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Editorial

Top 100 Countries in the Elsevier-Stanford University List of World's 2% Most-cited Scientists: 2017-2020 Data

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Abstract

Research publications and their citation impact have been a topic of extensive studies in the recent past. In the current highly competitive environment, universities are struggling to maintain and enhance their research productivity and citations. This article presents the summary of a secondary analysis of the Elsevier-Stanford University list of the global 2% most-cited scientists released so far. The data regarding the career-long category were sorted according to the number of authors, affiliated university, and the country. Subsequently, the countries were ranked based on the total number of authors in each year from 2017 to 2020, and the top 100 countries were further analyzed to see their annual progress. The analysis shows that countries with clear, focused, and strategic approaches towards promoting collaborative research and open access to research data and publications could succeed in producing highly cited scientists.

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1. Introduction

Research productivity is considered one of the parameters to evaluate academic excellence especially in the outcome-based education evaluation and accreditation system. The numbers of funded projects completed, publications, and patents are some of the indicators. However, the usefulness of publications for the research community is given more attention than the number of publications. The number of times an article is cited by other researchers generally indicates the article's usefulness (Jurgens et al., 2018; Tahamtan & Bornmann, 2018). The number of citations adds credits to the authors, the journal where it is published, and the affiliated institutions (Bornmann & Daniel, 2008). For instance, h-index indicates an author's citation credit (Rahardja et al., 2019), while impact factor is a similar indicator for journals. The world university ranking systems use exclusive criteria for research and citation (Ebrahim et al., 2013). In

the recent past, there has been increased awareness among the research community and institutions about the importance of citations (Ioannidis et al., 2016; Aksnes et al., 2019). The most common citation management databases are those hosted by Web of Science, Scopus, and Google Scholar (Meho, 2007; Kousha & Thelwall, 2008; Baas et al., 2020). Many institutions have several schemes to motivate faculty and students in improving the number of publications and citations.

Substantial research has been reported on the various aspects of research publications, citation impact, and related topics, and a comprehensive review of such studies is beyond the scope of this article. To exemplify a few, Amara et al. (2015) focused on comparing the performances of publishing and non-publishing scholars and on the factors affecting research productivity. Several studies (Sooryamoorthy, 2009; Wallace et al., 2012; Gazni & Thelwall, 2014; Gazni & Thelwall, 2016; Gazni & Didegah, 2011; Smith et al., 2014; Khor & Yu, 2016; Matveeva et al., 2021) have focused on the role of collaborative research in citation impact. Lancho-Barrantes & Cantu-Ortiz (2021) studied the impact of publications on university ranking. Some researchers studied the impacts of sharing research data (Piwowar et al., 2007), monetary support (Tonta & Akbulut, 2020), and open access model (Hajjem et al., 2006; Gargouri et al., 2010) on citation impact. Nielsen & Andersen (2021) worked on the global citation inequality.

Since the year 2019, Elsevier and Stanford University have jointly initiated publishing the list of the global 2% top-cited scientist based on Scopus database (Baas et al., 2021; Baas et al., 2020; Ioannidis et al., 2019 & 2020), covering data until May 2020. The present study analyses this data to understand the trend of top 100 countries in terms of producing top-cited scientists.

2. Methodology

A secondary analysis of the Elsevier-Stanford University data was made to see the position of top 100 countries in the list and their yearly progress. Among various categories, the 'career-long' category was used for the analysis. The data was sorted according to the number of authors, affiliated university, and the country for each year from 2017 to 2020. The authors whose name of the country or affiliated university was missing were excluded. The countries were ranked according to the total number of authors, and the top 100 countries were listed for each year.

3. Analysis Summary

The following outputs have been extracted over the period 2017-2020:

- Top 100 countries based on number of top-cited authors (Table 1).
- Countries that consistently maintained top 5 ranks (Figure 1).
- Countries that steadily increased their ranks (Figure 2).
- Countries that unsteadily increased/maintained their ranks (Table 2).
- Countries that faced a decline in ranking (Table 3).

The analysis shows that the United States, the United Kingdom, Germany, Canada, and Japan have consistently maintained their top 5 positions (Figure 1) with yearly increase in ranking. If we observe the top 10 countries in 2017, Australia, France, Netherlands, Italy, and Switzerland were sequentially

positioned from 6th to 10th. However, China, which was on 12th position in 2017, had advanced to 10th position in 2018, dropping Switzerland to 11th rank. The China's advancement has continued to mark its 7th rank in 2019 and 6th rank in 2020, while Switzerland has maintained its 11th position so far. Among the countries that could enhance their ranks from the reference year (2017) to the year 2020, some have shown a remarkable increase in ranking. For instance, India and Taiwan moved from top 30 to top 20, Russia and Turkey from top 40 to top 30, Egypt and Malaysia from top 50 to top 40, and Ukraine, United Arab Emirates (UAE) and Pakistan from top 60 to top 50. A marvellous jump was made by Qatar from its top 70 position to top 50. Likewise, as shown in Table 3, the ranks of some countries such as Costa Rica, Ireland, and Hong Kong have come down compared to 2017 though there is an increase of the total number of authors.

Table: Top 100 countries ranked according to top-cited authors from 2017 to 2020.

Rank	2017		2018		2019		2020	
	Country	No. of Authors	Country	No. of Authors	Country	No. of Authors	Country	No. of Authors
1	United States	46013	United States	49786	United States	68016	United States	75899
2	United Kingdom	9780	United Kingdom	10531	United Kingdom	15001	United Kingdom	17237
3	Germany	5459	Germany	6006	Germany	8792	Germany	9986
4	Canada	4483	Canada	4743	Canada	7225	Canada	8127
5	Japan	3381	Japan	3674	Japan	6316	Japan	7362
6	Australia	3106	Australia	3404	Australia	5441	China	6943
7	France	2415	France	3328	China	5272	Australia	6369
8	Netherlands	2133	Italy	2282	France	5048	France	5912
9	Italy	2064	Netherlands	2278	Italy	4008	Italy	4956
10	Switzerland	1695	China	2023	Netherlands	3350	Netherlands	3857
11	Sweden	1659	Switzerland	1856	Switzerland	2546	Switzerland	2974
12	China	1646	Sweden	1706	Sweden	2546	Sweden	2889
13	Spain	1120	Spain	1274	Spain	2290	Spain	2813
14	Israel	1005	Israel	1048	Israel	1630	India	2042
15	Denmark	998	Denmark	1023	Denmark	1495	Israel	1869
16	Belgium	911	Belgium	904	India	1491	Denmark	1808
17	Finland	620	Finland	706	Belgium	1413	South Korea	1750
18	Austria	532	India	645	South Korea	1350	Belgium	1666
19	Hong Kong	477	Austria	625	Taiwan	1151	Taiwan	1479
20	South Korea	464	Hong Kong	546	Finland	1037	Finland	1217
21	Norway	441	Norway	539	Austria	962	Austria	1162
22	India	428	South Korea	519	Norway	947	Norway	1152
23	Taiwan	404	New Zealand	461	Hong Kong	878	Hong Kong	1018
24	New Zealand	387	Taiwan	455	New Zealand	803	New Zealand	974
25	Singapore	313	Singapore	390	Singapore	756	Poland	957
26	Ireland	286	Russia	373	Poland	726	Singapore	875
27	South Africa	263	Poland	335	Russia	709	Russia	847
28	Brazil	257	South Africa	328	Greece	648	Greece	829
29	Greece	250	Ireland	312	Turkey	614	Turkey	828
30	Poland	244	Brazil	305	Brazil	600	Brazil	812
31	Russia	241	Greece	300	Ireland	547	South Africa	669
32	Turkey	163	Hungary	199	South Africa	536	Ireland	661
33	Czech Republic	153	Turkey	196	Iran	433	Iran	654
34	Hungary	150	Czech Republic	193	Portugal	385	Portugal	481
35	Portugal	142	Portugal	172	Czech Republic	335	Saudi Arabia	443
36	Iran	77	Saudi Arabia	141	Saudi Arabia	321	Czech Republic	428
37	Mexico	70	Iran	130	Mexico	291	Mexico	342
38	Argentina	68	Mexico	112	Hungary	282	Hungary	331
39	Saudi Arabia	65	Argentina	97	Egypt	219	Egypt	327
40	Chile	53	Egypt	74	Argentina	171	Malaysia	234
41	Slovenia	52	Chile	66	Malaysia	163	Argentina	204
42	Egypt	42	Slovenia	55	Thailand	136	Thailand	191
43	Thailand	40	Thailand	41	Chile	127	United Arab	177

							Emirates	
44	Romania	31	Malaysia	40	Slovenia	114	Chile	156
45	Malaysia	28	United Arab Emirates	40	United Arab Emirates	114	Slovenia	147
46	Bulgaria	25	Romania	39	Romania	100	Romania	133
47	Lebanon	22	Iceland	32	Pakistan	81	Pakistan	127
48	Slovakia	22	Slovakia	30	Qatar	75	Qatar	100
49	Iceland	19	Bulgaria	29	Cyprus	56	Ukraine	86
50	Kuwait	19	Ukraine	27	Ukraine	55	Bulgaria	73
51	Puerto Rico	19	Lebanon	25	Bulgaria	50	Nigeria	73
52	Croatia	18	Pakistan	25	Serbia	49	Slovakia	70
53	Ukraine	17	Cyprus	25	Lebanon	48	Serbia	69
54	United Arab Emirates	16	Qatar	25	Croatia	47	Cyprus	64
55	Estonia	13	Georgia	21	Slovakia	46	Kuwait	61
56	Macao	11	Kuwait	18	Kuwait	45	Croatia	60
57	Pakistan	11	Puerto Rico	18	Iceland	43	Lebanon	59
58	Cyprus	9	Croatia	18	Georgia	43	Jordan	53
59	Nigeria	9	Colombia	17	Estonia	42	Vietnam	53
60	Philippines	9	Estonia	15	Nigeria	42	Estonia	52
61	Serbia	9	Luxembourg	15	Luxembourg	34	Iceland	50
62	Venezuela	9	Philippines	14	Kenya	34	Luxembourg	42
63	Bangladesh	8	Nigeria	13	Jordan	34	Colombia	42
64	Kenya	8	Serbia	13	Vietnam	34	Bangladesh	40
65	Luxembourg	8	Macao	12	Colombia	33	Georgia	38
66	Qatar	7	Bangladesh	12	Lithuania	28	Oman	36
67	Jordan	6	Venezuela	10	Bangladesh	26	Kenya	35
68	Lithuania	6	Lithuania	10	Macao	22	Lithuania	31
69	Costa Rica	4	Uruguay	10	Puerto Rico	21	Macao	31
70	Peru	4	Peru	8	Oman	21	Philippines	26
71	Morocco	3	Kenya	7	Venezuela	18	Venezuela	24
72	Bahrain	3	Jordan	6	Jamaica	18	Tunisia	23
73	Malawi	3	Vietnam	6	Philippines	16	Jamaica	22
74	Oman	3	Oman	5	Algeria	15	Algeria	21
75	Uruguay	3	Algeria	5	Sri Lanka	15	Kazakhstan	21
76	Armenia	2	Bahrain	4	Belarus	15	Puerto Rico	20
77	Colombia	2	Malawi	4	Tunisia	15	Belarus	19
78	Algeria	2	Latvia	4	Uruguay	13	Morocco	19
79	Jamaica	2	Cuba	4	Ghana	12	Sri Lanka	18
80	Sri Lanka	2	Ecuador	4	Kazakhstan	11	Peru	17
81	Latvia	2	Costa Rica	3	Peru	10	Uruguay	15
82	Malta	2	Morocco	3	Costa Rica	9	Ghana	14
83	Belarus	1	Jamaica	3	Morocco	9	Costa Rica	13
84	Barbados	1	Tanzania	3	Latvia	8	Latvia	13
85	Cameroon	1	Uganda	3	Ecuador	7	Ecuador	13
86	Cuba	1	Gambia	3	Trinidad and Tobago	7	Trinidad and Tobago	10
87	Georgia	1	Grenada	3	Malta	7	Bahrain	10
88	Ghana	1	Kazakhstan	3	Uganda	6	Uganda	9
89	Montenegro	1	Armenia	2	Bahrain	5	Malta	7
90	New Caledonia	1	Sri Lanka	2	Cuba	5	Malawi	7
91	Senegal	1	Belarus	2	Armenia	5	Tanzania	7
92	Trinidad and Tobago	1	Cameroon	2	Malawi	4	Cuba	6
93	Tunisia	1	Ghana	2	Tanzania	4	Cameroon	6
94	Tanzania	1	Montenegro	2	Gambia	4	Armenia	5
95	Uganda	1	Trinidad and Tobago	2	Montenegro	4	Montenegro	5
96	Vietnam	0	Tunisia	2	Grenada	3	Grenada	4
97	Ecuador	0	Malta	1	Cameroon	3	Gambia	3
98	Gambia	0	Barbados	1	New Caledonia	3	New Caledonia	3
99	Grenada	0	New Caledonia	1	Senegal	2	Senegal	1
100	Kazakhstan	0	Senegal	1	Barbados	0	Barbados	1

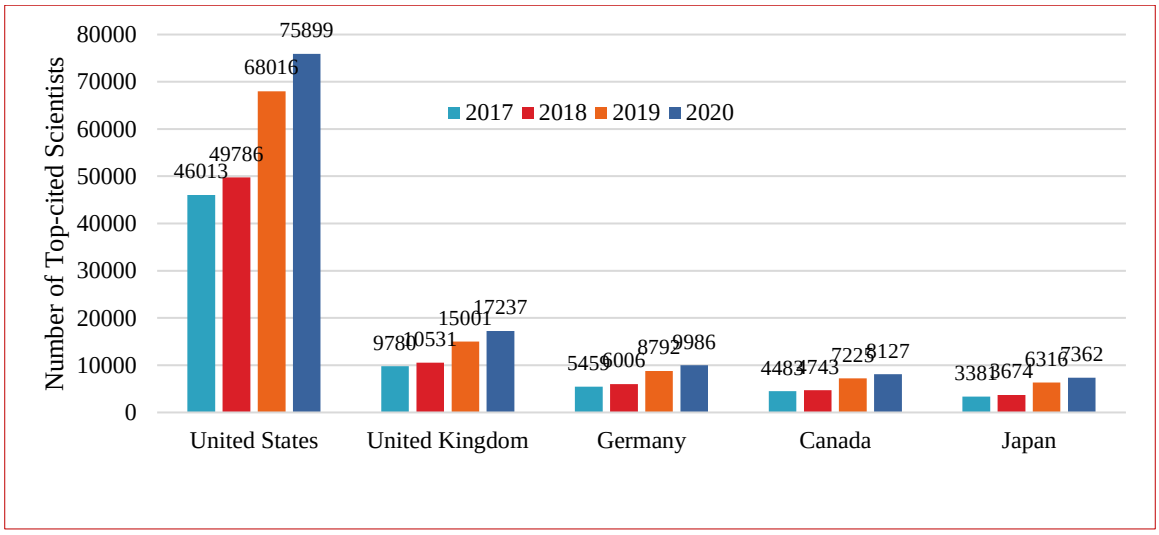

Figure 1: Countries that consistently maintained top five ranks.

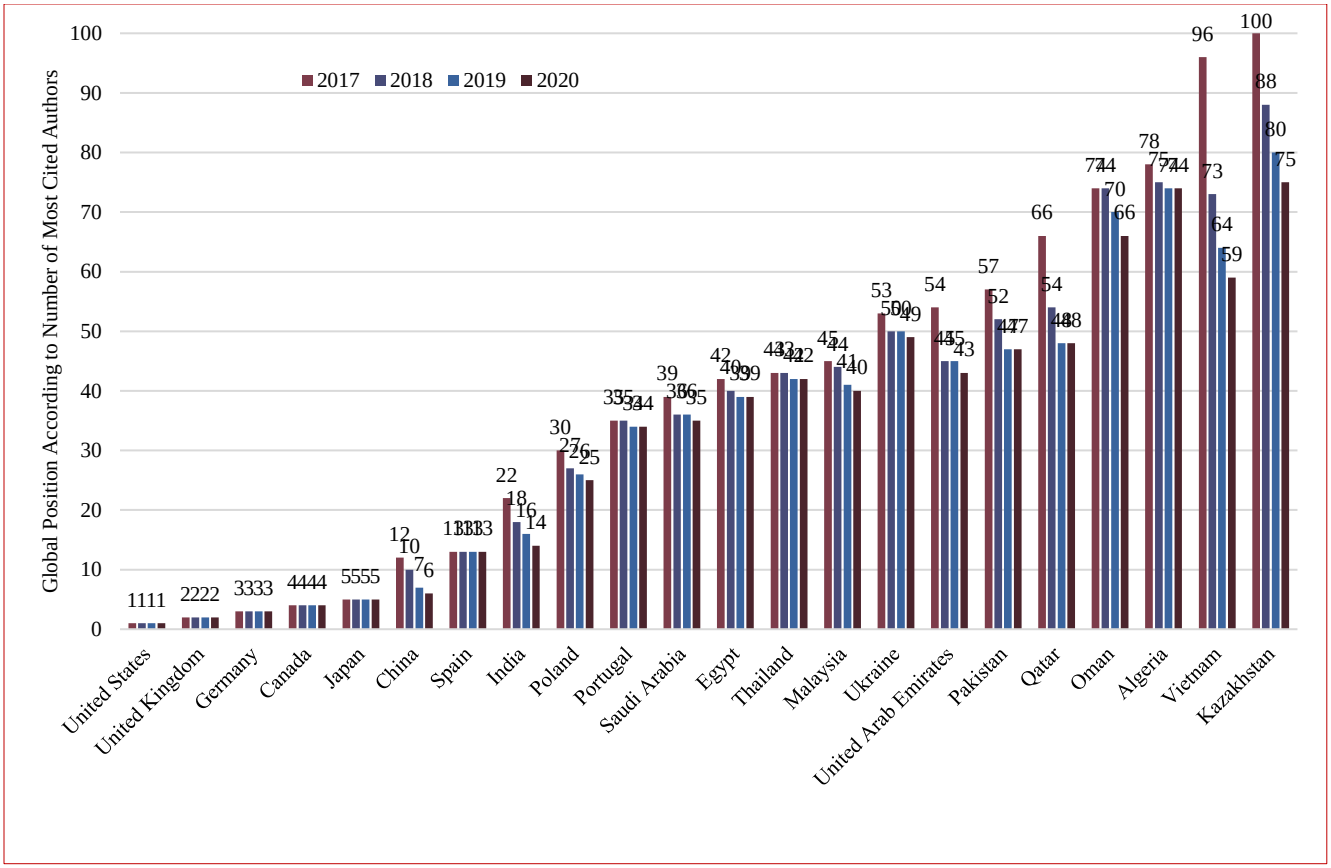

Figure 2. Countries that consistently improved their ranks from the reference year (2017).

Table 2: Countries that retained or increased their ranks unsteadily compared to the reference year (2017)

Country	Rank based on Number of Authors			
	2017	2018	2019	2020
Italy	9	8	9	9
South Korea	20	22	18	17
Taiwan	23	24	19	19
New Zealand	24	23	24	24
Greece	29	31	28	28
Russia	31	26	27	27
Turkey	32	33	29	29
Iran	36	37	33	33
Mexico	37	38	37	37
Cyprus	58	53	49	54
Nigeria	59	63	60	51
Serbia	61	64	52	53
Luxembourg	65	61	61	62
Jordan	67	72	63	58
Lithuania	68	68	66	68
Colombia	77	59	65	63
Jamaica	79	83	72	73
Sri Lanka	80	90	75	79
Belarus	83	91	76	77
Georgia	87	55	58	65
Ghana	88	93	79	82
Trinidad and Tobago	92	95	86	86
Tunisia	93	96	77	72
Tanzania	94	84	93	91
Uganda	95	85	88	88
Ecuador	97	80	85	85
Gambia	98	86	94	97
Grenada	99	87	96	96

Table 3: Countries with a decline in ranking compared to the reference year (2017)

Country	2017	2018	2019	2020
Australia	6	6	6	7
France	7	7	8	8
Netherlands	8	9	10	10
Switzerland	10	11	11	11
Sweden	11	12	12	12
Israel	14	14	14	15
Denmark	15	15	15	16
Belgium	16	16	17	18
Finland	17	17	20	20
Austria	18	19	21	21

Hong Kong	19	20	23	23
Norway	21	21	22	22
Singapore	25	25	25	26
Ireland	26	29	31	32
South Africa	27	28	32	31
Brazil	28	30	30	30
Czech Republic	33	34	35	36
Hungary	34	32	38	38
Argentina	38	39	40	41
Chile	40	41	43	44
Slovenia	41	42	44	45
Romania	44	46	46	46
Bulgaria	46	49	51	50
Lebanon	47	51	53	57
Slovakia	48	48	55	52
Iceland	49	47	57	61
Kuwait	50	56	56	55
Puerto Rico	51	57	69	76
Croatia	52	58	54	56
Estonia	55	60	59	60
Macao	56	65	68	69
Philippines	60	62	73	70
Venezuela	62	67	71	71
Bangladesh	63	66	67	64
Kenya	64	71	62	67
Costa Rica	69	81	83	83
Peru	70	70	81	80
Morocco	71	82	83	78
Bahrain	72	76	89	87
Malawi	73	77	92	90
Uruguay	75	69	78	81
Armenia	76	89	91	94
Latvia	81	78	84	84
Malta	82	97	87	89
Barbados	84	98	100	100
Cameroon	85	92	97	93
Cuba	86	79	90	92
Montenegro	89	94	95	95
New Caledonia	90	99	98	98
Senegal	91	100	99	99

4. Discussion

We have lessons to learn from the top 5 countries, which have been keen in the timely adoption of strategies to promote scientific research and innovation. They are among the top 15 largest producers of scholarly publications in the world (NSB, 2019). Their encouraging policies for research funding,

collaborative research, and open access to scholarly publications and research data have played significant roles in producing large number of highly cited researchers. For instance, the United States (US) has become a global leader in research and development (R&D) funding in the 20th century, spending about 69% of the annual global R&D funding (Sargent Jr., 2021). Promoting collaborative research is one of the US' strategic priorities to improve its R&D infrastructure (Lander & Koizumi, 2021; Souvaine, 2021). In 2018, the global collaborative publications increased with at least one in five articles having coauthors from other countries, and US and China were the largest producers of research publications (NSB, 2019; Souvaine, 2021). Even though the total number of science and engineering (S&E) peer-reviewed publications of US is less than that of China over 2008 -2018 (NSB, 2019), its highest position in top-cited researchers indicates the highest scientific or citation impact.

The United Kingdom (UK), though being the 6th among the top 15 producers of publications, has become the second highest in owning top-cited scientists. According to a report (K. Nielsen et al., 2017), the remarkably large amount (€9 billions) of funding by European Union (EU) during the period 2007-2013 had a great impact on the UK's growth in research and innovation. A study on international higher education by British Council (Ilieva & Peak, 2016) showed that UK is rated 'Very High' among the 5 countries (Australia, Germany, UK, Malaysia, and China) regarding 'openness and international mobility', which includes international research collaboration. The UK's research and innovation domain has been given new promising directions by the launching of UKRI (in 2018), sponsored by the Department for Business, Energy and Industrial Strategy (www.ukri.org). The UKRI's R&D roadmap had put collaborative research and open access of publications and research data in its priorities; the roadmap had highlighted that 54% of all UK's publications resulted from international collaboration (Sharma, 2012).

Similar explanations apply to the other three countries in the top 5 list. Germany stands 4th in the volume of S&E publications with an annual growth rate of 1.3%(NSB, 2019), while Japan and Canada are positioned 5th and 12th respectively. Having about 390 universities and 250 public research institutions, Germany is among the leaders in higher education and research. As part of the reforms in higher education, Germany has made the 'Excellence Initiative' to encourage inter-university competition (Oberlaender & Deher, 2021). From 2014, the Federal Ministry of Education and Research (BMBF) has been instrumental in promoting international collaborations with over 80 million euros. Currently, 32 international collaborations on R&D and innovation projects are in progress (BMBF, 2021). Moreover, BMBF released its open access policy named "Open Access in Germany" in 2016. The Deutsche Forschungsgemeinschaft (DFG), the main research funder in Germany, has incorporated open access into its funding policy (Oberlaender & Deher, 2021).

The scientific research of Canada is taken care by its science and innovation department, which has distinct scheme to avail international collaborative research options(*Research Funding and Awards*, 2021). Also, its tri-agency open access policy (*Tri-Agency Open Access Policy on Publications*, 2015) promotes free access to research publications and data. World-class university research and international cooperation are among the strategic priorities of the Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT)("Science & Technology Policy in Japan," 2021). In 1932, Japan established its Japan Society for the Promotion of Science (JSPS), which continues to function under MEXT. Apart from promoting research in all disciplines, JSPS looks after several programs of international scientific collaborations so as to maintain its global position as leading center of scientific research ("Japan: The Advancement of World-Class

Research in Science," 2019). As part of open, rapid, and wide dissemination of research publications and data, Japan has established the Research Center for Open Science and Data Platform (RCOS) under the National Institute of Informatics (NII)(RCOS, 2017). Moreover, NII has developed a cloud-based repository software WEKO, which is used by over 500 Japanese institutions (Increasing Japanese Open Access Using JAIRO Cloud, 2008). The could service is known as Japanese Institutional Repositories Online Cloud (JAIRO Cloud). The WEKO program has been studied and successfully implemented by a Malaysian university (Leng et al., 2016). Detailed overview of the NII research data could is available online (NII, 2017).

The rapid growth of China in this direction is worth noting. Over the last decade, China's research output has grown almost twice as fast as the world's annual average (NSB, 2019), while US and EU countries showed only less than half of the global annual growth rate. Though the scientific impact of publications from US and EU countries continues to be the highest, China has shown a rapid increase in delivering impactful publications, as reflected in the citations (NSB, 2019). India stands 3rd among the 15 most productive countries with the second highest annual growth (10.73%) after Iran (in S&E publications (NSB, 2019). This shows that India has a great potential to grow in citation impact by adopting proper strategies. Thus, in addition to improving the scholarly publishing trend, the need for focused efforts and techniques to enhance the citation impact (Ebrahim et al., 2013) is quite obvious, as demonstrated by the top performers.

5. Conclusion

An analysis has been made of the Elsevier-Stanford University data of the world's 2% top-cited scientists in the career-long category. The countries were ranked based on the total number of authors, and the top 100 countries were studied know their progress over the period 2017-2020. The study has shown that, even though there has been significant growth in the number of scholarly publications, specific strategic policies for promoting collaborative research and free access to research data and publications are vital to improve the citation impact. Following this study, forthcoming editorials will present extended country-wise analysis of the Elsevier-Stanford University data, as well as similar analysis of the Web of Science list of top-cited researchers.

Note: The author is Founder & Chief Editor of *International Journal of Advanced Thermofluid Research* and is listed among the world's 2% top-cited scientists published by Elsevier-Stanford University in both 2020 and 2021.

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