al. 2018; Merigó et al. 2015b), the English-speaking countries have dominated academic research during the second-half of the twentieth Century. However, this dominance is decreasing through time in favour of European countries and later also by

Table 11 Leading universities in RESS, TS and JQT

R	Reliability Engineering and System Safety	TP	Transportation Science	TP	Journal of Quality Technology	TP
1	Sandia National Laboratory	104	U Montreal	101	Virginia Polytechnic Institute State U	78
2	U I Stavanger	103	Georgia Institute of Tech.	53	Arizona State U	78
3	Polytechnic U Milan	99	MIT	52	U Minnesota Twin Cities	40
4	CNRS France	86	Erasmus U Rotterdam	25	Los Alamos National Laboratory	25
5	Delft U Technology	76	U California Berkeley	24	U Waterloo	23
6	Norwegian U Science Tech.	72	Princeton U	24	U Alabama Tuscaloosa	22
7	KAIST	67	U Bologna	18	U Michigan	21
8	U Maryland College Park	61	U Maryland College Park	17	Penn State U	18
9	Korea Atomic Energy Research Institute	59	U Iowa	17	Georgia Institute of Technology	18
10	Arizona State U	59	U Illinois Urbana Champaign	17	Hong Kong U Science Tech.	18
11	Universite Paris Saclay Comue	57	U Arizona	17	U Tennessee Knoxville	16
12	European Commission Joint Research Centre	55	Northwestern U	17	U North Carolina	15
13	Centralesupelec	46	U Texas Austin	16	U Wisconsin Madison	15
14	Ecole Centrale Paris	43	Virginia Polytechnic Institute State U	15	U Florida	14
15	U Technology of Troyes	41	Hong Kong U Science Technology	14	U Antwerp	14
16	Tsinghua U	41	U Toronto	12	US Dep Defense	14
17	Los Alamos National Laboratory	38	U Florida	12	Southwest Research Institute	12
18	U Electronic Science Technology of China	35	U Brescia	12	North Carolina State U	12
19	MIT	35	U Southern California	11	Southern Illinois U Edwardsville	11
20	Indian Institute of Tech.	34	U Quebec	11	Sas Inst Inc	
21	Idaho National Laboratory	34	Technical U Denmark	11	Pacific Northwest National Laboratory	10
22	Polytechnic U Valencia	33	UD Dep Defense	9	KU Leuven	10

Table 11 continued

R	Reliability Engineering and System Safety	TP	Transportation Science	TP	Journal of Quality Technology	TP
23	VTT Technical Research Center Finland	32	Cornell U	9	Georgia Southern U	10
24	Stevens Institute of Technology	29	U Washington Seattle	8	U Maryland College Park	9
25	Sintef	29	U Massachusetts Amherst	8	U Iowa	9

Asian countries. This growth of European and Asian publications is particularly relevant in pure, technical and life sciences where currently they publish almost at the same level than English-speaking countries (Merigó et al. 2018). But in social sciences, the differences are still significant (Martínez-López et al. 2018; Merigó et al. 2016). Therefore, since OR–MS stands at a mid-point between social and technical sciences, it is interesting to see the results and see how they are evolving through time.

We collect information regarding this study from WoS Core Collection database. This work reveals following insights. Firstly, number of publication in OR–MS increases significantly during the last decade. Secondly, the CNRS of France is the most productive institution while the MIT of USA is the most influential one. Thirdly, origins of the leading universities are mainly from North America and Asia and especially from USA and China. Fourthly, the temporal evolution shows that USA is trailing its dominancy while China progressing quickly. The evaluation also reveals that Asian universities outperform North American universities during the last 5 years. Fifthly, discussion of Top 20 productive universities citing thirty selected influential journals of OR–MS reveals that the universities tend to cite more in their local top journals being the USA a dominant leader in Management Science, Operations Research, JOM, DSS, TS, JQT, IIET, POM, ORL, NRL, IJP; Europe in SCL, RES; Asia in EJOR, Omega, COR, ESWA while a wider dispersion is seen in JORS, MOR, IJPE, TRPB, IJPR, TRPE, AOR, Technovation, Networks, COA and JGO.

Finally, this study depicts that some universities are leading in more than one journal. For example, Hong Kong Polytechnic University of China leads in IJPE, EJOR, Omega, and JORS; University of Montreal of Canada leads in Operations Research, Networks, TS, and COR; while CNRS of France leads in Mathematical Programming, SCL, and COA. The trends for the future indicate that the spreading of OR–MS research will continue with the appearance of more universities from Asian countries. It will be interesting to investigate whether universities from North America continuously losing their positions or can hold their positions by showing better improvement in future.

In future research, we expect to use other methodologies for analysing the leading universities in terms of bibliographic material published in OR–MS, especially by using graphical visualizations generated with the VOS viewer software (Van Eck and Waltman 2010) that connects the data according to co-citations (Martínez-López et al. 2018), bibliographic coupling (Wang et al. 2018) and co-occurrence of author keywords (Tur-Porcar et al. 2018). Additionally, future studies will focus on other variables such as authors and countries.

Table 12 Leading universities in AOR, IIET and JOTA

R	Annals of Operations Research	TP	IIE Transactions	TP	Journal of Optimization Theory and Applications	TP
1	Rutgers State U	70	Georgia Institute of Tech.	98	Chinese Academy of Sciences	71
2	CNRS France	55	Texas A M U College Station	92	CNRS France	71
3	U Montreal	52	U Michigan	88	Hong Kong Polytechnic U	69
4	Carnegie Mellon U	40	Hong Kong U Science Tech.	71	U Montreal	63
5	Georgia Institute of Technology	38	Purdue U	62	Institute of Mathematics Vietnam	63
6	U Florida	37	U North Carolina	58	National Sun Yat Sen U	61
7	U Texas Austin	32	U Wisconsin Madison	53	Rice U	47
8	U Michigan	29	Rutgers State U	53	Technion Israel	41
9	Russian Academy of Sciences	29	Tel Aviv U	51	U Florida	40
10	U Paris Saclay Comue	26	Northwestern U	49	Russian Academy of Sciences	40
11	U Federal Rio De Janeiro	26	U Texas Austin	48	U California Berkeley	39
12	U Lisboa	26	Virginia Polytechnic Institute State U	46	U Pisa	37
13	Chinese Academy of Sciences	26	National U Singapore	45	Georgia Institute of Tech.	37
14	U Toronto	25	Penn State U	43	U New South Wales	36
15	MIT	24	Arizona State U	42	Chongqing Normal Univ	35
16	INRIA	24	U California Berkeley	38	Polytechnique Montreal	34
17	U Wisconsin Madison	23	U Arizona	37	Languedoc Roussillon U	34
18	Technion Israel	23	Technion Israel	37	Chinese U Hong Kong	33
19	Eindhoven U Technology	23	McMaster U	35	Univ Trier	32
20	U North Carolina	22	Washington U St Louis	34	Sapienza U Rome	32
21	Purdue U	22	U Toronto	34	Tilburg U	31
22	Polytech U Catalonia	21	U Illinois Urbana Champaign	33	Chongqing U	28
23	Norwegian U Science Tech.	21	Hong Kong Polytechnic U	32	Aligarh Muslim U	28
24	KU Leuven	21	U Washington Seattle	30	INRIA	27
25	Hong Kong Polytechnic U	21	U Pittsburgh	29	Indian Institute of Tech.	27

Table 13 Leading universities in Technovation, JGO and POM

R	Technovation	TP	Journal of Global Optimization	TP	Production And Operations Management	TP
1	George Washington U	36	U Florida	67	U Texas Dallas	61
2	Tokyo Institute of Tech.	35	Hong Kong Polytechnic U	60	U North Carolina	46
3	Obafemi Awolowo U	33	Institute of Mathematics Vietnam	42	Georgia Institute of Tech.	42
4	Monash U	31	CNRS France	38	INSEAD Bus Sch	38
5	U Sussex	26	Chinese U Hong Kong	36	U Texas Austin	34
6	U Manchester	24	Princeton U	33	U California Los Angeles	34
7	Eindhoven U Technology	22	Chinese Academy of Sciences	32	Penn State U	32
8	U Cambridge	20	Virginia Polytechnic Institute State U	31	U Minnesota Twin Cities	31
9	Cranfield U	18	National Sun Yat Sen U	29	U Michigan	26
10	Chalmers U Technology	17	Imperial College London	29	U Maryland College Park	24
11	U Warwick	15	Chongqing Normal Univ	28	U California Berkeley	24
12	National Chiao Tung U	15	U Illinois Urbana Champaign	27	Texas AM U College Station	24
13	U Brighton	14	Shanghai U	27	Michigan State U	24
14	KAIST	14	U Montreal	26	Cornell U	24
15	U Quebec	13	Federation U Australia	26	Indiana U	23
16	U Montreal	13	U Vienna	24	MIT	22
17	U Birmingham	13	RWTH Aachen U	24	Columbia U	22
18	Open U UK	13	City U Hong Kong	23	Ohio State U	21
19	CSIR India	13	U Fed Toulouse Midi Pyrenees Comue	22	Indiana U Bloomington	21
20	Seoul National U	12	U Toulouse	22	Chinese U Hong Kong	21
21	Fraunhofer Gesellschaft	12	Curtin U	21	Hong Kong Polytechnic U	19
22	Brunel U	12	U Minnesota Twin Cities	20	Washington U St Louis	18
23	Aston U	12	Tsinghua U	20	Stanford U	18
24	Asian Institute of Technology	12	MIT	20	Purdue U	18
25	U Twente	11	National Cheng Kung U	19	Hong Kong U Science Tech.	17

Table 14 Leading universities in TRE-lTR, ORL and NRL

R	Transportation Research Part E	TP	Operations Research Letters	TP	Naval Research Logistics	TP
1	U Maryland College Park	43	Eindhoven U Technology	67	US Dep Defense	90
2	National U Singapore	41	Georgia Institute of Tech.	61	Naval Postgraduate School	54
3	U Sydney	28	Tel Aviv U	51	Hong Kong U Science Tech.	45
4	Hong Kong Polytechnic U	27	MIT	49	Columbia U	39
5	U California Berkeley	25	Columbia U	47	Georgia Institute of Tech.	36
6	Hong Kong U Science Technology	22	IBM	41	U Florida	34
7	National Chiao Tung U	21	CNRS France	41	Purdue U	34
8	Iowa State U	21	AT T	40	Hong Kong Polytechnic U	33
9	U British Columbia	18	U California Berkeley	38	Northwestern U	28
10	National Cheng Kung U	17	U Florida	37	U Michigan	27
11	City U Hong Kong	17	Hong Kong Polytechnic U	37	McMaster U	25
12	U Arkansas Fayetteville	16	Carnegie Mellon U	34	Florida International U	25
13	City U London	16	U Twente	33	Chinese U Hong Kong	25
14	U Leeds	15	Technion Israel	33	U California Berkeley	24
15	U Las Palmas Gran Canaria	15	Graz U Technology	33	Rutgers State U	24
16	Kobe U	15	Cornell U	33	U North Carolina	23
17	Shanghai Jiao Tong U	14	Rutgers State U	30	Texas AM U College Station	23
18	Georgia Institute of Technology	14	U British Columbia	29	Virginia Polytechnic Institute State U	22
19	U Piraeus	13	U Waterloo	27	Tel Aviv U	21
20	U Massachusetts Amherst	13	U Montreal	27	Cornell U	21
21	Dalian Maritime U	13	Purdue U	26	U Toronto	18
22	Cardiff U	13	Chinese U Hong Kong	23	Technion Israel	18
23	U Oklahoma Norman	12	U Toronto	22	Orta Dogu Teknik U	18
24	National Central U	12	Stanford U	21	New York U	18
25	De3lft U Tech	12	Hong Kong U Science Technology		MIT	17

Table 15 Leading universities in Networks, COA and SS

R	Networks	TP	Computational Optimization and Applications	TP	Safety Science	TP
1	U Montreal	55	CNRS France	28	Delft U Technology	94
2	CNRS France	48	U Florida	25	Norwegian U Science Technology	60
3	MIT	36	Sapienza U Rome	25	China U Mining Technology	37
4	Polytech U Catalonia	33	U Graz	21	Universitetet I Stavanger	35
5	AT T	29	U Estadual Campinas	21	Monash U	35
6	U Florida	26	National U Singapore	21	Loughborough U	29
7	U Maryland College Park	24	Hong Kong Polytechnic U	21	U New South Wales	25
8	U Libre Bruxelles	23	CNR Italy	20	U Aberdeen	23
9	Simon Fraser U	22	Virginia Polytechnic Institute State U	18	Queensland U Technology Qut	23
10	U Quebec	21	U Wisconsin Madison	18	U Quebec	21
11	Tel Aviv U	21	U Waterloo	17	Tsinghua U	21
12	National Chiao Tung U	20	U Illinois Urbana Champaign	17	Sintef	21
13	U Paris Saclay Comue	19	U Florence	17	Karolinska Institutet	20
14	Sapienza U Rome	19	Technical U Berlin	17	U Nottingham	18
15	U Melbourne	18	U North Carolina	15	Indian Institute of Technology IIT	18
16	Technion Israel	18	MIT	15	Vtt Technical Research Center Finland	17
17	INRIA	17	U Wurzburg	14	Royal Institute of Technology	17
18	U Paris Sud Paris XI	16	Northwestern U	14	Psl Research U Paris	17
19	National Taiwan U	16	Carnegie Mellon U	14	Istanbul Teknik U	17
20	U California Berkeley	15	U Montreal	13	Finnish Inst Occupat Hlth	17
21	U Bologna	15	Stanford U	13	U London	16
22	Rutgers State U	15	Rutgers State U	13	Liberty Mutual Res Inst Safety	16
23	U La Laguna	14	Kyoto U	13	Griffith U	16
24	U Waterloo	13	U Sao Paulo	13	Niosh	15
25	U Toronto	13	Nanyang Technological U	12	Memorial U Newfoundland	15

Appendix

See Tables 16, 17, 18, 19, 20, 21 and 22.

Table 16 Leading universities in OR–MS between 1991 and 1995

R	University	TP	TC	H	C/P
1	MIT	201	8750	49	43.53
2	ATT	198	5178	34	26.15
3	Purdue U	189	5504	40	29.12
4	U Montreal	169	7695	45	45.53
5	U California Berkeley	151	7640	37	50.60
6	U Michigan	147	3576	36	24.33
7	U Texas Austin	145	4348	35	29.99
8	Georgia Institute of Technology	142	3590	32	25.28
9	US Department of Defense	141	1558	20	11.05
10	Rutgers State U	136	3116	29	22.91
11	Ohio State U	136	3416	30	25.12
12	U Iowa	134	2623	26	19.57
13	Stanford U	130	4799	38	36.92
14	U Pennsylvania	128	6438	39	50.30
15	KAIST	128	1691	24	13.21
16	CNRS France	127	2234	25	17.59
17	Columbia U	124	5083	39	40.99
18	Carnegie Mellon U	121	4863	36	40.19
19	Tel Aviv U	120	2397	26	19.98
20	U Maryland College Park	118	2385	24	20.21
21	Penn State U	117	1842	22	15.74
22	IBM	115	2386	28	20.75
23	U Waterloo	108	2406	27	22.28
24	Technion Israel	105	2097	25	19.97
25	U Toronto	102	2112	26	20.71
26	Texas AM U College Station	102	1787	22	17.52
27	US Department of Energy	101	1673	21	16.56
28	U Manchester	100	782	14	7.82
29	National U Singapore	100	1292	22	12.92
30	U Minnesota Twin Cities	98	4363	31	44.52
31	U Arizona	95	2442	25	25.71
32	Cornell U	95	3229	33	33.99
33	Arizona State U	95	3133	25	32.98
34	U Florida	92	2809	26	30.53
35	U Wisconsin Madison	89	2512	26	28.22
36	Northwestern U	86	3053	28	35.50

Table 16 continued

R	University	TP	TC	H	C/P
37	McMaster U	85	2540	27	29.88
38	U Southern California	81	1561	22	19.27
39	United States Navy	81	1172	15	14.47
40	Louisiana State U	81	1202	19	14.84
41	U California Los Angeles	80	2642	24	33.03
42	Erasmus U Rotterdam	79	1746	24	22.10
43	Eindhoven U Technology	78	2110	22	27.05
44	U Illinois Urbana Champaign	73	1831	21	25.08
45	National Chiao Tung U	72	1287	17	17.88
46	U Massachusetts Amherst	71	1144	20	16.11
47	Nanyang Technological U	71	1437	16	20.24
48	Virginia Polytechnic Institute State U	70	981	17	14.01
49	North Carolina State U	70	1583	24	22.61
50	U British Columbia	69	1788	23	25.91

Table 17 Leading universities in OR–MS between 1996 and 2000

R	University	TP	TC	H	C/P
1	U Montreal	228	8985	52	39.41
2	KAIST	215	4344	33	20.20
3	Georgia Institute of Technology	197	6787	43	34.45
4	MIT	185	9442	51	51.04
5	National U Singapore	171	4429	30	25.90
6	U Michigan	164	5098	37	31.09
7	U Texas Austin	163	5661	42	34.73
8	Purdue U	157	5233	34	33.33
9	U California Berkeley	149	3746	34	25.14
10	Rutgers State U	148	6060	39	40.95
11	Eindhoven U Technology	147	3341	29	22.73
12	US Department of Defense	144	2619	29	18.19
13	City U Hong Kong	143	2618	26	18.31
14	Carnegie Mellon U	140	5331	39	38.08
15	Erasmus U Rotterdam	138	4671	36	33.85
16	Virginia Polytechnic Institute State U	137	3323	33	24.26
17	Tel Aviv U	136	2472	27	18.18
18	Columbia U	135	5442	42	40.31

Table 17 continued

R	University	TP	TC	H	C/P
19	Technion Israel	134	4391	28	32.77
20	Hong Kong U Science Technology	133	3450	35	25.94
21	Texas AM U College Station	131	3261	32	24.89
22	CNRS France	128	3526	28	27.55
23	ATT	122	2225	27	18.24
25	U Wisconsin Madison	121	3314	32	27.39
26	Penn State U	121	2309	23	19.08
27	Stanford U	117	6147	37	52.54
28	Chinese Academy of Sciences	116	2159	29	18.61
29	U Maryland College Park	115	5803	29	50.46
30	Arizona State U	114	2495	26	21.89
31	Chinese U Hong Kong	111	2390	26	21.53
32	National Chiao Tung U	107	1540	22	14.39
33	Delft U Technology	107	1959	23	18.31
34	U Pennsylvania	106	7367	42	69.50
35	U Florida	106	2884	31	27.21
36	Nanyang Technological U	105	1886	24	17.96
37	U Toronto	102	2935	27	28.77
38	US Department of Energy	102	1799	23	17.64
39	Hong Kong Polytechnic U	102	2232	27	21.88
40	U Waterloo	101	3017	25	29.87
41	INRIA	101	1457	19	14.43
42	U Iowa	100	1754	23	17.54
43	Northwestern U	100	4522	32	45.22
44	McMaster U	99	5359	25	54.13
45	Ohio State U	98	3703	32	37.79
46	U Illinois Urbana Champaign	95	2560	24	26.95
47	IBM	95	2413	27	25.40
48	Cornell U	89	3104	31	34.88
49	U Warwick	87	2277	27	26.17
50	Ben Gurion U	84	1055	16	12.56

Table 18 Leading universities in OR–MS between 2001 and 2005

R	University	TP	TC	H	C/P
1	Hong Kong Polytechnic U	298	7592	46	25.48
2	National U Singapore	266	6768	42	25.44
3	Georgia Institute of Technology	258	9635	54	37.34
4	U Montreal	243	7670	46	31.56
5	CNRS France	243	4493	35	18.49
6	MIT	232	12,057	57	51.97
7	KAIST	215	4220	35	19.63
8	City U Hong Kong	186	3927	33	21.11
9	Arizona State U	180	6512	40	36.18
10	Eindhoven U Technology	179	3951	32	22.07
11	Hong Kong U Science Technology	174	6258	44	35.97
12	Penn State U	165	4234	33	25.66
13	Chinese U Hong Kong	163	3466	33	21.26
14	U Michigan	162	5089	39	31.41
15	U California Berkeley	162	4200	37	25.93
16	U Florida	160	4599	37	28.74
17	U Maryland College Park	158	6394	42	40.47
18	Chinese Academy of Sciences	157	4127	36	26.29
19	National Chiao Tung U	152	3376	27	22.21
20	Purdue U	150	3492	31	23.28
21	U Texas Austin	149	5756	43	38.63
22	Virginia Polytechnic Institute State U	145	3598	36	24.81
23	Carnegie Mellon U	144	6511	38	45.22
24	Nanyang Technological U	142	3390	32	23.87
25	Indian Institute of Technology	142	2885	28	20.32
26	U Hong Kong	141	3895	36	27.62
27	Columbia U	138	8624	51	62.49
28	Tel Aviv U	137	2371	25	17.31
29	Rutgers State U	136	4463	35	32.82
30	U Pennsylvania	129	9384	49	72.74
31	Technion Israel	129	3797	33	29.43
32	Stanford U	125	5303	39	42.42
33	U Twente	122	2131	25	17.47
34	U Illinois Urbana Champaign	122	4229	36	34.66
35	Erasmus U Rotterdam	121	4112	37	33.98
36	US Department of Defense	117	1850	24	15.81
37	National Cheng Kung U	115	2076	26	18.05
38	Northwestern U	113	6895	39	61.02
39	INRIA	110	1986	24	18.05
40	Tilburg U	109	1855	22	17.02
41	U Toronto	107	2074	27	19.38
42	U Minnesota Twin Cities	106	5098	43	48.09

Table 18 continued

R	University	TP	TC	H	C/P
43	Texas AM U College Station	106	2250	28	21.23
44	U Southampton	103	2302	29	22.35
45	IBM	103	2173	26	21.10
46	Cornell U	99	2510	25	25.35
47	U Waterloo	95	1260	20	13.26
48	U Arizona	92	2538	28	27.59
49	US Department of Energy	91	3444	23	37.85
50	Tsinghua U	89	1445	19	16.24

Table 19 Leading universities in OR–MS between 2006 and 2010

R	University	TP	TC	H	C/P
1	CNRS France	493	6318	36	12.82
2	Hong Kong Polytechnic U	421	9491	50	22.54
3	Georgia Institute of Technology	396	8693	48	21.95
4	U Montreal	390	8413	47	21.57
5	National Cheng Kung U	335	5516	33	16.47
6	National U Singapore	331	7462	44	22.54
7	MIT	312	6288	39	20.15
8	National Chiao Tung U	300	5692	36	18.97
9	U Florida	286	4454	33	15.57
10	Indian Institute of Technology	281	4183	30	14.89
11	Chinese Academy of Sciences	249	3187	28	12.80
12	U Michigan	247	4049	31	16.39
13	City U Hong Kong	247	5417	41	21.93
14	Tsinghua U	245	4289	34	17.51
15	Eindhoven U Technology	231	3069	27	13.29
16	Shanghai Jiao Tong U	219	3326	30	15.19
17	Hong Kong U Science Technology	210	4177	33	19.89
18	U California Berkeley	209	5730	38	27.42
19	Arizona State U	209	4043	32	19.34
20	Penn State U	208	3690	31	17.74
21	U Toronto	203	3888	33	19.15
22	U Maryland College Park	199	4772	39	23.98
23	Virginia Polytechnic Institute State U	196	3168	27	16.16
24	Rutgers State U	191	3443	27	18.03
25	Northwestern U	189	4174	34	22.08
26	U Hong Kong	188	3881	30	20.64
27	National Taiwan U Science Technology	185	4212	35	22.77
28	Purdue U	184	2545	25	13.83
29	U Texas Austin	182	3800	33	20.88

Table 19 continued

R	University	TP	TC	H	C/P
30	Carnegie Mellon U	182	4924	32	27.05
31	Nanyang Technological U	176	3363	30	19.11
32	US Department of Defense	173	2135	24	12.34
33	Chinese U Hong Kong	171	3278	28	19.17
34	Columbia U	169	3490	33	20.65
35	U Illinois Urbana Champaign	167	3581	32	21.44
36	U Paris Saclay Comue	167	2216	23	13.27
37	Texas AM U College Station	166	3343	29	20.14
38	KU Leuven	164	3888	33	23.71
39	Erasmus U Rotterdam	158	4004	32	25.34
40	Cornell U	158	2609	28	16.51
41	U Texas Dallas	155	2319	27	14.96
42	National Central U	153	3106	29	20.30
43	KAIST	153	2021	24	13.21
44	National Tsing Hua U	152	2238	26	14.72
45	Stanford U	151	3246	29	21.50
46	U Bologna	148	2631	30	17.78
47	Technion Israel	148	1962	25	13.26
48	IBM	145	3558	26	24.54
49	Delft U Technology	144	2806	28	19.49
50	INRIA	143	1735	21	12.13

Table 20 Leading universities in OR–MS between 2011 and 2015

R	University	TP	TC	H	C/P
1	CNRS France	783	3863	26	4.93
2	Hong Kong Polytechnic U	635	5444	30	8.57
3	Tsinghua U	437	2426	21	5.55
4	U Montreal	436	2989	24	6.86
5	Georgia Institute of Technology	415	2389	24	5.76
6	City U Hong Kong	409	3087	24	7.55
7	Shanghai Jiao Tong U	395	2232	22	5.65
8	MIT	386	2223	22	5.76
9	National U Singapore	373	2503	23	6.71
10	Indian Institute of Technology	358	2192	20	6.12
11	KU Leuven	326	2505	22	7.68
12	U Paris Saclay Comue	315	1703	17	5.41
13	Islamic Azad U	310	2316	23	7.47
14	Chinese Academy of Sciences	301	1819	19	6.04
15	U Michigan	279	1274	15	4.57
16	Huazhong U Science Technology	278	1985	18	7.14

Table 20 continued

R	University	TP	TC	H	C/P
17	Eindhoven U Technology	268	1326	17	4.95
18	Penn State U	266	1544	18	5.80
19	Beihang U	264	1406	19	5.33
20	U Florida	263	1804	18	6.86
21	National Taiwan U Science Technology	244	1924	21	7.89
22	National Cheng Kung U	242	1347	18	5.57
23	Nanyang Technological U	237	1643	19	6.93
24	Hong Kong U Science Technology	236	1682	21	7.13
25	U California Berkeley	229	1582	21	6.91
26	U Toronto	226	1313	17	5.81
27	U Tehran	223	1406	17	6.30
28	U Illinois Urbana Champaign	216	1080	15	5.00
29	Northeastern U China	216	1358	17	6.29
30	Dalian U Technology	214	1586	19	7.41
31	Purdue U	212	1090	14	5.14
32	U Maryland College Park	208	1241	16	5.97
33	Carnegie Mellon U	206	866	13	4.20
34	Arizona State U	206	1560	18	7.57
35	Polytechnic U Milan	204	1630	17	7.99
36	National Chiao Tung U	204	1115	16	5.47
37	Erasmus U Rotterdam	203	1155	15	5.69
38	HEC Montreal	202	1535	19	7.60
39	Zhejiang U	201	883	15	4.39
40	Tongji U	201	1343	17	6.68
41	U Hong Kong	200	1716	21	8.58
42	U Lisboa	200	1421	17	7.11
43	Columbia U	200	1225	15	6.13
44	U Sevilla	199	876	14	4.40
45	Northwestern U	198	1025	16	5.18
46	Xi An Jiaotong U	196	1128	15	5.76
47	Polytech Montreal	196	1124	13	5.73
48	Virginia Polytechnic Institute State U	194	1012	15	5.22
49	U Texas Austin	194	913	13	4.71
50	Texas AM U College Station	193	986	14	5.11

Table 21 List of Top 30 OR–MS Journal

R	Source titles	TC	TP	H	TC/TP	>200	>100	>50	>10	>5	IF	IF5
1	Management Science	154,074	3309	170	46.56	130	369	839	2188	2584	2.741	3.728
2	European J Operational Research	249,707	11,985	163	20.83	106	357	1104	5640	7698	2.679	3.109
3	Operations Research	62,486	2314	104	27.00	20	110	347	1287	1660	1.777	2.838
4	Systems and Control Letters	59,043	3002	101	19.67	31	101	266	1201	1704	1.908	2.448
5	J Operations Management	35,365	664	101	53.26	24	103	225	507	563	4	8.229
6	Mathematical Programming	55,158	2234	93	24.69	29	80	245	1108	1461	2.062	2.471
7	International J Production Economics	85,373	5211	90	16.38	16	66	342	2257	3189	2.782	3.548
8	Expert Systems With Applications	120,838	9771	88	12.37	9	64	338	3530	5484	2.981	2.879
9	Computers and Operations Research	67,883	3936	86	17.25	11	55	288	1761	2452	1.988	2.382
10	Transportation Research Part B-Methodological	41,219	1527	84	26.99	10	65	227	898	1097	3.769	4.833
11	International J Production Research	86,569	6958	82	12.44	1	44	261	2545	3875	1.693	1.867
12	Omega-International J Management Science	35,126	1633	80	21.51	11	54	152	818	1074	3.962	4.289
13	Decision Support Systems	42,420	2497	76	16.99	13	41	155	1063	1553	2.604	3.271
14	Reliability Engineering and System Safety	52,339	3513	75	14.90	11	41	175	1397	2054	2.498	2.873
15	Transportation Science	23,921	834	74	28.68	8	41	149	503	616	3.295	3.735
16	J The Operational Research Society	47,261	3641	71	12.98	15	34	146	1156	1813	1.225	1.386
17	J Quality Technology	19,275	801	70	24.06	6	38	108	400	526	1.578	2.412
18	Annals of Operations Research	30,477	3023	67	10.08	5	27	98	791	1283	1.406	1.616
19	Iie Transactions	32,629	2075	66	15.72	3	26	121	902	1244	1.463	1.723
20	J Optimization Theory and Applications	39,835	3719	65	10.71	7	25	126	1047	1660	1.16	1.384

Table 21 continued

R	Source titles	TC	TP	H	TC/TP	> 200	> 100	> 50	> 10	> 5	IF	IF5
21	Technovation	26,906	1550	65	17.36	3	23	120	742	993	2.243	3.833
22	Mathematics of Operations Research	22,856	1263	65	18.10	8	33	89	536	773	1.406	1.692
23	J Global Optimization	31,574	2081	62	15.17	9	24	81	579	952	1.219	1.293
24	Production And Operations Management	17,376	954	62	18.21	6	33	76	361	509	1.732	2.257
25	Transportation Research Part E-	17,835	1072	60	16.64	2	18	86	455	631	2.279	3.319
26	Safety Science	25,947	2377	57	10.92	5	7	17	73	663	1126	1801
27	Operations Research Letters	21,163	2184	55	9.69	2	14	60	537	891	0.627	0.813
28	Naval Research Logistics	16,289	1398	49	11.65	1	7	45	459	701	0.787	1.121
29	Networks	13,688	1294	48	10.58	3	9	44	382	559	0.943	1.281
30	Computational Optimization And Applications	12,830	1178	48	10.89	2	12	46	335	540	1.444	1.659

Table 22 Top 50 universities in OR–MS research during 1991–2015. (30% of Normalized value of TP+70% of Normalized value of TC)

Rank	Name of the university	Score
1	Massachusetts Institute of Technology MIT	0.016954218
2	U Montreal	0.016215969
3	Georgia Institute of Technology	0.014418073
4	Hong Kong Polytechnic U	0.012543997
5	Centre National De La Recherche Scientifique CNRS	0.011465069
6	U Pennsylvania	0.011293552
7	National U Singapore	0.010937922
8	Columbia U	0.010336988
9	U California Berkeley	0.010295042
10	Carnegie Mellon U	0.009908603
11	U Texas Austin	0.009277207
12	U Maryland College Park	0.009236988
13	U Michigan	0.009168876
14	Stanford U	0.009036537
15	Northwestern U	0.008641119
16	Purdue U	0.008485173
17	Rutgers State U	0.008249092
18	Arizona State U	0.008232851
19	U Florida	0.008044748
20	City U Hong Kong	0.007907759
21	Hong Kong U Science Technology	0.007763952
22	Indian Institute of Technology Iit	0.007636238
23	Hec Montreal	0.007602451
24	U Minnesota Twin Cities	0.007529741
25	Erasmus U Rotterdam	0.00724655
26	Eindhoven U Technology	0.007054395
27	Penn State U	0.00692176
28	National Chiao Tung U	0.006609399
29	Ku Leuven	0.006461627
30	Korea Advanced Institute of Science Technology KAIST	0.006444963
31	U Illinois Urbana Champaign	0.006327781
32	Technion Israel Institute of Technology	0.006193512
33	Chinese Academy of Sciences	0.006183263
34	U Toronto	0.006144387
35	Virginia Polytechnic Institute State U	0.00605632
36	Nanyang Technological U NIE Singapore	0.005902651
37	Ohio State U	0.005799237
38	Texas A M U College Station	0.00579263

Table 22 continued

Rank	Name of the university	Score
39	National Cheng Kung U	0.005761763
40	Cornell U	0.005694821
41	Mcmaster U	0.005476771
42	U Wisconsin Madison	0.005476345
43	International Business Machines Ibm	0.005443015
44	Chinese U Hong Kong	0.005351115
45	U Hong Kong	0.005347326
46	New York U	0.00534346
47	At T	0.00529114
48	National Taiwan U Science Technology	0.005154207
49	Duke U	0.005005275
50	U California Los Angeles	0.00500393

References

Altay, N., & Green, W. G. (2006). OR/MS research in disaster operations management. *European Journal of Operational Research, 175*(1), 475–493.

Avkiran, N. K., & Alpert, K. (2015). The influence of co-authorship on article impact in OR/MS/OM and the exchange of knowledge with finance in the twenty-first century. *Annals of Operations Research, 235*(1), 51–73.

Bonilla, C. A., Merigó, J. M., & Torres-Abad, C. (2015). Economics in Latin America: A bibliometric analysis. *Scientometrics, 105*(2), 1239–1252.

Bornmann, L., & Daniel, H. D. (2005). Does the H-index for ranking of scientists really work? *Scientometrics, 65*(3), 391–392.

Brans, J. P., & Gallo, G. (2007). Ethics in OR/MS: past, present and future. *Annals of Operations Research, 153*(1), 165–178.

Broadus, R. N. (1987). Toward a definition of "Bibliometrics". *Scientometrics, 12,* 373–379.

Cancino, C., Merigó, J. M., Coronado, F., Dessouky, Y., & Dessouky, M. (2017). Forty years of computers and industrial engineering: A bibliometric analysis. *Computers & Industrial Engineering, 113,* 614–629.

Corbett, C. J., & Van Wassenhove, L. N. (1993). The natural drift: What happened to operations research? *Operations Research, 41*(4), 625–640.

Daraio, C., Bonaccorsi, A., & Simar, L. (2015). Rankings and university performance: A conditional multidimensional approach. *European Journal of Operational Research, 244,* 918–930.

Evans, J. R. (1997). Creativity in OR/MS: The creative problem-solving process, Part 1. *Interfaces, 27*(5), 78–83.

Fahimnia, B., Sarkis, J., & Davarzani, H. (2015). Green supply chain management: A review and bibliometric analysis. *International Journal of Production Economics, 162,* 101–114.

Galindo, G., & Batta, R. (2013). Review of recent developments in OR/MS research in disaster operations management. *European Journal of Operational Research, 230*(2), 201–211.

González-Benito, J., Lannelongue, G., & Alfaro-Tanco, J. A. (2013). Study of supply-chain management in the automotive industry: A bibliometric analysis. *International Journal of Production Research, 51*(13), 3849–3863.

Hicks, D., Wouters, P., Waltman, L., De Rijcke, S., & Rafols, I. (2015). The Leiden manifesto for research metrics. *Nature, 520*(7548), 429.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences of the United States of America, 102,* 16569–16572.

Laengle, S., Merigó, J. M., Miranda, J., Slowinski, R., Bomze, I., Borgonovo, E., et al. (2017). Forty years of the European Journal of Operational Research: A bibliometric overview. *European Journal of Operational Research, 262,* 803–816.

Lampe, H. W., & Hilgers, D. (2015). Trajectories of efficiency measurement: A bibliometric analysis of DEA and SFA. *European Journal of Operational Research, 240,* 1–21.

Landström, H., Harirchi, G., & Aström, F. (2012). Entrepreneurship: Exploring the knowledge base. *Research Policy, 41*(7), 1154–1181.

Leone, R. P., Robinson, L. M., Bragge, J., & Somervuori, O. (2012). A citation and profiling analysis of pricing research from 1980 to 2010. *Journal of Business Research, 65*(7), 1010–1024.

Lim, M. K., Bahr, W., & Leung, S. C. (2013). RFID in the warehouse: A literature analysis (1995–2010) of its applications, benefits, challenges and future trends. *International Journal of Production Economics, 145*(1), 409–430.

Liu, J. S., Lu, L. Y. Y., Lu, W. M., & Lin, B. J. Y. (2013). Data envelopment analysis 1978–2010: A citation-based literature survey. *Omega—International Journal of Management Science, 41,* 3–15.

Martínez-López, F. J., Merigó, J. M., Valenzuela, L., & Nicolás, C. (2018). Fifty years of the European Journal of Marketing: A bibliometric analysis. *European Journal of Marketing, 52,* 439–468.

Merigó, J. M., Cancino, C., Coronado, F., & Urbano, D. (2016). Academic research in innovation: A country analysis. *Scientometrics, 108*(2), 559–593.

Merigó, J. M., Gil-Lafuente, A. M., & Yager, R. R. (2015a). An overview of fuzzy research with bibliometric indicators. *Applied Soft Computing, 27,* 420–433.

Merigó, J. M., Mas-Tur, A., Roig-Tierno, N., & Ribeiro-Soriano, D. (2015b). A bibliometric overview of the Journal of Business Research between 1973 and 2014. *Journal of Business Research, 68*(12), 2645–2653.

Merigó, J. M., Pedrycz, W., Weber, R., & de la Sotta, C. (2018). Fifty years of Information Sciences: A bibliometric overview. *Information Sciences, 432,* 245–268.

Merigó, J. M., & Yang, J. B. (2017). A bibliometric analysis of operations research and management science. *Omega—International Journal of Management Science, 73,* 37–48.

Mingers, J. (2009). Measuring the research contribution of management academics using the Hirsch-index. *Journal of the Operational Research Society, 60,* 1143–1153.

Mingers, J., & Leydesdorff, L. (2015). A review of theory and practice in scientometrics. *European Journal of Operational Research, 246,* 1–19.

Mingers, J., & Xu, F. (2011). The drivers of citations in management science journals. *European Journal of Operational Research, 205,* 422–430.

Mishra, D., Gunasekaran, A., Papadopoulos, T., & Childe, S. J. (2016). Big Data and supply chain management: A review and bibliometric analysis. *Annals of Operations Research*. https://doi.org/10.1007/s10479-016-2236-y

Narin, F. (1976). *Evaluative bibliometrics: The use of publication and citation analysis in the evaluation of scientific activity*. Washington D.C: National Science Foundation.

Ormerod, R., & Kiossis, I. (1997). OR/MS publications: Extension of the analysis of U.S. flagship journals to the United Kingdom. *Operations Research*, *45*(2), 178–187.

Pidd, M. (2004). Contemporary OR/MS in strategy development and policy-making: Some reflections. *Journal of the Operational Research Society, 55*(8), 791–800.

Podsakoff, P. M., MacKenzie, S. B., Podsakoff, N. P., & Bachrach, D. G. (2008). Scholarly influence in the field of management: A bibliometric analysis of the determinants of university and author impact in the management literature in the past quarter century. *Journal of Management, 34,* 641–720.

Pritchard, A. (1969). Statistical bibliography or bibliometrics? *Journal of Documentation, 25,* 348–349.

Reisman, A., & Kirschnick, F. (1994). The devolution of OR/MS: Implications from a statistical content analysis of papers in flagship journals. *Operations Research, 42*(4), 577–588.

Rinia, E. J., van Leeuwen, Th N, van Vuren, H. G., & van Raan, A. F. J. (1998). Comparative analysis of a set of bibliometric indicators and central peer review criteria. Evaluation of condensed matter physics in the Netherlands. *Research Policy, 27,* 95–107.

Snyder, L. V., Atan, Z., Peng, P., Rong, Y., Schmitt, A. J., & Sinsoysal, B. (2016). OR/MS models for supply chain disruptions: A review. *IIE Transactions, 48*(2), 89–109.

Tsoukas, H., & Papoulias, D. B. (1996). Creativity in OR/MS: From technique to epistemology. *Interfaces, 26*(2), 73–79.

Tur-Porcar, A., Mas-Tur, A., Merigó, J. M., Roig-Tierno, N., & Watt, J. (2018). A bibliometric history of the Journal of Psychology between 1936 and 2015. *Journal of Psychology, 152,* 199–225.

Valenzuela, L., Merigó, J. M., Johnston, W., Nicolás, C., & Jaramillo, F. (2017). Thirty years of the Journal of Business and Industrial Marketing: A bibliometric analysis. *Journal of Business and Industrial Marketing, 32,* 1–18.

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics, 84,* 523–538.

Van Raan, A. F. J. (1996). Advanced bibliometric methods as quantitative core of peer review based evaluation and foresight exercises. *Scientometrics, 36,* 397–420.

Van Raan, A. F. J. (2004). Measuring science. Capita selecta of current main issues. In H. F. Moed, W. Glänzel, & U. Schmoch (Eds.), *Handbook of quantitative science and technology research* (pp. 19–50). Dordrecht: Kluwer Publishers.

Van Raan, A. F. (2006). Comparison of the Hirsch-index with standard bibliometric indicators and with peer judgment for 147 chemistry research groups. *Scientometrics, 67*(3), 491–502.

Wagstaff, A., & Culyer, A. J. (2012). Four decades of health economics through a bibliometric lens. *Journal of Health Economics, 31*(2), 406–439.

Waltman, L., & Van Eck, N. J. (2012). The inconsistency of the h-index. *Journal of the Association for Information Science and Technology, 63*(2), 406–415.

Wang, W., Laengle, S., Merigó, J. M., Yu, D., Herrera-Viedma, E., Cobo, M. J., et al. (2018). A bibliometric analysis of the first twenty-five years of the International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems. *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, 26,* 169–193.

Wysocki, R. K. (1979). OR/MS implementation research: a bibliography. *Interfaces, 9*(2-part-1), 37–41.

Zhang, W., & Wilhelm, W. E. (2011). OR/MS decision support models for the specialty crops industry: A literature review. *Annals of Operations Research, 190*(1), 131–148.