Comparative evaluation of top papers outputs of OIC member countries in the Essential Science Indicators database

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ABSTRACT
The objective of this study was to analyze the top papers from Organization of Islamic Cooperation (OIC) member countries covered in the Essential Science Indicators (ESI) database during 2010-2019. The findings of the study showed that 41 out of 57 OIC member states have published 7,369 highly cited papers and 249 hot papers. The leading countries based on the overall top papers produced were Saudi Arabia, followed by Iran, Turkey, Malaysia, Pakistan and Egypt. Iran was ranked first in terms of hot papers. When analysed by document type, all of the top papers were articles and published in the English language. The Lancet ranks among the top in terms of publishing OIC member countries' top papers, showing that it has a great academic influence producing highly cited papers and hot papers. The top five organizations producing top papers are all top universities in their country and they are also ranked globally. King Abdulaziz University contributed the most for both highly cited papers and hot papers. NANOFLUID was the most common keyword and core subject in highly cited papers, and the keyword MECHANICAL-PROPERTIES was the core subject identified in hot papers. Cluster 1 is the largest subject cluster of highly cited papers with the topic Nanotechnology and it is also the largest cluster of hot papers.

Keywords: Top papers; Highly cited papers; Hot papers; Essential Scientific Indicators; Organization of Islamic Cooperation (OIC)

INTRODUCTION

The Organization of Islamic Cooperation (OIC), comprising 57 countries, is the second largest organization after the United Nations, and is the collective voice of the Muslim world endeavours to "safeguard and protect the interests of the Muslim world in the spirit of promoting international peace and harmony among various people of the world" (OIC 2021). OIC member states hold approximately 20.6 percent of the world's land, account for about a quarter of the world's population, and hold 70 percent of the world's oil and gas energy. OIC member states, while lagging behind in Gross Domestic Product (GDP), are spending significantly lower on R&D activities than the world average and still far away from the implied target of 1% of GDP, that leads to a need for studying the state of

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development of science and technology in these countries and the necessary policy-making in this direction (Nayyernia, Tabatabaeifar and Mousavi Movahedi 2006).

Scientific output as an indicator of the activities and operations of a country and its institutes' scientific system is presently the focus of policymakers and decision-makers at national and international levels (Manzano-Agugliaro et al. 2013; Ortiz-Martínez 2017). Although a slight increase in the scientific output cannot individually be regarded as a definitive sign of an all-encompassing scientific development, the work's quality is probably improved with a slight increase in scientific output (Kaur et al. 2015; Feist 1997). Accordingly, many decisions in the social, economic, health and overall development domains are based on the scientific outputs of countries and the results of research activities, thus, providing them with an opportunity to compare, judge and benchmark (Norouzi Chakoli et al. 2007).

The number of scientific publications in global citation databases, such as Clarivate Analytics' Web of Science (WoS) and Elsevier's Scopus and the measure of the degree to which a researcher is influenced or scientifically influenced by other researchers and scientific works through citations (Davarpanah 2007, p. 86) have been widely used in national science and technology statistics publications to measure scientific capacity and linkages to world science. Initial research shows that 56 out of 57 OIC member countries have scientific output indexed in Essential Scientific Indicators (ESI) during 2009-2018. ESI is an analytical tool enabling the scientists, researchers, and research evaluators to identify top-performing research in the Web of Science Core Collection, measure scientific and research performance and track scientific interests. ESI includes 22 defined subject areas that can be accessed by searching each of its top-performing papers, including Agriculture, Biology & Biochemistry, Chemistry, Clinical Medicine, Computer Science, Ecology/Environment, Economics & Business, Engineering, Geosciences, Immunology, Material Sciences, Mathematics, Microbiology, Molecular Biology & Genetic, Multidisciplinary Sciences, Neuroscience & Behavior, Pharmacology & Toxicology, Physics, Plant & Animal Science, Psychology & Psychiatry, Social Sciences, and Space Science.

Only the most highly cited researchers, institutions, journals, countries and papers are included in ESI. This considerably precise analytical tool considers a maximum of 1% of required citations for researchers and institutions, and a maximum of 50% of required citations for journals and countries based on the citation thresholds set in each subject area and after calculating it in each subject area and discipline. It indicates that if the researcher or institution is placed in the top 1% of the scientists and institutions and the journal or country is placed in the top half of the journals and countries, they are included in ESI database after calculating the number of citations in each subject area (Mehrad and Gazni 2008). The selection of researchers, journals, or institutions to be included in ESI is based on the number of citations received over a 10-year period. Table 1 shows the citation thresholds that must be met in order to appear in ESI. The absence of the name of a scientist, institution, or journal in ESI means that they do not meet the threshold number of citations required for this database (Clarivate Analytics 2019).

Highly Cited Papers (HCPs) are papers that have received enough citations to place them in the top 1% when compared to all other papers published in the same year in the same field. Papers that make up the top 0.1% of their peer-reviewed papers are referred to as Hot Papers (HP). HPs are the articles that have been published in the last two years and receive a considerable number of citations over a short period compared to other related papers.

Table 1: Required Citation Thresholds to be Included in ESI

Entity	Percentile	Data Years
Researchers	1%	10
Institutions	1%	10
Countries	50%	10
Journals	50%	10
Highly Cited Papers	1%	10
Hot Papers	0.1%	2

Source: Clarivate Analytics (2021) (https://clarivate.libguides.com/esi)

Numerous methods have been designed and developed for evaluating scientific products, which are one of the most common methods for assessing scientific activities and research management (Soheili, Khasseh and Koranian 2019). The scientific evaluation of countries in one of the prestigious scientific databases such as ESI is recognized as one of the Research and Development (R&D) indicators. Many studies have been conducted worldwide considering the importance of citation analysis (Garfield 1972; Moravcsik, Murugesan and Shearer 1976; Moed and Vriens 1989; Minor and Dostatni, 1991; Mahajan 1993; Gupta, Kumar and Khannaal 1999; Koganuramath et al. 2002; Vinkler 2004). Understanding the scientific status of countries in scientific databases such as ESI, along with identifying different aspects of the status of OIC-indexed journals in this database or the WoS in general, is one of the most important issues to be addressed. Therefore, the knowledge of the number of scientific outputs and their citations, the status and composition of the scientific outputs of the leading OIC member countries in the subject areas, the ranking of countries in terms of scientific output, and the comparison of the status of OIC member countries with their purposes and visions in producing scientific documents will lead to OIC member countries to achieve their aims and prospects in producing science. This study provides a more descriptive overview of the internationally published research outputs of OIC member countries' scientific community. In the present study, the status of OIC member countries in the production of science worldwide has been measured using ESI covering the 2010-2019 timeframe data and by reference to the countries section based on the latest update in November 2020.

LITERATURE REVIEW

This review finds that quantitative studies on the growth of research output in the Muslim world has gained remarkable momentum in the literature. However, such growth is largely manifested in Iran perhaps of the country's research productivity and a conducive atmosphere for this type of research (ISC 2019). Mehrad and Ghazni (2007) studied the top scientific countries of the Islamic world, and their study listed Turkey, Iran and Egypt as the most productive, based on Thomson-Reuters' WoS database from 2003-2007 in 22 disciplines. Data analysis revealed that these countries account for 1 percent of the world's scientific output. Ghazani and Binesh (2007), in a related study, reported that only 37 out of 57 Islamic countries were included the ESI, and these countries were active on average in 10 ESI subject areas. A total of 20 countries were not in the top half of the world, and only three countries, namely Iran, Turkey, and Egypt, were forerunners in ESI's 22 subject areas. Iran was ranked 37th globally, and its growth was 360 percent in scientific publication production. Iran's growth in the citation count was close to 473 percent, and was the highest in the subject area chemistry.

A few years later, Mansoori and Osareh (2010) analyzed the scientific publications of 16 out of the 57 OIC member countries indexed in the WoS between 1944–2008. The 16 countries contributed 303,369 papers, i.e. 83.3 percent of the total number of indexed publications by Islamic countries in WoS. The analysis revealed that the studied countries had an average growth rate in 15 years in the publication of their works, with Iran as the leading country. In the field of chemistry, Iranian authors were most cited among authors of Islamic countries, and at a global level, Lebanon was the most cited country in the field of immunology. Rahimi and Didegah (2010) investigated the prevalence of HPs from 19 Middle-East countries in the ESI database. They found that Turkey leads in terms of HPs (27 HPs, 48.21%). The obtained results revealed that each paper's average number of citations was in the range of 13–73. Engineering was the main scope of HPs from Middle-East countries, followed by chemistry and clinical medicine. Most countries in the region have worked jointly to produce HPs.

In another study, Samimi (2011) focused on Iran's scientific output and compared it to selected Middle-East countries during 1996-2009. The author found that Turkey and Iran expanded their scientific research output more than the other countries in the region during the studied years. Iran had demonstrated remarkable growth and the fastest growth rate worldwide in the last five years of the studied period. Besides, most of the Iranian HPs were internationally co-authored.

Haseli-Mofrad, Shekofteh and Kazerani (2019) studied collaboration in OIC countries between 2007-2017 of HCPs in medical related fields. The most important finding was that there is a low collaboration among Islamic countries. Most of the HCPs from Islamic countries are a result of international collaboration with other countries. There is a considerably low impact of scientific papers from Islamic countries. Only 30 countries (52.6%) from OIC countries had HCPs, which accounted for 2.58 percent of the global share.

Noorhidawati et al. (2017) examined HCPs from Malaysia in the 22 subject areas in WoS based on a highly cited threshold and publication years. Results indicated that Malaysian scientists activley collaborated with scientists from Iran, Australia, and the United Kingdom, which led to increased citations of Malaysian HCPs. Malaysia had a considerably limited number of papers being highly cited, and the authors came up with nine characteristics for HCPs based on 708 datasets obtained from the WOS. Malaysian HCPs are mainly represented by articles (62.6 percent), and review papers received higher citation impact with an average citation of 125.22 per paper. Malaysian HCPs are predominantly from the Sciences; Engineering & Technology contributed the most HCPs, followed by Science, and Medical & Health Sciences. Malaysian HCPs are typically a result of co-authored work, and only 17 papers are single-authored. As Malaysian (or Malaysian based) authors contributed to at least 60 percent of the HCPs, it is safe to conclude that Malaysian authors are major contributors to HCPs. The highest collaboration was with Iran (29%), followed by Australia and the UK. Moreover, the findings indicated that Asian countries (Iran, India, Indonesia, Saudi Arabia, Pakistan, Japan, Singapore, South Korea, Turkey, Egypt, Iraq, and Bangladesh) are the most collaborative in Malaysian HCPs with a total of 146 (53.7%) papers.

Shehatta and Mahmood (2017) studied publications from Egypt in health sciences, focusing on research collaboration sourced from the WoS database from 1980 to 2014. The total publications of Egyptian scientists in health sciences was 31,382 during the studied period, of which 27,693 articles were multi-authored, indicating a co-authorship ratio of 88 percent. It reveals that Egyptian scientists have a great tendency to collaborate. The trend of the number and share of collaborative papers over seven 5-year periods

(1980 –2014) was upward. The findings indicated that Egyptian researchers tended to co-author most of their publications with the USA and Europe. The most frequent disciplines in collaboration are rheumatology (96%), infectious diseases (95%), tropical medicine (95%), immunology (95%), and oncology (94%), in which more than 94 percent of their publications are collaborative papers.

HCPs have been considered as potential candidates for identifying and monitoring "excellent" scientific research in various fields. Zhang et al. (2018) examined 2140 HCPs in the field of Economics and Business from 4499 authors, 914 universities, and 64 countries/territories. Their findings showed three lists: the top 76 scientists, 50 most influential universities, and 33 most influential countries/territories. Yuan and Sun (2019) analyzed TPs in the subject category of green and sustainable science and technology based on ESI between 2008-2018. Their findings revealed 6,228 authors, 2,019 organizations, and 94 countries/territories listed in 30 journals in the field. The analysis of keywords showed that the research waas separated into nine clusters. Sun and Yuan (2020) studied TPs in Library and Information Science (LIS) using the ESI database from 2009 to 2019. They evaluated the LIS 501 TPs (499 HCPs and 16 HPs) in ESI. Their findings showed that 501 papers were published by 1,579 authors employed at 680 organizations and based in 59 countries/territories, and the papers were published in 40 journals in the field. Their work demonstrates that there are more TPs coming from journals with higher impact factor and higher rank in the LIS subject category.

OBJECTIVE, MATERIALS AND METHOD

The objective of the present study is to compare the scientific production status of the leading Islamic countries in the ESI database during 2010-2019. The scientific subject-based mapping of Islamic countries is presented, and the relationship between the number of scientific outputs and the number of citations in the studied countries is studied. This assessment examines the TPs originated from the OIC member countries in terms of: evolution of growth rates, quality of publications, productivity of countries, institutes and authors, collaborative countries, and prevalent topics with major concerns.

This is a quantitative study employing bibliometric techniques. For executing the present bibliometric analysis, Clarivate analytics' ESI database was used to extract the required data for this analysis. Table 2 presents the overall process of the research flow for this study.

TPs refer to a small group of papers that have received a large number of citations. These papers are also known as the top 1% and top 10% papers, respectively named hot papers (HPs) and highly-cited papers (HCPs). As described earlier, papers that make up the top 0.1% of their peer-reviewed papers are referred to as HPs, whereas HCPs are papers that have received enough citations to place them in the top 1% when compared to all other papers published in the same year in the same field. HPs are the articles that have been published in the last two years and receive a considerable number of citations over a short period compared to other related papers. The time frames for calculating HPs and HCPs are two months and five years, respectively; therefore, all TPs are not cited due to the average number of citations in each discipline, and the opposite of this description is true.

The data for the current study were extracted from ESI on November 20, 2020 and saved for analysis using Microsoft Excel spreahsheet. The reason for the selection of a 10 year

period (2010 - 2019) is so that it could present a general overview of scientific performance of OIC member countries. The data represented 41 out of 57 OIC member countries; the total number of articles published were 1,425,113, of which 7369 are HCPs and 249 are HPs, which made up the final data of the study.

Table 2: The Overall Process of The Research Flow to Retrieve the Data for This Study

No.	Process	Description
1	Selection of Search Strategy	CU=(Algeria OR Benin OR Burkina Faso OR Cameroon OR Chad OR Comoros OR Djibouti OR Egypt OR Gabon OR Gambia OR Guinea OR Guinea-Bissau OR Ivory Coast OR Libya OR Mali OR Mauritania OR Morocco OR Mozambique OR Niger OR Nigeria OR Senegal OR Sierra Leone OR Somalia OR Sudan OR Togo OR Tunisia OR Uganda OR Afghanistan OR Azerbaijan OR Bahrain OR Bangladesh OR Brunei OR Indonesia OR Iran OR Iraq OR Jordan OR Kazakhstan OR Kuwait OR Kyrgyzstan OR Lebanon OR Malaysia OR Maldives OR Oman OR Pakistan OR Palestine OR Qatar OR Saudi Arabia OR Syria OR Tajikistan OR Turkey OR Turkmenistan OR United Arab Emirates OR Uzbekistan OR Yemen OR Albania OR Guyana OR Suriname)
2	Operator	OR
3	Tag	CU = Country/Region
4	Type of Documents	Top Papers (Highly-cited Papers and Hot Papers)
5	Selection of Search Database	Essential Science Indicators (ESI) Database
6	Selection of Documents Language	English
7	Selection of Period of Time	2010- 2019
8	Downloading the Retrieved Documents	– In full record and cited references – Labeled format – Plain text files – Combine and create seamless files on PC – Call in Excel 2016 software
9	Data Refining	– Edit, modify, delete, and unify extracted keywords – Using Ravar Matrix software: Ravar PreMap version 1.0.0.0 2017 – Creating relational matrices
10	Data Analysis and Creating Relational Matrices	– Scientometrics analysis with SPSS 16 and VOSviewer software version 1.6.14 – Mapping and analyzing the data with VOSviewer – Also, the correlation between the number of scientific outputs and the number of citations was studied using Pearson's statistical test.

RESULTS

The TPs, produced by 41 OIC member countries during 10 years period (2010 to 2019) comprise 7,369 HCPs and 249 HPs. The sum of times cited for HCPs is 1,517,963; with average citations per item of 205.99 (without self citations: 1,028,272; citing articles: 1,032,790; with self citations: 1,494,837). The sum of times cited for HPs is 40,300; with

average citations per item of 161.84 (without self citations: 33,293; citing articles: 33,360; with self citations: 40,101).

Citation Growth of Top Papers

Citation is an important element in scientific publication as well as the stature and credibility of scientists and their institutions, for it has a significant role in disseminating the scientific impact and relevance of the research or its quality. Table 3 presents the number of TPs and the citations they garnered based on the year of publication, thus indicating the growth of HCPs by OIC member countries' TPs since 2010. The number of HPs tripled from 2018 to 2019.

Table 3: The Number of IOC Member Countries' Top Papers and Citations Based on the Year of Publication

Highly Cited Papers					
Publication Years	Total HCPs	% of 7369	Sum of Times Cited	Citing Articles	Average Citations Per Paper
2010	267	3.623	106,715	100,033	399.68
2011	337	4.573	118,013	111,836	350.19
2012	390	5.292	165,650	146,214	424.74
2013	491	6.663	212,624	195,380	433.04
2014	627	8.509	182,813	161,576	291.57
2015	700	9.499	196,513	169,853	280.73
2016	866	11.752	188,371	161,063	217.52
2017	1003	13.611	151,094	123,571	150.64
2018	1124	15.253	119,654	93,996	106.45
2019	1564	21.224	77,042	53,162	49.26
Hot Papers					
Publication Years	Total HPs	% of 249	Sum of Times Cited	Citing articles	Average Citations Per Paper
2018	59	23.695	20,195	18,853	342.29
2019	190	76.305	20,105	15,592	105.82

Most Cited Top Papers, Core Journals and Types of Top Papers Cited

Table 4 presents the top ten HCPs and HPs and their source titles, ranked by the total citations garnered since their initial publication to November 20, 2020. The Lancet published four HCPs and HPs respectively.

Table 4: The Most Cited HCPs and HPs from 41 OIC Member Countries (2010 to 2019)*

Highly Cited Papers					
No	**Titleof Highly Cited Paper**	**Source Title**	**Publication Year**	**Total Citations**	**Average per Year**
1	MEGA6: Molecular Evolutionary Genetics Analysis Version 6.0	*Molecular Biology and Evolution*	2013	62386	7798.3
2	MEGA7: Molecular Evolutionary Genetics Analysis Version 7.0 for Bigger Datasets	*Molecular Biology and Evolution*	2016	17520	3504.0
3	Cancer incidence and mortality worldwide: Sources, methods and major patterns in GLOBOCAN 2012	*International Journal of Cancer*	2015	15681	2613.5
4	Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the Global Burden of Disease Study 2010	*The Lancet*	2012	6917	768.6

5	A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010	*The Lancet*	2012	6527	725.2
6	Comprehensive molecular portraits of human breast tumors	*Nature*	2012	6132	681.3
7	Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC	*Physics Letters B*	2012	5928	658.7
8	Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013	*The Lancet*	2014	5635	805.0
9	Integrative Analysis of Complex Cancer Genomics and Clinical Profiles Using the cBioPortal	*Science Signaling*	2013	5055	631.9
10	Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010	*The Lancet*	2012	4995	555.0
Hot Papers					
No	**Title of Hot Paper**	**Source Title**	**Publication Year**	**Total Citations**	**Average Per Year**
1	Summary of the contents and survey properties	*Astronomy & Astrophysics*	2018	2662	887.3
2	Alcohol use and burden for 195 countries and territories, 1990-2016: A systematic analysis for the Global Burden of Disease Study 2016	*The Lancet*	2018	1205	401.7
3	Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease Study 2017	*The Lancet*	2018	1176	392.0
4	Minimal information for studies of extracellular vesicles 2018 (MISEV2018): A position statement of the International Society for Extracellular Vesicles and update of the MISEV2014 guidelines	*Journal of Extracellular Vesicles*	2018	1147	382.3
5	PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation	*Annals of Internal Medicine*	2018	1106	368.7
6	Sarcopenia: Revised European consensus on definition and diagnosis	*Age and Ageing*	2019	1011	505.5
7	Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: A systematic analysis for the Global Burden of Disease Study 2017	*The Lancet*	2018	891	297.0
8	Pembrolizumab plus chemotherapy for Squamous Non-Small-Cell Lung Cancer	*New England Journal of Medicine*	2018	702	234.0
9	Global, regional, and national comparative risk assessment of 84 behavioral, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease Study 2017	*The Lancet*	2018	692	230.7
10	Alirocumab and cardiovascular outcomes after acute coronary syndrome	*New England Journal of Medicine*	2018	592	197.3

* Sourced from ESI on November 20, 2020

Table 5 presents the top five journals publishing OIC member countries' HCPs and HPs. They are all in the first quartile of JCR 2019 in their subject category. For HCPs, *Lancet* was the most productive journal, followed by *New England Journal Of Medicine, Chemical Engineering Journal, Nature,* and *International Journal of Heat and Mass Transfer.* These

five journals published more than 100 OIC member countries' HCPs. For HPs, both *International Journal of Heat and Mass Transfer* and *Lancet* were the most productive journals, followed by *Nature, New England Journal of Medicine* and *Ceramics International.* One can conclude that TPs are coming from journals with higher impact factor and higher JIF quartile rank.

Table 5: Top Journals Publishing OIC Member Countries' Top Papers (2010-2019)

Journal Titles of Highly Cited Papers	No of Papers	% of 7369	JIF 2019	Average Citation Per Paper	Sum of Times Cited	No of Citing articles
Lancet	172	2.334	60.39	688.9	118,500	99,319
New England Journal of Medicine	136	1.846	74.69	460.3	62,606	52,221
Chemical Engineering Journal	134	1.818	52.22	144.6	19,371	14,652
Nature	123	1.669	42.78	579.4	71,264	62,586
International Journal of Heat and Mass Transfer	110	1.493	4.95	139.9	15,393	7,307
Journal Titles of Hot Papers	**No of Papers**	**% of 249**	**JIF 2019**	**Average Citation Per Paper**	**Sum of Times Cited**	**No of Citing articles**
International Journal of Heat and Mass Transfer	10	4.016	4.95	143.0	1,430	769
Lancet	10	4.016	60.39	585.3	5,853	5,157
Nature	9	3.614	42.78	139.3	1,254	1,251
New England Journal of Medicine	9	3.614	74.69	394.0	3,546	3,391
Ceramics International	8	3.213	3.83	59.5	476	158

To increase the visibility of research, it is essential to know not only what and where a research has been published, but also the type of communication channel chosen for the publication. A quality paper published in an internationally well-known journal tends to attract scientists instantly and receives many citations. In contrast, an important paper published in an unknown journal may remain dormant and uncited for years despite its high potential research value (Mishra, Panda and Goswami 2010). When analysed by document type, all of the HCPs (100%, 7369) and HPs (100%, 249) were articles. All of the papers were published in the English language.

Top Papers' Country, Institutional and Author Analysis

Table 6 identifies 41 OIC countries having TPs, in ranked order based on their number of WoS publications. Six countries have more than 1000 TPs during the 10 year period (2010 to 2019), and some of their HCPs are also HPs. Based on the overall TPs produced, Saudi Arabia is ranked first (3018 TPs, 3012 HCPs, 133 HPs), followed by Iran (2838 TPs, 2827 HCPs , 158 HPs), Turkey (1957 TPs, 1951 HCPs, 106 HPs), Malaysia (1598 TPs, 1591 HCPs, 63 HPs), Pakistan (1326 TPs, 1319 HCPs, 76 HPs) and Egypt (1007 TPs, 1005 HCPs, 43 HPs). Nevertheless, Iran is ranked first in terms of HPs. Sixteen OIC countries (Afghanistan, Albania, Chad, Comoros, Djibouti, Guinea, Guinea-Bissau, Guyana, Ivory Coast, Maldives, Mauritania, Somalia, Suriname, Tajikistan, Togo and Turkmenistan) do not have any publications in WoS, consequently TPs, therefore, lacks any proportionate position.

The contribution of different OIC organizations was estimated by the institute of the affiliation of at least one author of the published papers. Table 7 lists the top 5 organizations that had published TPs, and their total number of HCPs and HPs respectively, average citations and citations. King Abdulaziz University contributed the most for both HCPs (1050 papers) and HPs (29 papers). The other top HCPs producers in ranked order were Islamic Azad University (501 papers), King Saud University (378 papers), King Abdullah University of Science & Technology (345 papers) and University of Malaya (331

papers). The other top HPs producers in ranked order were King Fahd University of Petroleum Minerals (22 papers), University Djillali Liabes Sidi Bel Abbes (20 papers), Islamic Azad University (19 papers) and Cankaya University (18 papers).

Table 6: OIC Member Countries and their Top Papers in the ESI database (2010-2019)

No.	Country	WoS Documents	Cites	Cites /Paper	Highly Cited Papers	Hot Papers	Top Papers
1	Iran	328477	3134120	9.5	2827	158	2838
2	Turkey	298834	2461328	8.2	1951	106	1957
3	Saudi Arabia	130146	1847203	14.2	3012	133	3018
4	Malaysia	112663	1338623	11.9	1591	63	1598
5	Egypt	112279	1100516	9.8	1005	43	1007
6	Pakistan	100281	939665	9.4	1319	76	1326
7	Tunisia	40379	351955	8.7	196	8	196
8	Nigeria	30438	284145	9.3	321	27	321
9	Algeria	30107	254461	8.5	266	34	268
10	United Arab Emirates	25639	300744	11.7	387	27	387
11	Indonesia	24757	279534	11.4	285	18	285
12	Morocco	21800	231063	10.6	222	11	222
13	Bangladesh	20662	253948	12.3	329	21	331
14	Qatar	17656	265210	15.0	412	21	414
15	Jordan	16627	170246	10.2	210	18	210
16	Lebanon	14977	205904	13.8	260	17	260
17	Iraq	13800	119159	8.6	206	16	207
18	Uganda	10928	189580	17.4	154	4	154
19	Cameroon	9287	114214	12.3	127	8	127
20	Kuwait	8955	94875	10.6	141	13	141
21	Kazakhstan	8692	61458	7.17	83	8	83
22	Oman	7933	98023	12.4	119	2	119
23	Azerbaijan	6160	73035	11.9	111	3	111
24	Senegal	4496	52841	11.8	58	5	58
25	Sudan	4254	57918	13.6	39	1	39
26	Burkina Faso	3772	46506	12.3	35	0	35
27	Uzbekistan	3604	24561	6.8	18	0	18
28	Benin	3246	57773	17.8	75	11	75
29	Syria	2930	35164	12.0	19	0	19
30	Mozambique	2719	63838	23.5	81	8	81
31	Yemen	2651	32373	12.2	45	6	45
32	Libya	2206	26710	12.1	27	4	27
33	Bahrain	2173	44885	20.7	55	10	56
34	Palestine	2167	30973	14.3	70	11	70
35	Mali	1973	33525	17.0	32	1	32
36	Brunei	1749	23156	13.2	42	6	42
37	Gabon	1402	25166	17.9	33	1	33
38	Gambia	1397	44354	31.8	36	1	36
39	Kyrgyzstan	1246	24096	19.3	43	8	43
40	Niger	1217	15678	12.9	12	0	12
41	Sierra Leone	860	17908	20.8	19	1	19

The top five authors producing HCPs were HAYAT T (124 papers), ALSAEDI A (112 papers), SHEIKHOLESLAMI M (110 papers), TOUNSI A(90 papers), and AHMAD M (89 papers). On the other hand, the top five authors producing HPs were TOUNSI A (20 papers), BALEANU D (17 papers), GUPTA R (16 papers), KASAEIAN A (14 papers), and QORBANI M (14 papers). Table 8 presents the top five authors of HCPs and HPs and their respective organizations, h-index, average citations and citations for their HCPs and HPs respectively.

Table 7: Top Five OIC Organizations Publishing HCPs and HPs (2010-2019)

Highly Cited Papers						
Organizations	**No of HCPs**	**% of 7369**	**Country**	**Citations Per Paper**	**Sum of Times Cited**	**Citing Articles**
King Abdulaziz University	1050	14.25	Saudi Arabia	270.82	284,356	218,075
Islamic Azad University	501	6.80	Iran	138.25	69,262	42,737
King Saud University	378	5.13	Saudi Arabia	205.52	77,688	60,819
King Abdullah University of Science & Technology	345	4.68	Saudi Arabia	248.16	85,616	68,884
University of Malaya	331	4.49	Malaysia	209.32	69,286	51,254
Hot Papers						
Organizations	**No of HCPs**	**% of 249**	**Country**	**Citations Per Paper**	**Sum of Times Cited**	**Citing Articles**
King Abdulaziz University	29	11.65	Saudi Arabia	198.27	5,750	4,241
King Fahd University of Petroleum Minerals	22	8.84	Saudi Arabia	191.40	4,211	2,546
University Djillali Liabes Sidi Bel Abbes	20	8.03	Algeria	91.50	1,831	354
Islamic Azad University	19	7.63	Iran	297.73	5,657	4,984
Cankaya University	18	7.23	Turkey	56.72	1,021	481

Table 8: Top Five Most Prolific OIC Authors Publishing HCPs and HPs (2010-2019)

Highly Cited Papers								
Author	**No of Papers**	**% of 7369**	**Country**	**Organizations**	**h-index**	**Citations Per Paper**	**Sum of Times Cited**	**Citing articles**
HAYAT T	124	1.68	Pakistan	Quaid I Azam Univ	76	102.65	12,729	6,218
ALSAEDI A	112	1.52	Saudi Arabia	King Abdulaziz Univ	72	102.69	11,501	5,889
SHEIKHOLESLAMI M	110	1.49	Iran	Babol Noshirvani Univ Technol	90	156.42	17,206	4,473
TOUNSI A	90	1.22	Algeria	Univ Djillali Liabes Sidi Bel Abbes	79	177.94	16,015	1,957
AHMAD M	89	1.21	Pakistan	Quaid I Azam Univ	76	289.72	25,785	14,211
Hot Papers								
Author	**No of Papers**	**% of 249**	**Country**	**Organizations**	**h-index**	**Citations Per Paper**	**Sum of Times Cited**	**Citing articles**
TOUNSI A	20	8.03	Algeria	University Djillali Liabes Sidi Bel Abbes	20	91.55	1,831	354
BALEANU D	17	6.88	Turkey	Cankaya University	17	54.59	928	399
GUPTA R	16	6.43	India	Rajasthan Univ Hlth Sci,	16	406.63	6,506	5,757
KASAEIAN A	14	5.62	Iran	Univ Tehran Med Sci	14	478.79	6,703	5,902
QORBANI M	14	5.62	Iran	Alborz Univ Med Sci	14	478.79	6,703	5,902

Country Co-Authorship Analysis

The country affiliation provides information about the country in which the author who has made an independent contribution to the TPs worked, within a certain organization, at the time they were publishing their HCPs and HPs. The country the author affiliated to could be considered the important contributors for the evaluation of research output (Sun and Yuan 2020). Table 9 lists the top five countries ranked by the number of TPs, and their average citations and citations, with USA and People's Republic of China being the largest contributor for OIC member countries' HCPs and HPs respectively.

Table 9: Top Five Largest Contributor for OIC Member Countries' Top Papers (2010-2019)

Highly Cited Paper					
Country	**No of HCPs**	**% of 7369**	**Citations Per Paper**	**Sum of Times Cited**	**Citing Articles**
USA	2371	32.175	328.32	778,449	606,499
Saudi Arabia	2257	30.628	249.01	562,026	416,192
Peoples R China	1950	26.462	231.25	450,947	324,860
Iran	1909	25.906	168.63	321,910	217,947
UK	1493	20.261	332.69	496,703	385,297
Hot paper					
Country	**No of HPs**	**% of 249**	**Citations Per Paper**	**Sum of Times Cited**	**Citing Articles**
Peoples R China	94	37.751	234.70	22,062	19,547
USA	91	36.546	272.21	24,772	23,020
Iran	78	31.325	172.84	13,482	10,482
Turkey	74	29.719	211.64	15,662	13,689
UK	72	28.916	301.83	21,732	20,635

Keywords Analysis and the Scientific Subject Map of Top Papers

Figure 1 and 2 illustrate the network map that links the keywords to the entire sample of the TPs analyzed by VOSviewer software. For the keywords map, full counting method was used, meaning that each co-occurrence link carried the same weight. The size of the node represents the weight of each author's scientific output, and the colours represent the cluster in which the keyword is included based on the number of co-appearances.

Figure 1 shows the network map that links the keywords to the entire sample of the HCPs analyzed (7369). The total number of keywords analyzed for HCPs is 16,324. Keywords that appeared more than 21 times with a count of 60 keywords were included.

Based on Figure 1, the keywords NANOFLUID, ADSORPTION, OPTIMIZATION, GIS, and NANOPARTICLES with the frequency of 232, 122, 68, 59, and 58, respectively, are high-frequency keyword networks. The keyword NANOFLUID is in the center of the network map indicated by a larger node. The topics are presented in five clusters of yellow, blue, green, red, and purple nodes. Words in a cluster have similar concepts and topics. Lines are related to other topics. Low-frequency topics are on the margins of the map. Low-frequency subjects are placed at the margins of the map with smaller nodes.

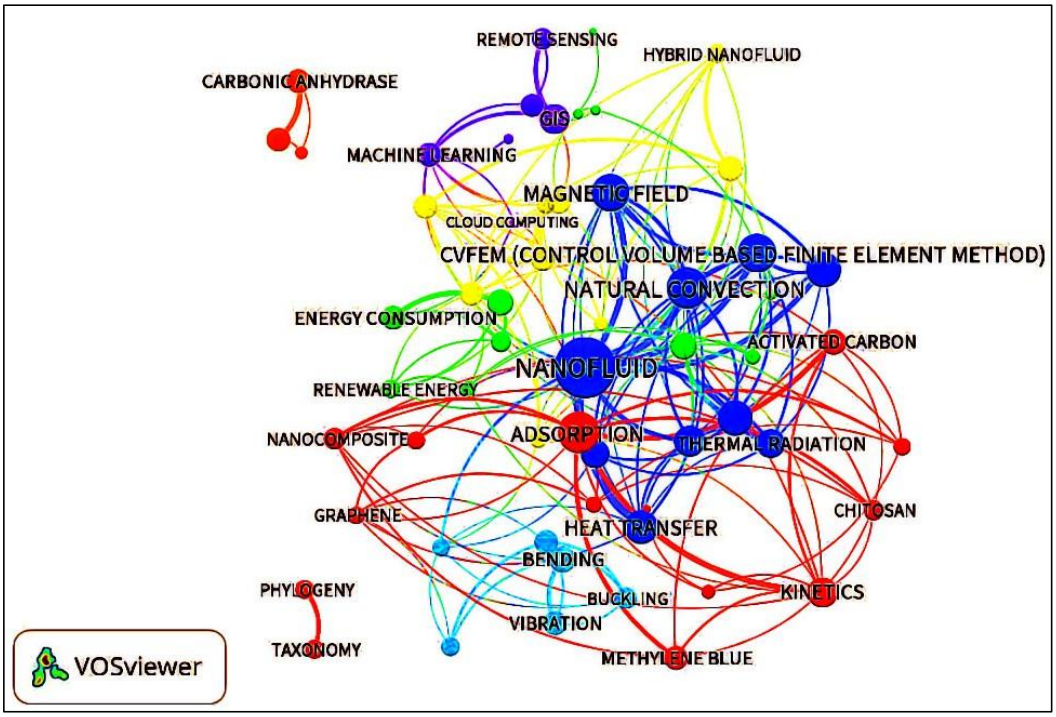

Figure 1: The Network Structure of the Main Topics based on Most Frequent Keywords in OIC Member Countries' Highly Cited Papers (2010-2019)

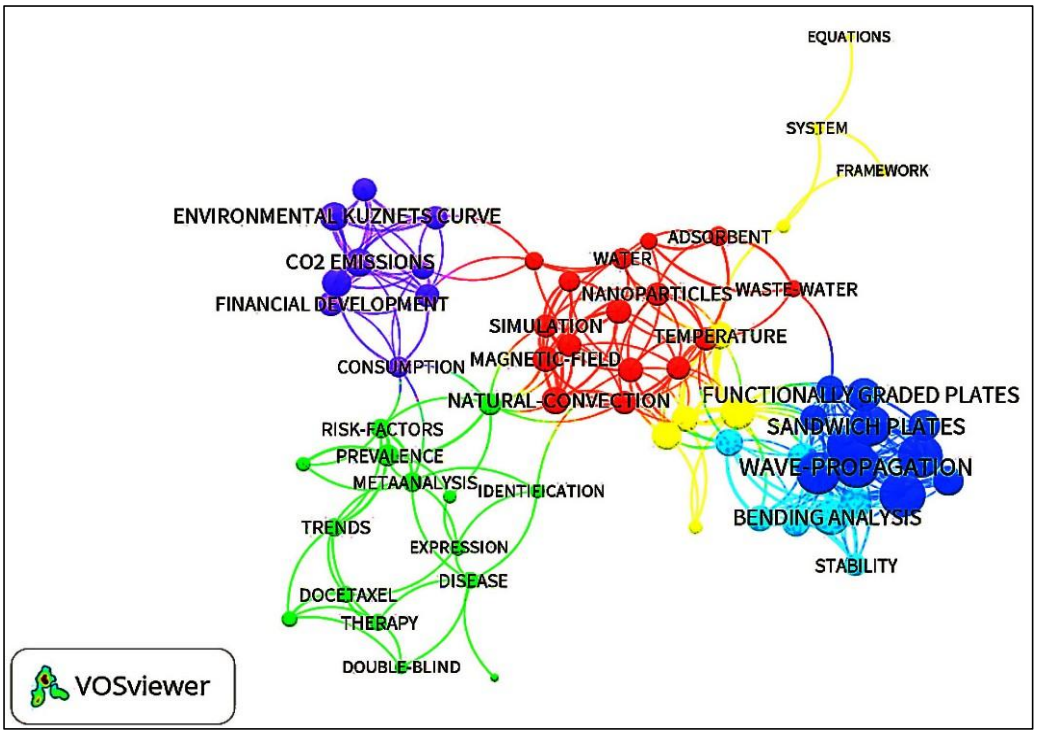

Figure 2: The Network Structure of the Main Topics based on Most Frequent Keywords in OIC Member Countries' Hot Papers (2010-2019)

Table 10 presents the most frequent keywords of HCPs identifiable in eight clusters, along with the number of words in each topic cluster. The hierarchical clustering analysis was implemented using SPSS and VOSviewer. Cluster 1 contains the highest number of topics and 12 conceptual keywords. ADSORPTION is the second most important and frequent word and topic in this cluster. Cluster 2 has 11 keywords. The fifth (NANOPARTICLES) and eighth (ECONOMIC GROWTH) most common and important keywords in HCPs are in this cluster. NANOFLUID, the most frequently used keyword in HCPs is in Cluster 3, that has 10 keywords. OPTIMIZATION, the third most frequent topic in HCPs is in Cluster 4, that also has 10 keywords. The fourth most frequent topic, GIS is Cluster 5, with 6 keywords. The presence of VIBRATION, BUCKLING, and BENDING as keywords forms Cluster 6. This cluster has 6 keywords. Cluster 7 has 3 three keywords. The keyword ANTIOXIDANT ACTIVITY is the most frequent topic in this cluster. Finally, cluster 8 has only 2 keywords, TAXONOMY and PHYLOGENY.

Table 10: Clustering of high-frequency HCPs of OIC Member Countries

Cluster	Keywords	Frequency
1	ADSORPTION; KINETICS; PHOTOCATALYSIS; ACTIVATED CARBON; GRAPHENE OXIDE; OXIDATIVE STRESS; CHITOSAN; HEAVY METALS; GRAPHENE; METHYLENE BLUE; BIOCHAR; NANOCOMPOSITE	12
2	NANOPARTICLES; ECONOMIC GROWTH; ENERGY CONSUMPTION; BIODIESEL; CONSENSUS; RENEWABLE ENERGY; UNCERTAINTY; SYNCHRONIZATION; CO2 EMISSIONS; EPIDEMIOLOGY; STABILITY	11
3	NANOFLUID; HEAT TRANSFER; NATURAL CONVECTION; MAGNETIC FIELD; ENTROPY GENERATION; MAGNETO HYDRODYNAMICS (MHD); CVFEM (CONTROL VOLUME BASED FINITE ELEMENT METHOD); THERMAL RADIATION; POROUS MEDIA; BROWNIAN MOTION	10
4	OPTIMIZATION; THERMAL CONDUCTIVITY; ARTIFICIAL NEURAL NETWORK; PARTICLE SWARM OPTIMIZATION; GENETIC ALGORITHM; FEATURE SELECTION; HYBRID NANOFLUID; CLIMATE CHANGE; MULTI-OBJECTIVE OPTIMIZATION; RESPONSE SURFACE METHODOLOGY	10
5	GIS; MACHINE LEARNING; LANDSLIDE; CLOUD COMPUTING; DEEP LEARNING; REMOTE SENSING	6
6	VIBRATION; BUCKLING; BENDING; FREE VIBRATION; NONLOCAL ELASTICITY THEORY; FINITE ELEMENT METHOD	6
7	ANTIOXIDANT ACTIVITY; ACETYLCHOLINESTERASE; CARBONIC ANHYDRASE	3
8	TAXONOMY; PHYLOGENY	2

Figure 2 shows the network map that links the keywords to the entire sample of the HPs analyzed (249).The total number of keywords analyzed for HPs is 1357. Keywords that appeared more than 4 times with a count of 67 keywords were included.

Based on Figure 2, the keywords MECHANICAL-PROPERTIES with a frequency of 13, and SHEAR DEFORMATION-THEORY, FREE-VIBRATION ANALYSIS, HIGHER-ORDER SHEAR and WAVE-PROPAGATION with the frequency of 12 respectively are high-frequency keyword networks. Similarly, the topics are presented in five clusters of yellow, blue, green, red, and purple nodes.

Table 11 presents the most frequent keywords of HPs identifiable in six clusters, along with the number of words in each topic cluster. The hierarchical clustering analysis was also implemented using SPSS and VOSviewer. Cluster 1 has the highest number of topics and 16 conceptual keywords. PERFORMANCE is the most frequent topic in this cluster.

Cluster 2 has 15 keywords. Cluster 3 (11 keywords) is the most important cluster because it includes high-frequent words i.e. SHEAR DEFORMATION-THEORY, FREE-VIBRATION ANALYSIS, HIGHER-ORDER SHEAR, WAVE-PROPAGATION, THERMAL BUCKLING ANALYSIS, and SANDWICH PLATES. MECHANICAL-PROPERTIES and SYSTEM are the words with high repetition in Cluster 4. This cluster has 9 keywords. CO2 EMISSIONS and ENVIRONMENTAL KUZNETS CURVE are the words with high frequency in Cluster 5. Cluster 5 has also 9 keywords. Finally, Cluster 6 has 7 keywords. The topics BENDING ANALYSIS, BUCKLING ANALYSIS, and DYNAMIC-ANALYSIS are high-frequency keywords in this cluster.

Table 11: Clustering of high-frequency HPs of OIC Member Countries

Cluster	Keywords	Frequency
1	PERFORMANCE; NANOPARTICLES; FABRICATION; CLIMATE-CHANGE; NATURAL-CONVECTION; MAGNETIC-FIELD; WATER; WASTE-WATER; THERMAL-CONDUCTIVITY; TRANSFER ENHANCEMENT; ADSORBENT; NANOFLUID; SIMULATION; ENCLOSURE; AQUEOUS-SOLUTION; HEAT-TRANSFER	16
2	IMPACT; METAANALYSIS; PREVALENCE; RISK-FACTORS; IDENTIFICATION; DISEASE; EXPRESSION; NIVOLUMAB; DOCETAXEL; THERAPY; MORTALITY; GUIDELINES; DOUBLE-BLIND; EFFICACY; TRENDS	15
3	SHEAR DEFORMATION-THEORY; FREE-VIBRATION ANALYSIS; HIGHER-ORDER SHEAR; WAVE-PROPAGATION; THERMAL BUCKLING ANALYSIS; SANDWICH PLATES; FUNCTIONALLY GRADED PLATES; WALLED CARBON NANOTUBES; NONLINEAR VIBRATION; REFINED PLATE-THEORY; RECTANGULAR-PLATES	11
4	MECHANICAL-PROPERTIES; SYSTEM; TEMPERATURE; DENSIFICATION; FRAMEWORK; MICROSTRUCTURE; EQUATIONS; OPTIMIZATION; CLIMATE	9
5	CO2 EMISSIONS; ENVIRONMENTAL KUZNETS CURVE; ECONOMIC-GROWTH; CONSUMPTION; ENERGY-CONSUMPTION; CAUSALITY; CARBON-DIOXIDE EMISSIONS; RENEWABLE ENERGY; FINANCIAL DEVELOPMENT	9
6	BENDING ANALYSIS; BEHAVIOR; BUCKLING ANALYSIS; DYNAMIC-ANALYSIS; FOUNDATION; COMPOSITE PLATES; STABILITY	7

DISCUSSION AND CONCLUSIONS

The TPs produced by 41 out of 57 OIC member countries during 10 year period (2010 to 2019), obtained using scientometrics tools and techniques, comprise 7,369 HCPs and 249 HPs, all of which were articles document type and published in the English language. This study is similar to the studies conducted by Zhang et al. (2018), Mofrad, Shekofteh, Kazerani (2019), Yuan and Sun (2019), and Sun and Yuan (2020), who evaluated TPs scientometrically.

At the macro level, the leading countries based on the overall TPs produced were Saudi Arabia, followed by Iran, Turkey, Malaysia, Pakistan and Egypt. However, Iran was ranked first in terms of HPs, followed by Saudi Arabia and Turkey. The results indicated that Iran had a higher position among OIC member countries by producing the largest number of WoS publications and receiving the most citations, which has the tendency to be highly cited and be hot paper. The results also revealed that Saudi Arabia, Iran, and Turkey are the leaders in producing scientific research among the OIC member countries. The findings confirm the results of the studies conducted by Gerber et al. (2014) and Norouzi Chakley and Sprain (2015). The findings of this study show that 16 OIC member countries may not have a favorable situation and conducive environment in research and producing scientific works. These findings are in line with the results of the studies conducted by Falagas et al. (2006) and Zeng and Cheng (2013). New science and technology policies, OIC leadership and collaboration and funding are urgently needed to address this situation.

At the meso level, King Abdulaziz University contributed the most for both HCPs and HPs. The other top HCPs producers were Islamic Azad University, King Saud University, King Abdullah University of Science & Technology, and University of Malaya. The other top HPs producers were King Fahd University of Petroleum Minerals, University Djillali Liabes Sidi Bel Abbes, Islamic Azad University, and Cankaya University. Most of these universities are top universities in their country and also ranked globally. The results also showed that most of the OIC member countries scientifically collaborated with USA, People's Republic of China and the UK, with USA and People's Republic of China being the largest contributor for OIC member countries' HCPs and HPs respectively.

At the micro level, *The Lancet* ranks among the top in terms publishing OIC member countries' TPs, showing that it has a great academic influence producing HCPs and HPs. The analysis of network map using VOSviewer showed that the TPs were distributed into five research hotspots namely NANOFLUID, ADSORPTION, OPTIMIZATION, GIS, and NANOPARTICLES which are high-frequency keyword networks. The results also revealed that the keyword NANOFLUID was identified as the most frequent keyword and core subject in HCPs, and the keyword MECHANICAL-PROPERTIES was identified as the core subject in HPs. This results may suggest researchers to strengthen cooperation, share research results and pay more attention to research hotspots and frontiers in these topics around the world, so as to produce more high-quality research results in the forms of HCPs and HPs. However, this study is descriptive and focuses on the OIC member countries for TPs only during a 10 year period (2010-2019), therefore, the results are of limited generalisability. Nevertheless, studying the research background of TPs reveals the importance of scientometrics quantitative analyses, mapping, and scientific structuring.

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