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Original Research

Middle East Countries' Contribution to Global Engineering Research: A Bibliometric Analysis

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Abstract

This study aims to examine the research output in engineering by the Middle East countries. The data on engineering research by Middle East countries were collected from Web of Science. Collected data were analyzed with various tools such as Average Annual Growth Rate (AAGR), Compound Annual Growth Rate (CAGR), Activity Index (AI), and Relative Specialization Index (RSI). The level of regional and international cooperation in the Middle East countries was also identified. Findings showed Iran has the highest overall performance in total documents, total citations, h-index, and highly cited papers, but most of the publications by Yemen were international cooperation. Iran, Kuwait, Oman, Saudi Arabia, UAE, and Yemen in the field of petroleum engineering; Bahrain and Qatar in industrial engineering; Turkey in geological engineering; Syria in agricultural engineering; Lebanon in medical engineering; Israel in cell & tissue engineering; Iraq in civil engineering; Egypt in Chemical Engineering; and Jordan in Software Engineering have the highest RSI in their countries. Results show that Iran had the best performance in most of the indicators (quantitative indices) and Saudi Arabia has good performance in qualitative indices among Middle East countries.

Keywords: Scientometrics, Research Output, Engineering, Middle East Countries

Introduction

The Middle East accounts for 5% of the world's population, while it produces only 1.5% of the world's scientific productions (Habibzadeh, 2014). Science and technology enhance the ability of nations and communities to acquire and transform the resources necessary for development. On the other hand, lack of access to scientific knowledge and technology not only impedes the country's development, but also endangers its national security (Stivachtis, 2019). The economic hurdles in the Middle East have created a challenge for regional research, high-level cooperation, and communication with the world's top institutions (Kent, 2019). The term *engineering* is derived from the Latin word *ingenium* means "cleverness" and *ingeniare* means "to contrive, devise" (International Association of Engineers, 2014). According to the Cambridge Dictionary, Engineering is the application of scientific principles to the design and construction of machinery, structures, and others such as bridges, tunnels, roads, vehicles, and buildings. American Engineers' Council for Professional Development (1947) also defines engineering as the creative application of scientific principles for the design or development of structures, machines, devices, or production processes, or works used separately or in combination.

An overview of the scientific status of any science field can always be obtained by studying past and present documents in that field. Documents and research with the scientometric approach, bibliometric analysis, and content analysis provide this overview to researchers, scientists, and science policymakers. Also, this kind of research is an appropriate measurement scale of researchers, organizations, and countries' status and activities in scholarly societies (Fazeli varzaneh, Ghorbi, Ghaderi Azad, Fahimifar & Bahmani, 2020). The scientometric tools are used to monitor the growth of research in various subject areas (Sweileh, Huijer, Al-Jabi, Sa'ed & Sawalha, 2019; Sa'ed, Al-Jabi, Sweileh, Awang & Waring, 2015a; Sa'ed et al. 2015b). The publication count of research productivity is meaningful when analyzed and compared with different bibliometric indices. These indicators have a scientific basis background, and measured and compared countries' research performance (Maurya, Shukla & Ngurtinkhuma, 2018). The documents published by a country in a particular subject area can serve as an indicator of its credibility and contribution to the production of that subject area (Stackelberg, Furlong, Meyer, Zaugg, Henderson & Reissman, 2004). Differences in research orientations, capacities, and patterns of cooperation between countries and institutions can be illustrated by comparing bibliometric characteristics (Ellegaard & Wallin, 2015). In addition, universities and academic institutions do things like promotion, recruitment, budgeting, etc. based on scientific analysis (Akl et al., 2012; Kairouz, Raad, Fudyma, Curtis, Schünemann & Akl, 2014).

With the growth of science and the branching of fields of science, specialization also becomes more important. Specialized tendencies in academic disciplines and highly specialized research approaches point to a growing trend in the branches of science. On the other hand, the development of specialized tendencies in a country reflects the efforts of science policymakers to develop science. In other words, specialization is an indicator of the scientific progress in each country. The field of engineering is regarded as one of the most important areas in the development of any society. Numerous studies have been done in this subject, including but not limited to analysis of scholarly publications (Cañas-Guerrero, Mazarrón, Pou-Merina, Calleja-Perucho & Suárez-Tejero, 2013), bibliometric analysis of engineering research among different countries (Elango, 2019a; Abuelma'atti, 2013) and the study of international cooperation (Tirgar, Sajjadi & Aghalari, 2019; Dhawan, Gupta, Singh & Rani, 2017). But there is no sufficient research in engineering of Middle Eastern countries. Measuring the Relative Specialization Index (RSI) of engineering subfields in the Middle Eastern countries can help us find the most active countries in these subfields. Specialized ranking can help science policymakers identify their strengths and weaknesses in engineering subfields, and make better choices in allocating funds to their universities and researchers. Therefore, this study will attempt to examine subject areas and research priorities of Middle Eastern countries in a comparative manner.

Literature Review

Only few studies have been conducted on scientific productivity in the field of engineering and its subfields. For example, Elango (2019a) studied and compared the scholarly publication in the field of engineering among the BRIC countries. Tirgar et al. (2019) analyzed the level of international collaboration in Iranian scientific articles on environmental health engineering. Dhawan et al. (2017) analyzed the number of documents, number of citations, citations per document, activity index, etc. in the Metamaterials research indexed in Scopus during 2007-2016. Elango, Rajendran & Bornmann (2013) examined global nanotribology research output during 1996-2010. Cañas-Guerrero et al. (2013) analyzed the scientific productivity of the civil engineering field during 1997-2011 that are indexed in the WOS database. Franceschini & Maisano (2011) studied the journals in the field of manufacturing engineering with a bibliometrics approach and analyzed impact factor, h-index, and the number of citations.

Even though the Middle Eastern countries are having more than 1.5% of world scientific output, the scientific productivity behavior of this group of countries is seldom studied. For example, Fazeli Varzaneh, Bahmani & Ghaderi Azad (2018) examined the energy and fuel scientific productions of Middle East countries from 1998-2017, result showed that the UAE, Iraq, Kuwait, Qatar, and Oman had the most specialization in this field, respectively. Siddiqi, Stoppani, Anadon & Narayanamurti (2016) studied the products of the Middle East and North Africa between 1981-2013 and compared them result with some countries in the world. The results showed an increase in international cooperation in these countries publication, as well as attention to petroleum and chemical engineering field. Sweileh, Sa'ed, Al-Jabi & Sawalha (2015) examined the research activities of Arab countries and non-Arab Middle Eastern countries in the field of breast cancer. The data included original research and review articles that retrieved using the ISI Web of Science database. The research also identified the highest research productivity of countries, organizations, and journals. Abuelma'atti (2013) evaluated the research productivity and activity in the field of engineering in Arab countries and compared them to a selected number of other countries in the world. This research used the number of documents and the number of citations as bases for evaluation.

To our best knowledge, there has been no detailed study on engineering research output in Middle East countries.

Objectives

- To examine the number of documents, citations, and investigation of international cooperation in Middle Eastern countries in the field of engineering.
- To investigate the activity index and RSI of Middle Eastern countries in the field of engineering.
- To examine the average annual growth rate (AAGR) of engineering publications in Middle Eastern Countries.
- To investigate the RSI and the rank of Middle Eastern countries in different engineering subfields.

Materials and Methods

ISI Web of Science Core Collection (now called Clarivate Analytics) is used for collecting the data for the present study. These data include the scientific publication of Middle Eastern countries (Iran, Turkey, Saudi Arabia, Egypt, Israel, UAE, Qatar, Iraq, Jordan, Lebanon, Kuwait, Oman, Bahrain, Yemen, Syria), during 2009-2018. The search strategy for engineering (general) field for each country:

CU=(Country name) AND SU=(Metallurgy & Metallurgical Engineering OR Engineering) AND PY=(2009-2018)

The search strategy for engineering sub-fields for each country:

CU=(Country name) AND WC=(sub-Engineering name) AND PY=(2009-2018)

Further, the following indicators and tools have been used.

The average annual growth rate (AAGR) is the average change in the value of measurement over the period of a year. The following formula was used to calculate AAGR:

$$AAGR = \frac{GR_A + GR_B + \cdots + GR_n}{N}$$

GR_A = Growth rate in period A
GR_B = Growth rate in period B
GR_n = Growth rate in period n
N = Number of years

The compound annual growth rate (CAGR) provides a constant rate of return over the time period. Its formula is as follows (Elango 2019b):

$$CAGR = \left(\frac{Ending\ Value}{Beginning\ Value}\right)^{\frac{1}{n-1}} - 1$$

n = Number of years and calculated value is multiplied with 100 for interpreting in the percentage.

AI is calculated as follows:

$$AI = \frac{n_{ij}/n_{i.}}{n_{.j}/n_{..}} = \frac{n_{ij}n_{..}}{n_{i.}n_{.j}}$$

n_{ij}: Number of documents by country j in the field i.
$n_{i.}$: Number of documents by all the countries in the field i.
$n_{.j}$: Total documents of country j.
$n_{..}$: Total documents of all the countries.

The following formula is used to calculate Relative Specialization Index (RSI):

$$RSI = \frac{AI - 1}{AI + 1}$$

RSI always contains a value between -1 to 1. A value close to 1 indicates more specialization in the field, and a value close to -1 indicates less specialization in that field. If it is greater than zero, it means the country was more active than the global average in that field, and vice versa (Glänzel, 2000; Aksnes, van Leeuwen & Sivertsen, 2014). The RSI has been calculated using Excel software. This software was also used to draw figures. To generate a collaboration network among the Middle East countries, UCINET (Borgatti, Everett & Freeman, 2002) is used. To visualize the collaboration network, the following steps were taken (Elango et al. 2013). Step 1 – A co-occurrence matrix was developed using the number of publications collaborated on by the countries with each other country among the Middle East in Excel matrix editor.

Step 2 – Collaboration map was visualized with Netdraw.

Results

Table 1 provides the general overview of important indicators of Middle Eastern countries' performance. Iran ranks first in terms of publications (TP) while Iraq ranks first in terms of CAGR. Similarly, Syria was the least country in terms of publications while Israel was the least country in terms of CAGR. Non-Arab countries (Iran, Turkey, & Israel) rank high in total publication, but these countries do not have good rank in CAGR, and the first ranks in this index belong to Arab countries (Iraq, Qatar, & Saudi Arabia are ranked first to third in the CAGR.

Table 1

Publication and growth of Middle East countries

Country	TP (2009-2018)	Rank (TP)	CAGR	Rank (CAGR)
Iran	89629	1	8.80	9
Turkey	54696	2	4.72	13
Saudi Arabia	22895	3	21.75	3
Egypt	21806	4	10.66	6
Israel	17477	5	-0.49	15
UAE	9479	6	13.02	5
Qatar	5190	7	22.52	2
Iraq	4478	8	40.13	1
Jordan	4048	9	8.91	8
Lebanon	3740	10	13.89	4
Kuwait	2169	11	2.99	14
Oman	1948	12	7.55	10
Bahrain	485	13	7.25	11
Yemen	300	14	9.20	7
Syria	261	15	5.96	12

According to figure 1, Iran has the highest h-index (154) in the field of engineering (general). Saudi Arabia has the highest CPP (10.2). The lowest h-index is belonged to Yemen (21) and the lowest CPP belongs to Iraq (4.6). While, as Figure 1 show, Iran ranks first and Yemen ranks lowest in h-Index. Therefore, high cooperation in research will not necessarily indicate the high impact of research and higher h-index.

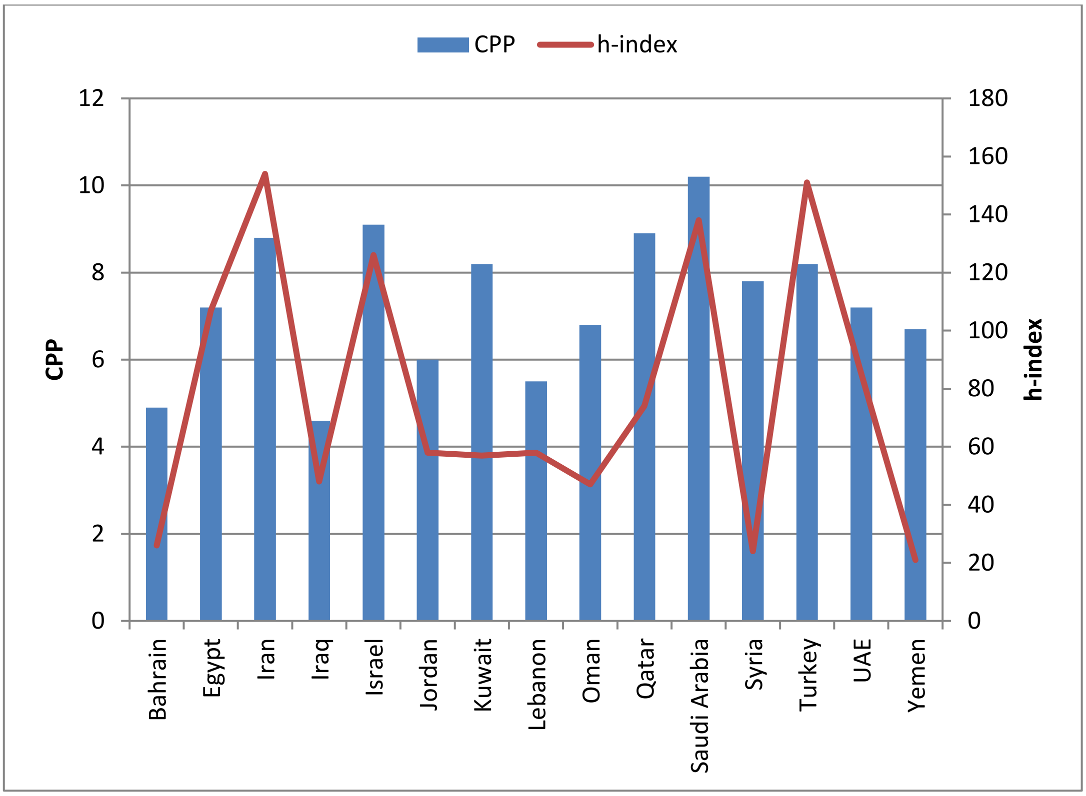

Figure 1. Citations per publication (CPP) and h-index

Figure 2 provides the share of international collaborative papers of Middle East countries. Among the Middle East countries, Yemen has the highest percentage of international cooperation (89.3%) and Iran has the lowest international cooperation (21.7%). Four countries (Iran, Turkey, Egypt and Israel) having below 50% of internationally collaborative papers while other countries having more than 50%.

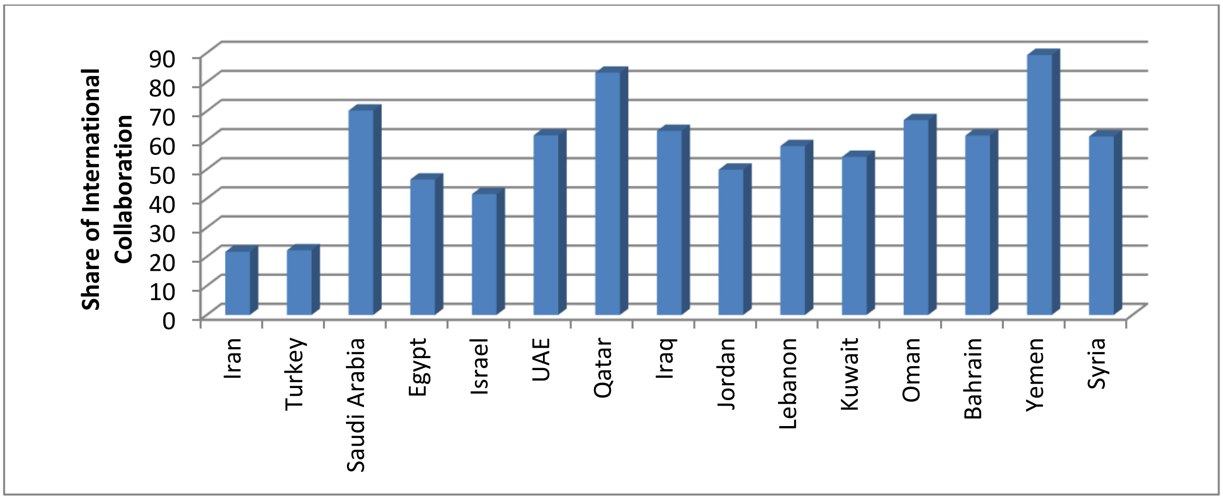

Figure 2. International Collaboration

Scientific collaboration is one of the approaches that has become commonplace in the scientific community for many years (Didgah & Erfanmanesh, 2009). Researchers share their ideas in scientific collaborations, and influence the quality of collaborative production. As such, they utilize both the specialized skills and the achievements of each other in teamwork, which leads to a quantitative and qualitative expansion of research outputs (De Stefano, Fuccella, Vitale & Zaccarin 2013). Figure 3 shows the cooperation of the Middle East countries with other countries. Turkey, Iraq, Bahrain, and Syria have had the most cooperation with England and Iran, UAE and Kuwait have had the most cooperation with Canada. Egypt and Lebanon have had the most cooperation with the United States, also Jordan and Yemen have had the most cooperation with Saudi Arabia. Saudi Arabia also has the most cooperation with Egypt.

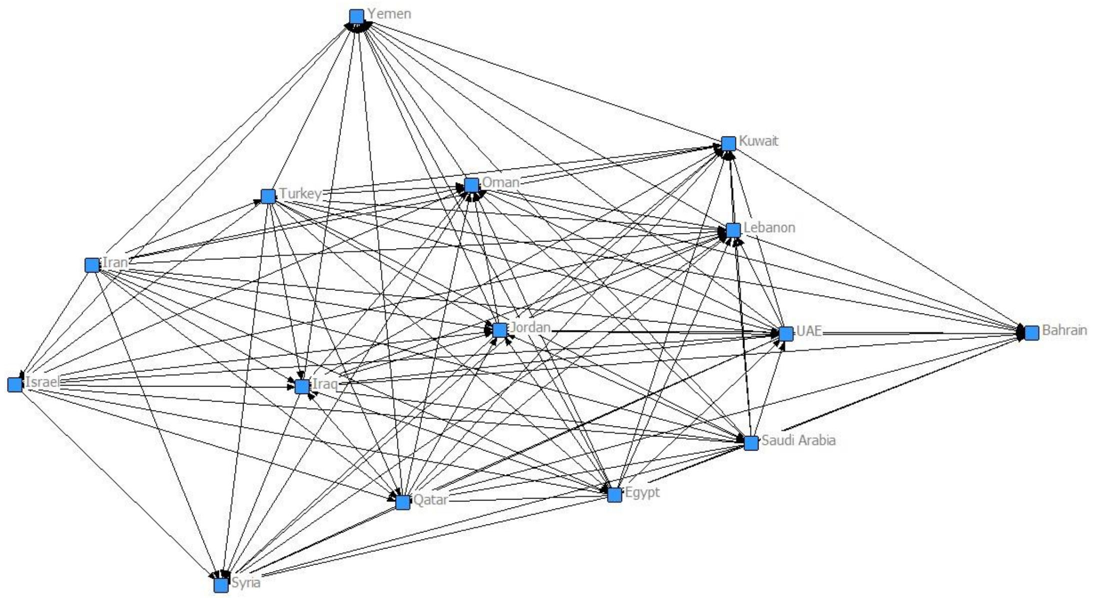

Figure 3. *Collaboration network among Middle East countries with other countries*

Analysis shows that UAE has the best performance in AI (1.959) and RSI (0.324), and Syria has the lowest performance in AI (0.483) and RSI (-0.348) in the Middle East. In terms of RSI, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, and the UAE have positive performances whereas Bahrain, Israel, Syria, Turkey, and Yemen have negative performances (Table. 2).

Table 2
Activity Index and RSI

Country name	AI	RSI
UAE	1.96	0.324
Iraq	1.83	0.293
Iran	1.72	0.264
Qatar	1.72	0.264
Jordan	1.38	0.158
Oman	1.35	0.148
Kuwait	1.32	0.137
Lebanon	1.29	0.127
Saudi Arabia	1.20	0.092

Country name	AI	RSI
Egypt	1.19	0.087
Bahrain	0.99	-0.005
Turkey	0.96	-0.021
Yemen	0.76	-0.139
Israel	0.61	-0.239
Syria	0.48	-0.348

According to Fig. 5, Bahrain, Syria, and Iraq have the highest annual growth rate of activity index, respectively. Israel, Qatar, and Oman have the lowest annual growth rate of activity index in the Middle East countries, respectively.

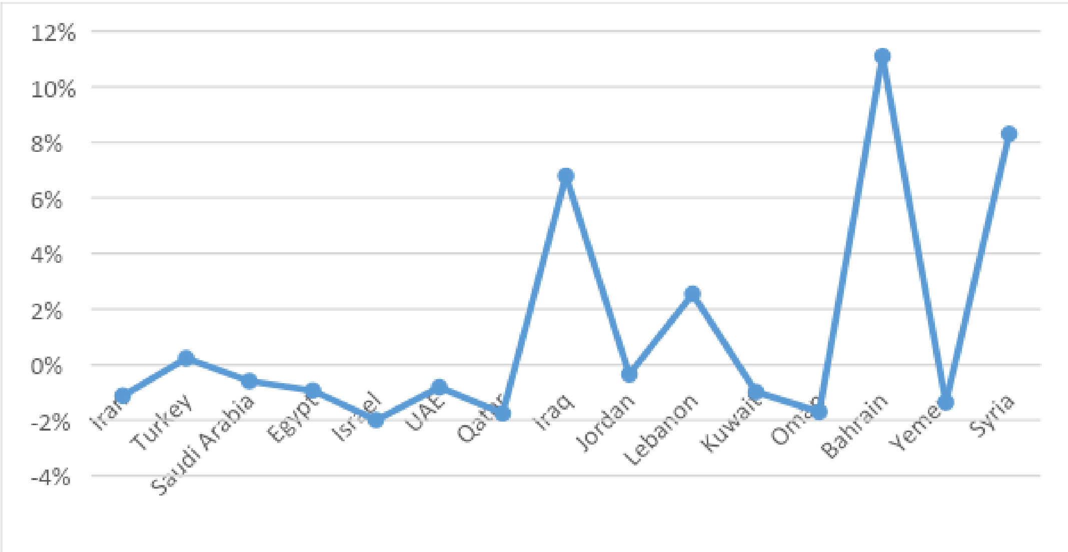

Figure 5. *The average annual growth rate of the activity index*

According to table 3, Iran, Kuwait, Oman, Saudi Arabia, UAE, and Yemen in the field of petroleum engineering; Bahrain and Qatar in industrial engineering; Turkey in geological engineering; Syria in agricultural engineering; Lebanon in medical engineering; Israel in cell & tissue engineering; Iraq in civil engineering; Egypt in Chemical Engineering; and Jordan in Software Engineering have the best performance in their countries. Also, findings indicate that Bahrain, Iran, Iraq, Kuwait, Oman, Syria, and the United Arab Emirates have the weakest performance in cell & tissue engineering; and the weakest performance of other countries include Jordan in marine engineering and ocean engineering; Egypt in manufacturing engineering; Israel in petroleum engineering; Lebanon in metallurgy & metallurgical engineering; Qatar in aerospace engineering; Saudi Arabia in ocean engineering; Turkey in petroleum engineering and Yemen in aerospace engineering, ocean engineering, and marine engineering.

Table 3
RSI and ranking of Middle East country in sub-fields of engineering

		Aerospace Engineering	Agricultural Engineering	Biomedical Engineering	Cell & Tissue Engineering	Chemical Engineering	Civil Engineering	Computer Science, Software Engineering	Electrical & Electronic Engineering	Environmental Engineering	Geological Engineering	Industrial Engineering	Manufacturing Engineering	Marine Engineering	Mechanical Engineering	Metallurgy & Metallurgical Engineering	Multidisciplinary Engineering	Ocean Engineering	Petroleum Engineering
IR	Rank/ Country	15	10	14	18	2	4	17	12	8	3	11	9	13	5	7	6	16	1
	Rank/ME	1	4	2	5	1	2	11	6	5	2	6	2	1	1	1	2	2	5
	RSI	.10	.16	.11	-.24	.48	.43	-.16	.13	.22	.44	.14	.17	.13	.31	.30	.30	.10	.53
TR	Rank/ Country	13	5	7	17	3	2	16	12	4	1	11	15	10	14	8	6	9	18
	Rank/ME	4	6	6	6	10	9	13	12	11	3	9	5	4	11	6	9	5	12
	RSI	-.11	.07	.06	-.38	.11	.13	-.20	-.08	.07	.23	-.08	-.15	-.06	-.13	.05	.06	-.06	-.39
SA	Rank/ Country	16	10	12	9	2	11	5	6	14	3	13	15	17	7	8	4	18	1
	Rank/ME	7	8	9	2	7	13	5	8	8	12	11	7	7	8	4	5	11	7
	RSI	-.26	-.06	-.08	-.06	.35	-.07	.10	.08	.14	-.16	-.08	-.17	-.46	.04	.02	.12	.-50	.40
EG	Rank/ Country	17	6	13	12	1	2	15	7	5	10	16	18	9	11	4	8	14	3
	Rank/ME	5	5	10	3	8	8	12	7	10	6	13	11	2	10	3	6	7	9
	RSI	-.24	.09	-.11	-.06	.23	.18	-.18	.09	.10	.05	-.20	-.34	.08	-.05	.13	.09	-.14	.18
IL	Rank/ Country	3	7	4	1	10	9	2	5	8	12	6	13	16	11	15	14	17	18
	Rank/ME	3	11	7	1	15	15	4	13	15	15	12	12	12	12	13	15	13	15
	RSI	-.01	-.18	-.06	.17	-.41	-.39	.16	-.15	-.31	-.45	-.16	-.48	-.61	-.42	-.51	-.49	-.71	-.80
AE	Rank/ Country	14	17	12	18	3	5	7	4	9	8	2	11	13	6	16	10	15	1
	Rank/ME	2	12	3	8	5	3	2	1	6	4	3	3	3	2	8	4	4	3
	RSI	.03	-.31	.09	-.45	.40	.37	.27	.38	.20	.22	.42	.10	.05	.30	-.14	.13	-.01	.64
QA	Rank/ Country	18	17	8	15	2	6	7	4	5	12	1	13	16	9	14	10	11	3
	Rank/ME	11	13	4	4	3	10	6	2	3	9	2	4	6	6	7	12	3	8
	RSI	-.55	-.44	.08	-.18	.42	.11	.09	.36	.25	-.06	.44	-.07	-.22	.05	-.12	.01	.00	.38
IQ	Rank/ Country	15	7	10	18	6	1	11	9	2	3	12	14	17	8	13	4	16	5
	Rank/ME	6	3	5	11	6	1	9	5	1	1	10	8	9	3	9	1	10	6
	RSI	-.26	.25	.05	-.60	.37	.62	-.07	.19	.50	.47	-.08	-.19	-.50	.23	-.15	.44	-.48	.42
JO	Rank/ Country	15	8	11	16	5	2	1	4	3	10	6	12	18	7	13	9	17	14
	Rank/ME	10	7	8	10	9	4	1	4	4	8	8	6	14	7	10	10	15	11
	RSI	-.52	.04	-.06	-.54	.21	.27	.34	.21	.22	-.04	.09	-.15	-1	.05	-.26	.04	-1	-.26
LB	Rank/ Country	16	11	14	14	12	3	7	2	6	4	5	13	15	8	18	10	17	9
	Rank/ME	12	10	1	7	14	5	7	3	9	5	7	10	8	9	15	13	12	10
	RSI	-.56	-.18	.34	-.41	-.21	.23	.05	.25	.10	.18	.12	-.30	-.50	-.04	-.61	-.13	-.60	-.10
KW	Rank/ Country	14	17	15	18	2	4	7	9	8	16	3	12	11	5	13	10	6	1

		Aerospace Engineering	Agricultural Engineering	Biomedical Engineering	Cell & Tissue Engineering	Chemical Engineering	Civil Engineering	Computer Science, Software Engineering	Electrical & Electronic Engineering	Environmental Engineering	Geological Engineering	Industrial Engineering	Manufacturing Engineering	Marine Engineering	Mechanical Engineering	Metallurgy & Metallurgical Engineering	Multidisciplinary Engineering	Ocean Engineering	Petroleum Engineering
	Rank/ME	8	14	15	9	4	6	3	10	7	14	4	9	5	4	11	11	1	1
	RSI	-.31	-.47	-.41	-.52	.41	.23	.17	.02	.15	-.41	.31	-.22	-.12	.21	-.28	.01	.20	.79
OM	Rank/ Country	17	3	14	18	2	6	11	10	4	13	5	7	16	9	15	8	12	1
	Rank/ME	14	2	13	15	2	7	10	9	2	11	5	1	13	5	12	7	6	2
	RSI	-.67	.40	-.29	-.78	.47	.19	-.07	.05	.37	-.15	.22	.18	-.63	.07	-.33	.07	-.11	.76
BH	Rank/ Country	12	13	8	18	6	4	11	5	9	7	1	17	14	15	2	3	10	16
	Rank/ME	9	15	11	13	12	11	14	11	14	10	1	13	10	15	2	3	8	14
	RSI	-.36	-.49	-.18	-.70	-.12	.08	-.35	-.01	-.23	-.13	.51	-.65	-.50	-.55	.26	.16	-.26	-.64
YE	Rank/ Country	16	6	10	14	5	8	4	7	9	11	13	15	18	12	3	2	17	1
	Rank/ME	15	9	12	12	11	14	8	14	13	13	15	14	15	13	5	8	14	4
	RSI	-1	-.08	-.19	-.64	-.06	-.18	-.05	-.15	-.19	-.36	-.62	-.67	-1	-.48	.02	.06	-1	.53
SY	Rank/ Country	16	1	8	18	5	2	11	10	4	3	12	17	14	15	13	7	6	9
	Rank/ME	13	1	14	14	13	12	15	15	12	7	14	15	11	14	14	14	9	13
	RSI	-.65	.43	-.40	-.72	-.18	.06	-.46	-.45	-.13	-.04	-.49	-.68	-.54	-.55	-.52	-.37	-.30	-.43
	Max	.10	.43	.34	.17	.48	.62	.34	.38	.50	.47	.51	.18	.13	.31	.30	.44	.20	.79
	Min	-1	-.48	-.40	-.78	-.40	-.39	-46	-.44	-31	-.44	-.62	-.67	-1	-.55	-.61	-.48	-1	-.79
	Mean	-.36	-.05	-.07	-.41	.16	.15	-.02	.05	.10	-.01	.03	-.24	-.39	-.06	-.15	.03	-.33	.13

Discussion

Results show that Iran had the best performance in most of the indicators (total documents, total citations, H-index, and highly cited papers); Saudi Arabia was first in the CPD, and Yemen was first in international cooperation. Generally, the results indicate that Iran has good performance in quantitative indices, and Saudi Arabia has good performance in qualitative indices (first place in CPD, second place in highly cited papers). As the result showed, the highest number of documents and H-index belonged to Iran and the highest CPD was to Saudi Arabia, But most of the international cooperation was belong to Yemen. On the other hand, the results of Elango, Rajendran & Bornmann's (2013) research showed that in terms of the number of documents, CPD, and h-index, United States was the highest level, and Switzerland had the highest percentage of international cooperation. So it can be concluded that the highest performance in these indicators does not always lead to greater international cooperation, and conversely. England, Canada, and the United States have had a very vibrant role in cooperation with the Middle East countries, respectively; this confirms the statement of Kent (2019) about the weakness of the local cooperation network and the central role of the USA and European countries on the Middle East cooperation network. Also, the most international cooperation of

Yemen, Jordan, and Saudi Arabia were with the Middle East countries. The study of cooperation between the countries of the Middle East also showed that cooperation between Saudi Arabia-Egypt comes first, followed by cooperation between Iran-Turkey, Turkey-Saudi Arabia. Of course, given the high number of Iran and Turkey documents in this field, it was expected that most cooperation would be between the two countries, which was not so on. The unexpected strong cooperation between Saudi Arabia and Egypt could be due to the common language of the two countries. Iraq has the highest average annual growth rate of engineering (general) publication in the Middle East countries, Israel has an almost zero-percent growth rate. The high growth rate reflects the increasing attention of countries in this field.

Examination of the relative specialization index (RSI) of the engineering field among the Middle Eastern countries revealed that the UAE, Iraq, Qatar, and Iran have the highest RSI (above +0.2), and Syria and Israel had the lowest RSI (below -0.2), respectively. The value of this indicator was close to zero for other countries, which reflects the average performance of these countries relative to the other competitors in the world. Also, the results of this study are not in line with the results of Abuelma'atti (2013) which means in the field of engineering, Middle Eastern countries are not so far behind the world.

The survey of the average annual growth rate of activity index showed that Bahrain, Syria, Iraq, and Lebanon (with a positive growth rate) are more desirable to increase their specialization in this field. This growth rate was negative or zero for other countries. Due to the world's tendency to increase activity and positive growth rate in engineering (Cañas -Guerrero et al., 2013), most countries in the Middle East have slacked in this field.

The survey of RSI identified national and regional rankings of each country in engineering subfields. The highest RSI was the petroleum engineering subfield in Kuwait. The top three countries (Kuwait, Oman, and UAE) in the subfield of petroleum engineering, were also among the top five countries in the field of energy and fuel (Fazeli Varzaneh et al., 2018).

It was found that among the countries studied, 5 out of 7 countries with RSI above +0.4 in the field of petroleum engineering are also among the top 10 countries with the largest oil reserves in the world (The World Factbook, 2017). The weakest performance was for cell & tissue engineering, excluding Israel, other countries have negative RSI. Yemen had no publication in aerospace engineering, marine engineering, and ocean engineering, which earned the lowest RSI (-1) in these sub-fields.

Conclusion

Because some countries' specialization in the engineering subfields is below the global average (RSI below zero), we suggest that science policymakers pay more attention to these sub-fields, and cooperate more with the specialist countries. In general, Iran and Saudi Arabia had the best performance in the Middle East countries in the field of engineering. The international cooperation of the Middle East countries was assessed at a low level, which requires more attention from researchers and policymakers in these countries regarding further cooperation with other countries, especially cooperation with the top countries. In terms of the activity index and RSI, the Middle East countries are in a good position compared to the activities of the world in the field of engineering, although some countries need more attention.

Supplementary data

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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