International Journal of Information Science and Management
Vol. 20, No. 1, 2022, 337-357
https://dorl.net/dor/ 20.1001.1.20088302.2022.20.1.19.2

Original Research

Co-authorship Networks of Iranian Researchers' Publications on the Field of Management during a Half-Century (1969-2018)

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Received: 15 January 2021
Accepted: 05 March 2021

Abstract

As one of the main bibliometric concepts, co-authorship has been thoughtfully considered in recent years. Despite many bibliometric studies on the co-authorship in different scientific fields and worldwide countries/regions, Iranian researchers' collaboration in the management field has not been studied. This study aimed to investigate the co-authorship networks in the management papers contributed by Iranian researchers indexed in the Web of Science (WoS) during the recent half-century (years, 1969-2018). Bibliometric data on 5414 papers were extracted from WoS and analyzed in Excel, UCINET, and VOSviewer to measure bibliometric indicators, the map needed co-authorship networks, and depict time-based maps and keyword clustering. Findings showed that co-authored papers increased from two items in 1973 to 721 items in 2018. Expert Systems with Applications, African Journal of Business Management, and International Journal of Production Research were ranked first to third in co-authored papers. Top 20 authors published about 17% of papers (946). Islamic Azad University, University of Tehran, and the Amirkabir University of Technology ranked first to third. Most co-authorship frequencies were made from 2012 to 2014. The first to third ranks of collaborating countries were the USA, Canada, and England. Six main keyword clusters were formed, including main topics in the field. In conclusion, Iranian researchers increasingly co-authored in management, especially during the last decade, and published in various journals that some top ones are prestigious journals. However, some gaps need to be bridged by the low contribution of research institutes and universities countrywide and the limited number of authors with high productivity and low collaboration with neighbor countries and influential universities worldwide.

Keywords: Bibliometrics, Scientometrics, Management, Iran, Co-Authorship Networks.

Introduction

Co-authorship is one of the most objective and documented scientific collaboration and main goals of bibliometric studies (Inzelt, Schubert & Schubert, 2009; Leydesdorff & Vaughan, 2006; Kumar, 2015). Co-authorship is the collaboration between two or more authors in authoring a scientific work that results in a more quality paper compared to that of a one-authored paper (Hudson, 1996). In addition, it is an interaction that is made between two or more researchers within a social network (Lu & Wolfram, 2012). Co-authorship results in an opportunity to explore knowledge, increase specialty, and make innovation in science (Kumar, 2015). Researchers can create co-authorship networks to share ideas, resources and information and have a role in providing new knowledge, decreasing costs, and increasing scientific output (Fonseca, Sampaio, de Araújo Fonseca & Zicker, 2016). Although the co-authorship cannot be an objective indicator of quality, it can improve the quality of scientific works as possible (Kim, 2006).

Scientific collaboration is a new knowledge capital that its existence needs some co-authorship (Monteiro, Neto, Cardoso & Correia, 2009). It can improve the research and help identify the nature of different disciplines (Glänzel & Schubert , 2004). The plurality of group authorship in a field results in a co-authorship network. A co-authorship network is very similar to the state of a scientific community and knowledge structure in which researchers as continuous objects structure the universal system of scientific production (Giuliani, De Petris & Nico, 2010). A co-authorship network consists of authors as nodes and lines as their connections or links (Bródka, Skibicki, Kazienko & Musiał, 2011). It can be analyzed by different indicators (Li, Liao & Yen, 2013). The base of co-authorship networks assumes that authors of papers affiliated with different research institutes and universities have some familiarity and similarities. Such a network consists of nodes and links showing co-authors and their collaborations (Cheong & Corbitt, 2009).

Producing scientific maps in a discipline is a necessity of scientific policy-making and development. Mapping and analyzing researchers' co-authorship networks make a context for manifesting collaboration patterns. Its results can be helpful in making scientific policies, identifying subject trends, and promoting the scientific space. Therefore, this study aimed to investigate the bibliometric indicators of the co-authorship networks in the management publications contributed by Iranian researchers indexed in the Web of Science (WoS) during the recent half-century (years 1969-2018).

Literature Review

Studies on bibliometrics, especially co-authorship in different fields, show their influence on their scientific policies and research promotion. This has hardly been considered in the field of management. In studying the co-authorship networks of studies on mathematics and statistics, Nadhiroh, Hardiyati, Amelia and Handayani (2018) found that the studies on the field with the affiliation of Indonesia were very low. A scale-free network and the power-law distribution were found in the networks. This study showed the achievement of Indonesian scholars in mathematics and statistics. Such studies can evaluate the knowledge transfer in these subjects and related areas countrywide. The co-authorship networks analyze economics, Molina

et al. (2016) found a significant correlation between author centrality and scientific output. They emphasized the need for highly productive authors with low co-authorship rates to interact with other authors in their field who may be well-positioned but minimally productive to improve their scientific productivity. These approaches can result in field promotion and more collaboration.

In analyzing the evolution of collaboration among researchers, Cheng, Huang, Tsaih & Wu (2018) found that most papers of the *journal of Library Hi Tech* were one-authored, and few papers had more than 6 authors. They concluded that multi-authorship must be encouraged among the journal researchers as multi-authorship research has some advantages described in related literature. Gaskó, Lung and Suciu (2016) showed that Romanian authors in mathematics and computer sciences had the network centrality of .0003 and .0004, respectively. Their degree centrality rates were 4 and 3, respectively. Their proposed type of network revealed the patterns of collaborative behavior and offered new insights into practices in the field. These networks were smaller and denser than the common co-authorship networks with a better-defined community structure. They directly represented the results of collaborative entities by focusing on published papers. Fonseca et al. (2016) showed that the network centrality and degree centrality of authors in healthcare were .048 and .128, respectively, and a weak collaboration rate was seen among research institutes. Despite USA's higher papers than France's, French authors had a higher degree centrality rate than those of the USA. In conclusion, healthcare researchers are not independent players but teams that bring together their skills and professional approaches around common aims. Social network analysis and co-authorship networks need to be powerful tools to assess collaboration trends and identify leading scientists and organizations in all scientific fields.

Leane, Fletcher and Garg (2017) studied the co-authorship networks in English literacy studies and found an unusual network centrality of .4 in the field, with the two-authored pattern as a dominant one (81%). In addition, evidence showed that co-authorship is becoming more common in the discipline. Therefore, academics in literary studies need to begin explicitly addressing co-authorship traditions and practices in their discipline for being more visible and citable. Ezema and Azogva (2014) analyzed the co-authorship pattern in the two journals on linguistics and found a low collaboration. They found low multi-authored contributions. This study is useful for the linguistics field in analyzing an individual journal research performance and for the collection development of libraries, particularly academic libraries that support researchers in linguistics.

Badar, Hite & Badir (2013) found a significant relationship between authors' degree centrality and closeness centrality and their research performance. However, they emphasized that the author's centralities (degree, closeness and betweeness) have not been deeply investigated and must be heavily considered. Erfanmanesh, Rohani Vala and Abdullah (2017) found that a couple of key researchers did not dominate scientometrics as a field as a pretty significant number of famous researchers were identified. In addition, the USA occupied the topmost position in all measures except for degree centrality, and the most active, central, and collaborative academic discipline in scientometrics was Library and Information Science. The main point was that the scientometrics research community was a healthy small-world community that kept evolving to provide an environment supporting collaboration and sharing

ideas between researchers in the quantitative study of research communication.

Wang, Zhang, Liu, Liu and Wen (2012) showed that scientific collaboration was common among the authors in social computing and found a low centrality among research institutes. They gave a snapshot of the current research in social computing and provided initial guidance to new researchers in the field. Collaboration was popular both at the researcher and institution level. Notably, scientific productivity is often proportional to influence, and the active collaborators are often the knowledge transmitters at the researcher or institution level. Olmeda-Gómez, Perianes-Rodriguez, Ovalle-Perandones, Guerrero-Bote & de Moya Anegón, (2009) analyzed the scientific publications of Spain's universities and found that they were authored by the collaboration of the European Union countries as well as those in South and North America. They showed that old-established universities tended towards co-authorship more than newly established ones. However, the scientific impact was measured in journals rather than individual papers. The obtained data provided some guidance for public policymakers seeking to develop the internationalization of scientific production in Spanish universities.

In studying the co-authorship network of Turkish researchers in humanities and social science, Gossart and Özmanwhile (2009) found that co-authorship networks are composed mainly of isolated groups. There is a little intersection between the two studied databases, permitting little knowledge diffusion. There seem to be two disparate populations of researchers. It can be said that while Turkish social sciences and humanities publications have been growing impressively in the recent decades, domestic networks to ensure the dissemination of knowledge and research output are weak and should be supported by domestic policies and research agencies. Cheong & Corbitt (2009) showed an ever-increasing co-authorship pattern among papers presented in the *Pacific Asia Conference on Information Systems*. They revealed that social network analysis (SNA) is a main sociological approach for analyzing the patterns of relationships and interactions between social actors in information science.

Acedo, Barroso, Casanueva and Galán (2006) investigated the co-authorship network of management and organizational studies and found an increasing trend in the scientific collaboration in the field. They dedicated that the network analysis permits the exploration of the peculiarities of the field of management in comparison with other fields and the existing linkages between the most central and prominent authors within this developing discipline.

In summary, bibliometric methods and co-authorship networks introduce a measure of objectivity in the evaluation of scientific production. They can increase possible researcher bias in reviews of scientific literature by aggregating the opinions of multiple scholars working in different scientific fields. Scientific collaboration is considered both at individual and national levels, focusing on multinational collaborations. Co-authorship networks have evolved among researchers over time in specific research domains and interdisciplinary research areas in different aggregated levels. Scientists from diverse research areas and geographical locations may participate in one specific co-authorship network, whereas an individual scientist may belong to different co-authorship networks.

As Table 1 shows and briefly described above, co-authorship networks have been studied in many scientific fields, different periods, and countries/regions at the level of different

scientific items (papers, journals, authors, research institutes, etc.). However, Iranian authors' co-authorship network in management has not been studied yet.

Table 1
Some Studies on the Co-Authorship Networks in Different Fields

Author(s)	Field	Time span	Source
Nadhiroh et al. (2018)	Mathematics and statistics	2002-2014	WoS
Cheng et al. (2018)	Library and information science	2006-2017	WoS
Molina et al. (2016)	Economics	2002-2014	WoS
Fonseca et al. (2016)	Health research	2010-2014	WoS
Gasko et al. (2016)	Computer science and mathematics	2005-2014	Scopus
Ezema & Asogwa (2014)	Linguistics	2001-2010	Two journals
Badar et al. (2013)	Chemistry	2002-2009	WoS
Erfanmanesh et al. (2017)	Scientometrics	1980-2012	WoS
Wang et al. (2012)	Social computing research	1998-2011	WoS
Leane et al. (2011)	Literary studies	1995-2015	MLAIB
Olmeda- Gómez et al. (2009)	Scientific productions in Spanish universities	2000-2004	WoS
Gossart and Özman (2009)	Social science	2000-2007	WoS ULAKBIM
Cheong & Corbitt (2009)	Information systems Conferences	1990-2006	Conferences
Acedo et al. (2006)	Management	1980-2002	WoS

Methodology

In this bibliometric survey, a co-authorship network analysis was applied. The study population included all 5414 publications authored by Iranian researchers in management and indexed in WoS during 1969-2018. These publications were all included in the study as a census. The following formula was used for retrieving data in April 2020:

WC= Management

Timespan: 1969-2018

Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC

Refined by: COUNTRIES/REGIONS: (IRAN) AND [excluding] DOCUMENT TYPES: (CORRECTION OR RETRACTION OR RETRACTED PUBLICATION)

This study was conducted in three steps. At the first step, the study sample was retrieved from WoS. At the second step, some corrections and amendments were done, and data were entered into Excel for mapping matrixes of authors, research institutes/universities, and countries/regions. In mapping the proximity matrix in Excel, each entity was included in a column. If there was an overlap in the intersection of two groups, the number of co-authorship items was recorded in their intersection cells. Excel, UCINET, and VOSviewer were used at the third step for bibliometric analyses, mapping needed co-authorship networks, and depicting

time-based maps and keyword clustering, respectively.

Findings

Table 2 shows the number of publications published by Iranian authors in management during 1969-2018. As can be seen, the number of publications increased from two items in 1973 to 721 items in 2018. In total, 5414 publications have been published in these years, with an increasing trend.

Table 2

The Number of Publications by Year in the Field Of Management Authored By Iranian Researchers during 1969-2018 (N=5414)

Publication Years	Records	%	Publication Years	Records	%
1969	0	.00	1997	6	.11
1970	0	.00	1998	10	.18
1971	0	.00	1999	4	.07
1972	0	.00	2000	10	.18
1973	2	.04	2001	9	.17
1974	2	.04	2002	23	.42
1975	1	.02	2003	54	1.00
1976	4	.07	2004	25	.46
1977	1	.02	2005	51	.94
1978	3	.06	2006	86	1.59
1979	1	.02	2007	116	2.14
1980	2	.04	2008	199	3.68
1982	1	.02	2009	283	5.23
1985	2	.04	2010	289	5.34
1986	1	.02	2011	719	13.28
1987	1	.02	2012	353	6.52
1989	1	.02	2013	317	5.86
1990	2	.04	2014	369	6.82
1991	4	.07	2015	542	10.01
1992	2	.04	2016	595	10.99
1993	1	.02	2017	594	10.97
1995	3	.06	2018	721	13.32
1996	5	.09	Total	5414	100

Table 3 shows the top 20 highly-productive authors in the field. Tavakkoli-Moghaddam, R, with 107 publications ranked first, producing about 2% of all publications (107 papers). The second and third ranks belonged to Ghomi, SMTF with 61 publications, and Niaki, and STA with 60 publications. These top 20 authors published about 17% of papers (946).

Table3
Top 20 Iranian Authors Publishing On the Field of Management during 1969-2018 (n=5414)

Authors	Records	%	Rank
Tavakkoli-Moghaddam, R	107	1.976	1
Ghomi, SMTF	61	1.127	2
Niaki, STA	60	1.108	3
Azadeh, A	59	1.090	4
Fazlollahtabar, H	56	1.034	5
Zandieh, M	55	1.016	6
Torabi, SA	53	.979	7
Taleizadeh, AA	49	.905	8
Soleimani-Damaneh, M	48	.887	9
Jolai, F	44	.813	10
Rabbani, M	43	.794	11
Farahani, RZ	38	.702	12
Saen, RF	38	.702	12
Salehi, M	37	.683	13
Tavana, M	36	.665	14
Jahanshahloo, GR	34	.628	15
Mohammadi, M	33	.610	16
Noorossana, R	33	.610	16
Karimi, B	32	.591	17
Mahdavi, I	30	.554	18

Table 4 depicts the top 20 publishing sources that published Iranian researchers' papers on management during 1969-2018. Out of a total of 5414 publications, 475 (8.77%), 210 (3.88%), and 207 (3.82%) were published in the *Expert Systems with Applications*, *African Journal of Business Management*, and *International Journal of Production Research*, respectively. These journals were ranked first to third in publishing these papers. These top 20 journals published 2602 (48%) papers.

Table 4
Top 20 Journals Publishing Iranian Researchers' Papers on Management during 1969-2018 (n=5414)

Source Title	Records	%	Ra Rank n
Expert Systems with Applications	475	8.774	1
African journal of business management	210	3.879	2
International Journal of Production Research	207	3.823	3
European Journal of Operational Research	178	3.288	4
International Conference on Industrial Engineering and Engineering Management (IEEM)	177	3.269	5
Journal of Optimization Theory and Applications	129	2.383	6
International Journal of Systems Science	124	2.290	7
Procedia - Social and Behavioral Sciences	117	2.161	8
Iranian Journal of Management Studies	112	2.069	9
Computers & Operations Research	106	1.958	10

Source Title	Records	%	Ra Rank n
Quality and Reliability Engineering International	92	1.699	11
Engineering Optimization	86	1.588	12
International Journal of Production Economics	84	1.552	13
Optimization	84	1.552	13
IEEE Systems Journal	79	1.459	14
International Proceedings of Economics Development and Research	74	1.367	15
Journal of Manufacturing Systems	72	1.330	16
International Journal of Computer Integrated Manufacturing	67	1.238	17
Safety Science	66	1.219	18
journal of the Operational Research Society	63	1.164	19

Table 5 shows the top 20 highly-productive Iranian research institutes/universities producing management papers during 1969-2018. Islamic Azad University with 1242 publications (23%), the University of Tehran with 929 publications (17%), and the Amirkabir University of Technology with 447 publications (8%) ranked first to third, respectively. These universities published 5057 papers (about 93%).

Table 5
Top 20 Highly-Productive Iranian Research Institutes Publishing Papers on Management During 1969-2018 (n=5414)

Organizations	records	%	Rank
Islamic Azad University	1242	22.941	1
University of Tehran	929	17.159	2
Amirkabir University of Technology	447	8.256	3
Iran University of *Science* and *Technology*	441	8.146	4
Sharif University of *Technology*	401	7.407	5
Tarbiat Modares University	253	4.673	6
Ferdowsi University of Mashhad	172	3.177	7
K. N. Toosi University of Technology	160	2.955	8
University of Isfahan	156	2.881	9
Shahid Beheshti University	126	2.327	10
Isfahan University of Technology	105	1.939	11
Mazandaran University of Science and Technology	81	1.496	12
Shahed University	81	1.496	12
Amirkabir University of Technology	79	1.459	13
Kharazmi Univbersity	73	1.348	14
Shiraz University	66	1.219	15
Shahid Bahonar University of Kerman	63	1.164	16
Yazd University	63	1.164	16
University of Tabriz	61	1.127	17
Allameh Tabataba'i University	58	1.071	18

Table 6 shows the highly-ranked co-authors and co-authorship frequencies of Iranian researchers' publishing papers on management during 1969-2018. As the table shows, the most

potent co-authorship was formed between Fazlollahtabar H and Saidi-Mehrabad M with 15 co-authorship frequencies. The second and third ranks belonged to Behboudi M and Hanafizadeh P with 13 and Zandieh M and Ghomi SMTF with 12 co-authorship frequencies.

Table 6
Highly-Ranked Co-Authoring Pairs and Co-Authorship Frequencies of Iranian Researchers Publishing Papers on Management during 1969-2018

Author 1	Author 2	Frequency (Rank)	Author 1	Author 2	Frequency (Rank)
Fazlollahtabar H	Saidi-Mehrabad M	15 (1)	Khaki-Sedigh A	Moaveni B	7 (8)
Hanafizadeh P	Behboudi M	13 (2)	Moradi M	Salehi M	7 (8)
Ghomi SMTF	Zandieh M	12 (3)	Taleizadeh AA	Cardenas-Barron LE	7 (8)
Mansouri H	Zangiabadi M	11 (4)	Mousavi SM	Tavakkoli-Moghaddam R	7 (8)
Babaie-Kafaki S	Ghanbari R	11 (4)	Pasandideh SHR	Niaki STA	7 (8)
Dawes RM	Foddy M	10 (5)	Naderi B	Zandieh M	7 (8)
Hashemkhani Zolfani S	Zavadskas EK	10 (5)	Roshani A	Roshani A	6 (9)
Azadeh A	Saberi M	10 (5)	Yazdani-Chamzini A	Zavadskas EK	6 (9)
Thorngate W	Foddy M	10 (5)	Azadeh A	Asadzadeh SM	6 (9)
Thorngate W	Dawes RM	10 (5)	Jahanshahloo GR	Lotfi FH	6 (9)
Amirteimoori A	Kordrostami S	9 (6)	Hajiagha SHR	Hashemi SS	6 (9)
Jolai F	Tavakkoli-Moghaddam R	9 (6)	Fakhar M	Zafarani J	6 (9)
Azadeh A	Sheikhalishahi M	9 (6)	Chaharsoogh i SK	Heydari J	6 (9)
Behnamian J	Ghomi SMTF	8 (7)	Haghighi AM	Mishev DP	6 (9)
Ghodsypour SH	O'Brien C	8 (7)	Behnamian J	Zandieh M	6 (9)
Salahi M	Terlaky T	8 (7)	Nakhaie H	Zadeh AE	6 (9)
Mahdavi I	Solimanpur M	7 (8)	Mahdavi I	Mahdavi-Amiri N	6 (9)
Azadi M	Saen RF	7 (8)	Mousavi SM	Mojtahedi SMH	6 (9)
Korhonen PJ	Wallenius J	7 (8)	Miandoabchi E	Szeto WY	6 (9)
Javadian N	Tavakkoli-Moghaddam R	7 (8)	-	-	-

Figure 1 shows the interconnected co-authorship network. Fazlollahtabar H and Saidi-Mehrabad M are dominant by a large node and close distance due to the greatest number in their co-authorship frequencies amounted to 15.

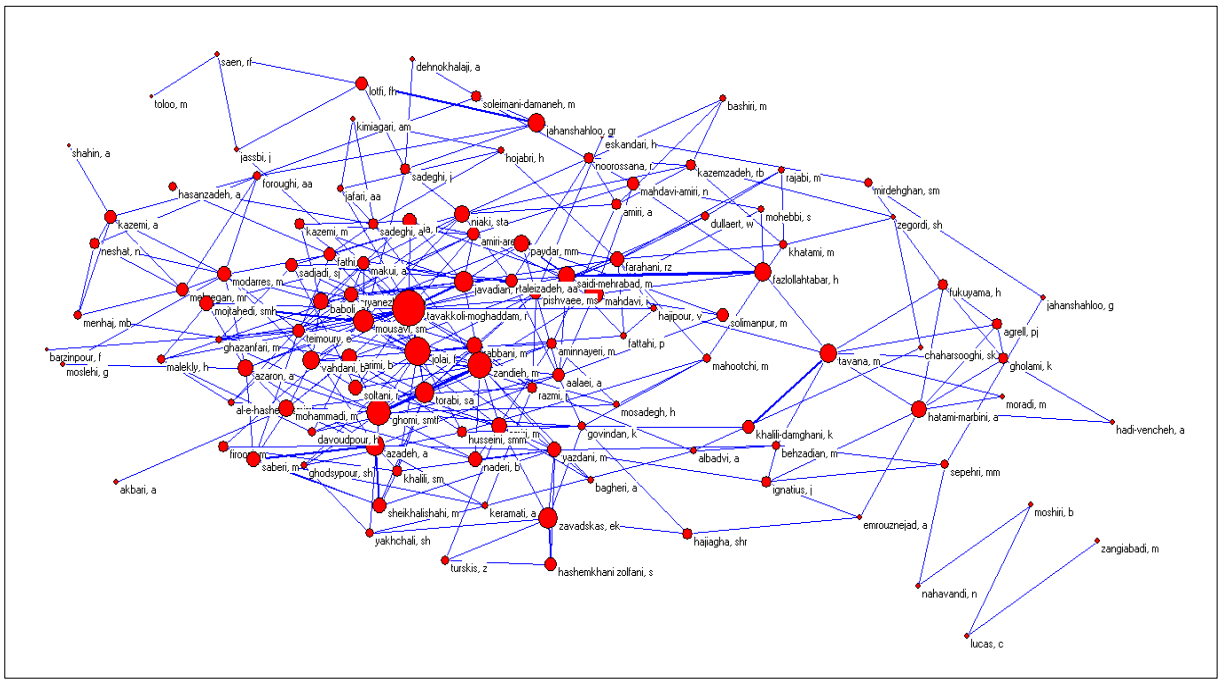

Figure 1: The Co-Authorship Network among Iranian Researchers Publishing Papers on Management during 1969-2018

As 80% of cooperation has been made since 2007, a time-based cooperation map was depicted for this period in Figure 2. Dark blue, light blue, green, yellow, and red colors show the co-authorship states in 2008, 2010, 2012, 2014, and 2016, respectively. It can be said that the rate of co-authorship was higher around 2012, considering the domination of green colors.

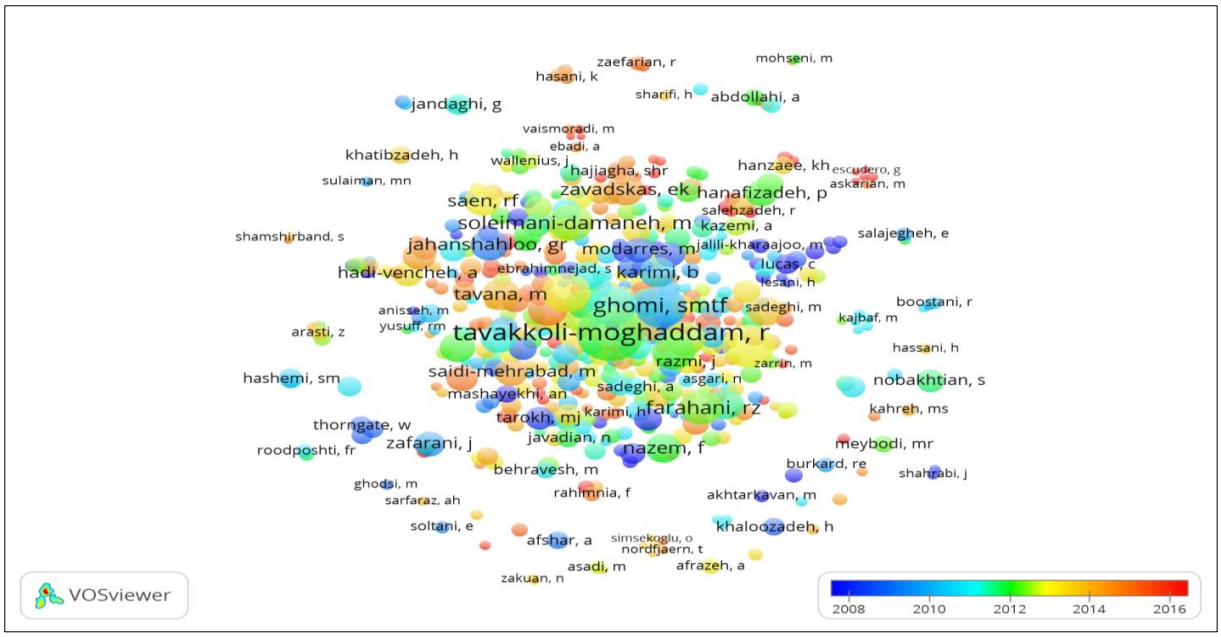

Figure 2: Time-Based Co-Authorship Networks of Iranian Researchers Publishing Papers on

Management during 1969-2018

Table 7 shows the highly-ranked co-authorship pairs of contributing research institutes/universities. As the table shows, the first rank belonged to Islamic Azad University and the University of Tehran with 76 co-authorship frequencies. Iran University of Science and Technology and the Sharif University of Technology ranked second with 41 co-authorship frequencies.

Table 7

Highly-Ranked Co-Authoring Pairs and Co-Authorship Frequencies of Iranian Research Institutes / Universities Publishing Papers on Management during 1969-2018

University 1	University 2	Frequency (Rank)
Univ Tehran	Islamic Azad Univ	76 (1)
Islamic Azad Univ	Iran Univ Sci & Technol	43 (2)
Sharif Univ Technol	Islamic Azad Univ	41 (3)
Univ Tehran	Iran Univ Sci & Technol	40 (4)
Islamic Azad Univ	Amirkabir Univ Technol	31 (5)
Univ Tehran	Amirkabir Univ Technol	31 (5)
Univ Tehran	Tarbiat Modares Univ	23 (6)
Univ Tehran	Sharif Univ Technol	22 (7)
Islamic Azad Univ	Allameh Tabatabai Univ	20 (8)
Univ Paderborn	La Salle Univ	18 (9)
La Salle Univ	Islamic Azad Univ	18 (9)
Univ Putra Malaysia	Islamic Azad Univ	18 (9)
Univ Tehran	Mazandaran Univ Sci & Technol	17 (10)
Sharif Univ Technol	Iran Univ Sci & Technol	15 (11)
Kharazmi Univ	Islamic Azad Univ	15 (11)
Univ Isfahan	Islamic Azad Univ	14 (12)
Vilnius Gediminas Tech Univ	Islamic Azad Univ	13 (13)
Mazandaran Univ Sci & Technol	Iran Univ Sci & Technol	13 (13)
Shahid Beheshti Univ	Islamic Azad Univ	13 (13)
Univ Tehran	Inst Res Fundamental Sci IPM	13 (13)
Univ Tehran	KN Toosi Univ Technol	13 (13)
Islamic Azad Univ	Ferdowsi Univ Mashhad	13 (13)
Univ Tehran	Amir Kabir Univ Technol	12 (14)
Iran Univ Sci & Technol	Amirkabir Univ Technol	12 (14)
Tarbiat Modares Univ	Islamic Azad Univ	12 (14)
Univ Isfahan	Sheikhbahaee Univ	12 14)
Univ Malaya	Islamic Azad Univ	12 (14)
Shahid Beheshti Univ	Amirkabir Univ Technol	11 (15)
Semnan Univ	Ferdowsi Univ Mashhad	11 (15)
Sharif Univ Technol	Amirkabir Univ Technol	11 (15)
Tarbiat Modares Univ	Iran Univ Sci & Technol	11 (15)
Tehrans Shahid Beheshti Univ	La Trobe Univ	10 (16)

University 1	University 2	Frequency (Rank)
La Trobe Univ	Carnegie Mellon Univ	10 (16)
Tehrans Shahid Beheshti Univ	Carleton Univ	10 (16)
Tehrans Shahid Beheshti Univ	Carnegie Mellon Univ	10 (16)
Opera Lyra Ottawa	Carnegie Mellon Univ	10 (16)
Mazandaran Univ Sci & Technol	Islamic Azad Univ	10 (16)
KN Toosi Univ Technol	Islamic Azad Univ	10 (16)
Semnan Univ	Inst Res Fundamental Sci IPM	10 (16)
Payame Noor Univ	Islamic Azad Univ	10 (16)

Figure 3 depicts the co-authorship network of research institutes/universities contributing to management. The highlighted node belonged to Islamic Azad University and the University of Tehran, with 76 connections.

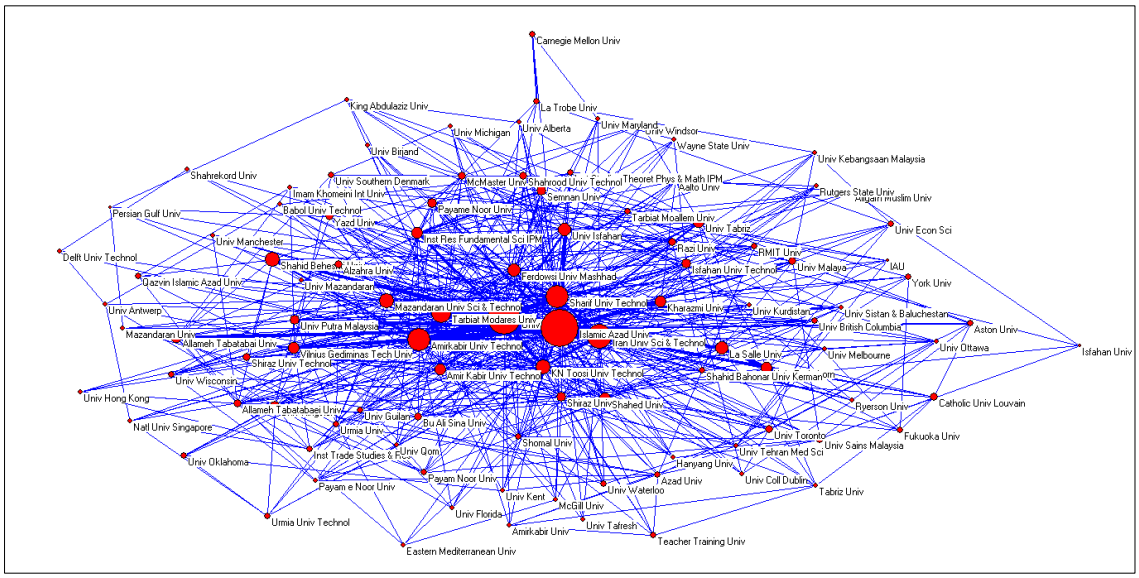

Figure 3: The Co-Authorship Network among Iranian Universities and Research Institutes Publishing Papers on Management during 1969-2018

Most collaboration has been done since 2008. Figure 4 depicts the time-based map of co-authorship network among contributing research institutes and universities. Most co-authorship frequencies were made in the green-colored area, i.e., from 2012 to 2014.

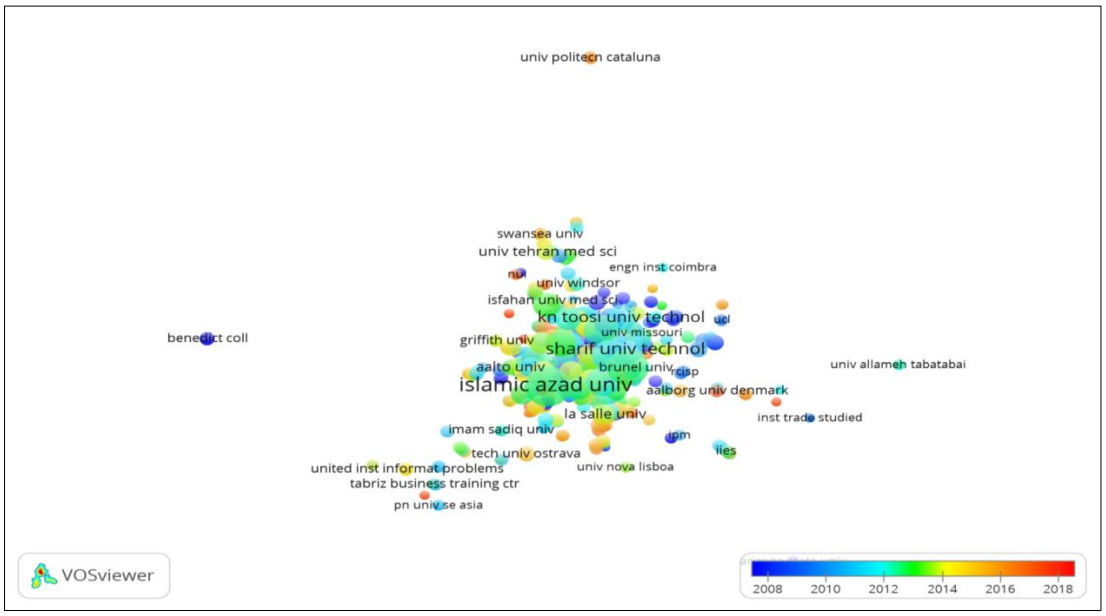

Figure 4: The Tine-Based Map of Iranian Co-Authoring Research Institutes and Universities Publishing Papers on Management during 1969-2018

They were clustered to understand better the co-authorship pattern of contributing universities and research institutes. As Figure 5 shows, these institutes were included in 14 clusters.

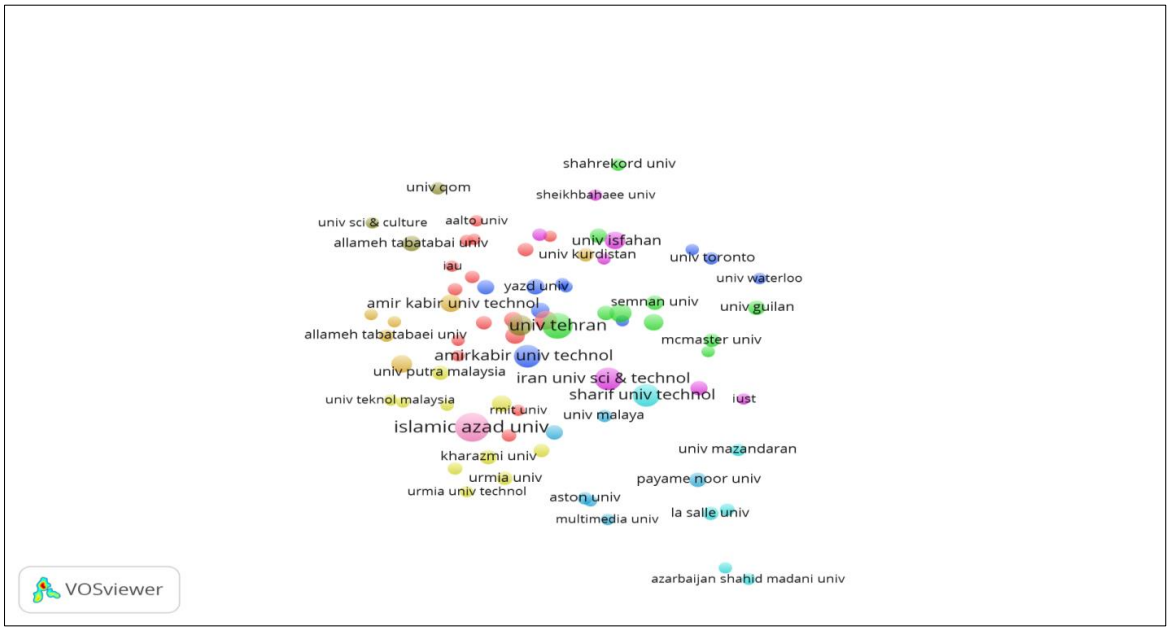

Figure 5: The Clustering Map of Iranian Co-Authoring Research Institutes / Universities Publishing Papers on Management during 1969-2018

The names of these institutes per cluster are included in Table 8. 13 universities were included in the first cluster. Ten institutes/universities were included in each of the 2nd and 3rd clusters.

Table 8

Names and Number of Co-Authoring Research Institutes / Universities in Each Cluster

Clusters	Institutes/ Universities	Frequencies
1	Amirkabir University of Technology; Azad University; Babol Noshirvani University of Technology; *Islamic Azad University*; K. N. Toosi University of Technology; Shahed University; Shahid Bahonar University of Kerman; *Shahrood University* of *Technology*; *Tarbiat Moallem University* of Tehran; *Shiraz University* of *Technology*; University of Sistan and Baluchestan; *University* of *Southern Denmark*; *Tehran University* of *Medical Sciences*	13
2	*Ferdowsi University* of *Mashhad; Institute* for Research in *Fundamental* Sciences*;* Isfahan University of technology*; McMaster University; Razi University; Semnan University; University of Shahrekord; University* of *Birjand; University of Guilan; University of Tehran.*	10
3	Amirkabir University of Technology; *Mazandaran University*; Persian Gulf University; Shiraz University; Shomal University; Shahid Bahonar University of Kerman; University of Toronto; University of Waterloo; *Vilnius Gediminas Technical University*; Yazd University	10
4	Urmia University of Technology; Kharazmi University; *Mazandaran University* of *Science and Technology*; Payame Noor University; *Kingston University*; Universiti Putra Malaysia; Universiti Teknologi Malaysia; Urmia University; Alzahra University	9
5	Imam Khomeini International University; *Iran University* of *Science* and *Technology*; *Sheikhbahaee University*; University of Isfahan; *University* of *Tabriz; University* of *Zanjan*	6
6	Azarbaijan Shahid Madani University; Catholic University of Leuven; La Salle University; Sharif University of Technology; *University* of *Mazandaran*; University of Paderborn	6
7	Aston University; Bu-Ali Sina University; Multimedia University; Payame Noor University; University of Malaya; *Universiti Sains Malaysia*	6
8	Allameh Tabataba'i University; *Amirkabir University* of *Technology*; Qazvin Islamic Azad University; Shahid Beheshti University; *University* of *Kurdistan*	5
9	Allameh Tabataba'i University; Tarbiat Modares University; University of Qom; University of Science and Culture	4
10	Islamic Azad University; Sahand University of Technology; Technical University of Ostrava	2
11	Carnegie Mellon University; La Trobe University	2
12	University of Tehran	1

Figure 6 depicts the network map of co-authoring countries/regions. Table 9 shows the country ranks and the number of collaborated items. The first to third ranks belonged to the USA (with 325), Canada (with 200), and England (with 153).

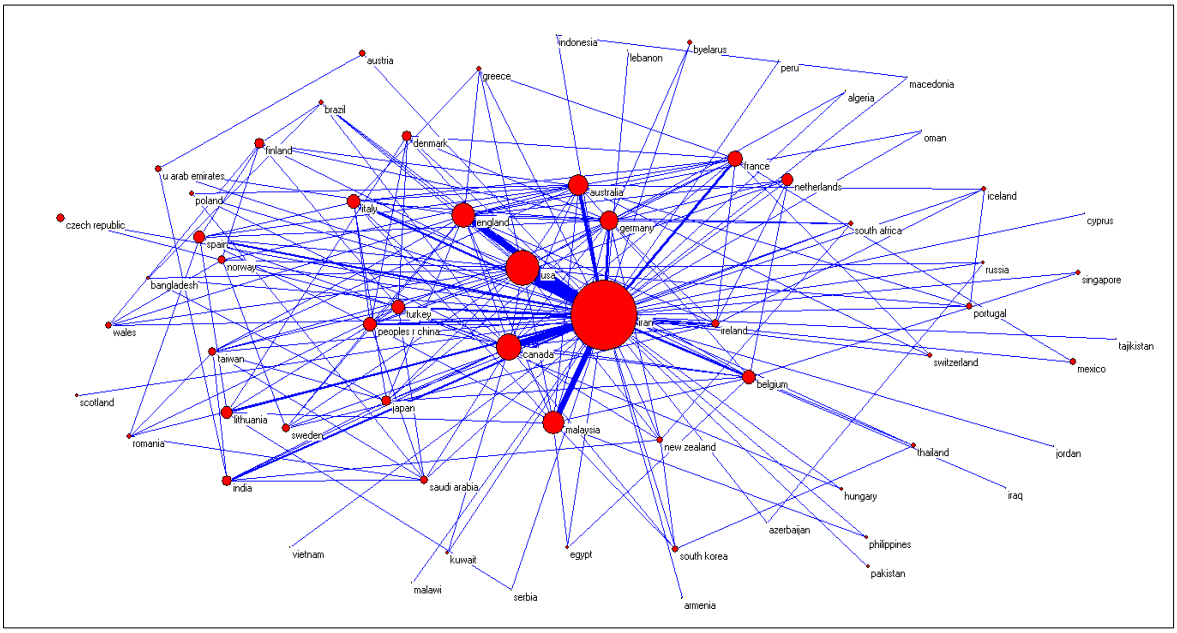

Figure 6: The Network Map of Countries/Regions Coauthoring With Iran in Publishing Papers on Management during 1969-2018

Table 9

The Ranks of Top 20 Countries / Regions Co-Authoring With Iran in Publishing Papers on Management during 1969-2018

Country / Region	Frequency	Rank
USA	325	1
Canada	200	2
England	153	3
Malaysia	133	4
Australia	117	5
France	76	6
Germany	70	7
Turkey	53	8
People's Republic of China	51	9
Italy	49	10
India	41	11
Denmark	39	12
Spain	39	13
Belgium	35	14
Netherlands	33	15
Lithuania	31	16
Finland	30	17
Czech Republic	24	18
Japan	24	20

Keyword clustering was used for determining the subject clusters and hot topics considered by Iranian researchers in their co-authorship activities in the field of management. After identifying 200 highly-frequent keywords, the six main keyword clusters were extracted in

Figure 7.

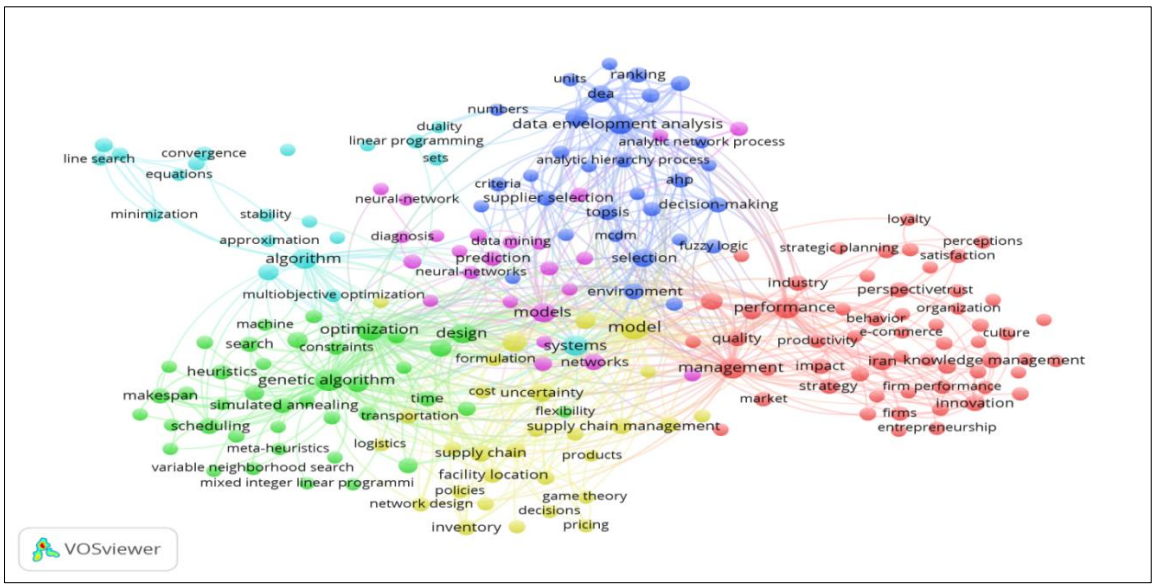

Figure 7: Keyword Clusters of Papers on Management Published By Iranians during 1969-2018

Table 10 shows the keywords included in each of these six clusters. As can be seen, the first cluster mainly focused on the keywords on performance management ranging from organizational culture to information technology. Main topics in the field can be found in these clusters.

Table 10
Keywords Included In Keyword Clustering Of Publications per Cluster

Clusters	Keywords	Color	Number of Keywords
First	work; balanced scorecard; behavior; business; commitment; competitive advantage; culture; customer satisfaction; decision making; determinants; e-commerce; education; entrepreneurship; firm; firm performance; firms; framework; growth; impact; implementation; industry; information; information technology; innovation; intellectual capital; internet; Iran; knowledge; knowledge management; loyalty; management; market; organization; organizational culture; organizational learning; organizational; performance; organizations; orientation; perceptions; performance; perspective; product; product development; productivity; quality; satisfaction; service; service quality; social capital; statistical process control; strategic planning; strategy; success; technology; transformational leadership; trust; antecedents	Red	59
Second	variable neighborhood search; ant colony optimization; complexity; constraints; costs; dependent setup times; design; flexibility; genetic algorithm; genetic algorithms; heuristics; imperialist competitive algorithm; machine; makespan; manufacturing systems; met heuristics; minimize; mixed-	green	40

Clusters	Keywords	Color	Number of Keywords
	integer linear programming; multi-objective optimization; NSGA-II; optimization; parallel machines; particle swarm optimization; preventive maintenance; project scheduling; reliability; reliability optimization; scheduling; scheduling problem; search; setup times; simulated annealing; simulation; single machine; tabu search; Taguchi method; tardiness; time; times; allocation		
Third	Ahp; vendor selection; analytic network process; chain; construction; criteria; data envelopment analysis; data envelopment analysis; decision; decision making; units; efficiency; environment; fuzzy logic; fuzzy sets; goal programming; group decision making; imprecise data; mcdm; methodology; multiple criteria; numbers; performance evaluation; programming approach; ranking; selection; supplier selection; TOPSIS; units; analytic hierarchy process	Blue	32
Fourth	Uncertainty; coordination; cost; decisions; demand; facility location; formulation; game theory; generation; inventory; inventory control; location; logistics; model; network design; policies; policy; price; pricing; products; risk management; robust optimization; strategies; supply chain; supply chain management; system; transportation; capacity	Yellow	28
Fifth	Time series; technical efficiency; scale; returns; regression; project management; prediction; parameters; neural networks; neural network; networks; network; models; integration; identification; forecasting; diagnosis; decomposition; data mining; classification; artificial neural network; adaptive network-based fuzzy inference system (ANFIS)	Purple	22
Sixth	Algorithm; algorithms; approximation; convergence; duality; equations; existence; global convergence; global optimization; line search; linear optimization; linear programming; minimization; multi objective optimization; optimal control; sensitivity analysis; sets; stability; systems; unconstrained optimization	Turquoise blue	20

Discussion

This study aimed at investigating the co-authorship network of the scientific output made by Iranian researchers in the field of management in WoS during the recent half-century (years, 1969-2018). This is the first study that evaluated the international collaboration of Iranians in the field in this broad period. As scientific research has been developed in Iran in various scientific fields (Banerjee, 2017), scientific collaboration has been more popular and interesting. Iranian researchers increasingly published in management, especially during the last decade. Their publication increased from 2 papers in 1973 to 721 items in the year 2018. This is a sign of the development of their contribution and collaboration worldwide.

Iranian researchers in management published in various journals that some top ones are prestigious journals in the field (such as the *Expert Systems with Applications*) and

internationally scoped (such as the *International Journal of Production Research*). This can signify their scientific influence throughout the World as internationally-scoped journals (Annalingam, Damayanthi, Jayawardena & Ranasinghe, 2014) and prestigious ones (Tahamtan, Afshar & Ahamdzadeh, 2016) receive more citations. The top 20 highly-productive universities produced over 90% of all papers, and it shows the low contribution of other universities, especially one placed in cities other than the Capital city, Tehran. Most highly-productive universities are located and centralized in Tehran, and the contribution made by another university countrywide is low and needs to be encouraged.

It can be said that the connections among authors are not satisfactory and limited to some known authors Considering the highly-ranked co-authoring pairs and co-authorship frequencies of Iranian researchers in the field. It is needed that these authors' degree, closeness, and betweenness centrality indicators be studied in further studies. In line with this study, Nikzad, Jamali & Hariri (2011) showed that management had the densest co-authorship network among Iranian authors active in social sciences during 2000–2009. The time-based cooperation map showed that the cooperation of authors was high around 2012. It is likely due to the relative increase of contributions and paper counts in these years. This is the case in the time-based co-authorship map among contributing universities and research institutes around 2012-2014.

Two points should be noted regarding co-authoring research institutes and universities in the field. First, most collaborating institutes and universities are placed in Tehran, and other institutes countrywide made low or no contribution. Second, few universities from other countries, especially European / American countries, are included (e.g., Vilnius Gediminas Technical University (VGTU) or La Salle University). It is needed that countrywide institutional cooperation and internationally-scoped one are considered in collaborative research on the field. Apart from Iran's co-authorship with the USA and some European countries, Asian and African countries, including its neighbors, are low and need to be emphasized. Hayati and Didegah (2010) found that Iran's main partners were the USA, Canada, and the UK during 1998-2007. European researchers were the main counterparts of Iranian researchers. In addition, Iranian researchers had mostly co-published with their colleagues in developed countries. Osareh, Khademi, Rostami and Serati Shirazi (2014) showed that most Iranian researchers' scientific collaboration was with the USA during 1991-2013.

Keyword clustering of papers co-authored by Iranian researchers in the field of management showed that authors considered a vast variety of topics in management, ranging from performance management to work evaluation and optimization. These topics included all subjects and subfields in management (Hopp, 2004). There are some field-related differences in co-authorship network and productivity rate (Parish, Boyack & Ioannidis, 2018) that can be seen in our results either. However, some deficiencies can be discovered in this regard that results in gaps in making more collaboration: low grants, the lack of governmental support, few research institutes, focus on productivity rather than influence, economic and historical ups and downs, language barriers, ignoring internationality in receiving more citations, low collaboration with neighbor countries, weak scientific diplomacy among poor and rich countries.

Co-authorship positively affected research on Iran's management field. Iranian researchers in this field should know that their international collaboration will enhance their scientific output, scientific prestige, and citation counts more than ever (Glänzel, 2001). Policy-makers should encourage researchers to make co-authored contributions and direct research to a

collaborative trend. Further studies need to be conducted for studying the scientific influence of contributions made by Iranians in the field by applying citation analysis techniques.

Conclusion

Despite a growing trend in Iranian researchers' contribution in the International management field, it is needed that some decentralization is made in contributing authors and research institutes. Regional contribution is needed for detecting and solving different domestic managerial issues. Newly-emerged topics relating to the country-wide problems need to be deeply investigated and published. As evaluative research, this study can provide useful information for those tasked with making decisions on and improving the performance of research on the management field as well as being a guide for researchers and authors interesting in the topic to identify hot topics, heavily-regarded subjects, authors with common interests and so on. Further studies need to be conducted to study the scientific influence of contributions made by Iranians in the field by applying citation analysis techniques and other indexing databases.

Funding

The study was funded by Vice-chancellor for Research and Technology, Hamadan University of Medical Sciences (No. 9802241569).

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