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A Study of Distribution and Growth of Open Access Research Journals Across the World

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Abstract
The study aims to assess the growth of Open Access (OA) research journals indexed in Directory of Open Access Journals (DOAJ) during the last two decades viz., for the period 2002 through 2021 across the world. More so the growth has also been assessed at the continental and subject level. Some of the key aspects evaluated include computation of research journals indexed each year during the period of study, their corresponding growth, subject wise distribution of OA journals, leading OA journals publishing countries and various other related aspects have been evaluated. From the data analysis it emerged that in 2002, 22 OA journals were indexed in DOAJ and on July 17, 2021 the date of data retrieval, the number of OA journals indexed were found 16,589, published across 126 countries. On average each year around 830 journals are indexed in DOAJ registering an average annual growth of around 51.46%. 46% journals were indexed during the last three years, reflecting exponential growth of OA research journals from 2018 onwards.

Keywords Research journals · Open access journals · DOAJ · Journal growth · Predatory journals · World · Continents

Introduction

The advances in Information and Communication Technology (ICT) have revolutionized every sphere of human activity and so has it taken publishing world by storm. The conventional practices of printing and publishing have changed altogether including reading habits among people. This digital revolution has

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immensely promoted open access movement, whereby research journals have started publishing content in open access format and so have started coming up more and more Open Access (OA) journals. The open access movement supports and advocates making all research results available to public free of cost without any barrier or hindrance. People advocating and supporting the open access movement are of the view that research results are meant for end users and if the same does not reach to the end users for the want of accessibility then what is the point to undertake any such research activity or coming up with new scientific findings which does not accrue benefit to the society at large alike, which is the only and ultimate purpose of undertaking any research or scientific investigation.

During the last two decades a manifold growth has been witnessed in global research activity, which resulted in launch and emergence of newer research journals especially in open access format known as Open Access (OA) journals. More than 7000 OA research journals are indexed in SCOPUS and over 4500 OA journals are indexed in WoS, the two leading and prominent journal indexes popular among the research and scientific community across the world [22] The growth of OA journals can be owed to the growing popularity of publishing research results in OA journals for having greater visibility and reach than Toll Access (TA) research journals. The advantages like greater visibility and wider reach among the end users has led medicos in Korea being encouraged to publish their research results in OA journals [26]. However a good lot of popular open access journals are yet to be covered by indexes like SCOPUS and WoS.

Information Technology if on one hand has opened up new vistas of publishing research results in OA format, at the same time it has encouraged the growth of predatory, fake, dubious and sub-standard research journals as well, an unethical spin-off of digital publishing [12]**.** It is being observed that a good lot of these predatory research journals are being published in OA format, mostly having APC and generally solicit the research and scientific community to publish their research results in their journals [9]. To improve the quality of research at the national level, each country is taking measures to draw awareness among scholars and other researchers of their country about the existence of dubious and predatory research journals and discouraging them from publishing research results in such journals. The University Grants Commission, the highest governing body of Higher Education Institutions (HEI's) in India came up with its list of journals, known as UGC CARE list journals [27].

Accordingly, the undergoing study has been undertaken with the view to assess the growth of Open Access (OA) journals during the last two decades across the world. The study is purely based on the secondary data retrieved from the Directory of Open Access Journals (DOAJ). The Directory of Open Access Journals (DOAJ) is one of the comprehensive indexes of OA journals, which has indexed more than 16,000 OA journals are published all across the world [5]. The study focuses on assessing the aspects like, distribution of OA research journals across continents, their language, growth, article processing charges if any, leading OA journal publishing countries, time lag between article submission and publication and more.

Problem Statement

The unprecedented growth of research journals has led to a different kind of problem, whereby researchers both budding and reasoned are not only robbed of their hard work by publishing their research results in fake, dubious and predatory research journals, but also of their money which these bogus journals charge from them in the name of Article Processing Charges (APC). All this has somewhere led to the situation whereby researchers before submitting their research results for publication in journals, invest a good amount of time in ascertaining whether the journal is authentic or not. Even the indexing of journals in good indexes like WoS and SCOPUS is no guarantee whether the journal is predatory or not. Given the fact, the undergoing study is an attempt to draw awareness among research and scientific community about the quantum of research journals which are being launched each new day (Tables 1, 2, 3, 4, 5, 6, 7, and 8).

Objectives of the Study

To determine the growth of OA journals indexed in DOAJ during the last two decades viz., for the period 2002–2021.

To assess the growth and distribution of OA journals across continents against the average OA journals published at continent level with the leading continent to publish OA journals and to determine the average annual growth of OA journals at continental level.

To tabulate the twenty leading OA journal publishing countries across the world and distribution of OA journals on the basis of language and subject.

To compute the average APC levied by an OA journal and the average number of weeks taken by an OA journal from article submission to publication.

Review of Literature

Research journals apart from being authoritative sources of scientific communication also play a significant role in validating the research results [11]. Timely communication of scientific investigations is important for many reasons and the foremost being that these scientific findings become obsolete within no time of their investigation, thereon limitations of publishing a certain number of research results in each issue of a journal either results in delay in publishing research results or results in higher article rejection rate of a journal. All this has somewhere resulted in emergence of new journals that too at an exponential rate including OA research journals. So in a way emergence and launch of new research journals is equally important for sustainable production and timely publication of scientific research results.

Table 1 Year wise indexing of OA journals in DOAJ

S. no	Year	No of journals indexed	Percentage of $B = \frac{B}{TotalofB} X100$	Annual corresponding growth percentage (AACG)	Cumulative growth of B	Percentage cumulative growth $F = \frac{E}{TotalofB} X100$
	A	B	C	D	E	F
01	2002	22	0.13	–	22	0.13
02	2003	152	0.92	590.90	174	1.05
03	2004	181	1.09	19.07	355	2.14
04	2005	152	0.92	− 16.02	507	3.06
05	2006	148	0.89	− 2.63	655	3.95
06	2007	172	1.04	16.21	827	4.99
07	2008	264	1.59	53.48	1091	6.58
08	2009	278	1.68	5.30	1369	8.25
09	2010	524	3.16	88.48	1893	11.41
10	2011	484	2.92	− 7.63	2377	14.33
11	2012	482	2.91	− 1.65	2859	17.23
12	2013	778	4.69	61.41	3637	21.92
13	2014	338	2.04	− 56.55	3975	23.96
14	2015	1137	6.85	236.39	5112	30.82
15	2016	1559	9.40	37.11	6671	40.21
16	2017	2375	14.32	52.34	9046	54.53
17	2018	2177	13.12	− 8.33	11,223	67.65
18	2019	1912	11.53	− 12.17	13,135	79.18
19	2020	2133	12.86	11.55	15,268	92.04
20	2021	1321	7.96	− 38.06	16,589	100.00
	Total (avg)	16,589 (829.45)		1029.20 (51.46)		

AACG average annual corresponding growth

Table 2 Distribution of OA journals on the basis of language

S. no	Name of the language	No of journals	% Age share	S. no	Name of the language	No of journals	% Age share
01	English	11,468	69.13	06	Persian	257	1.55
02	Spanish	1394	8.40	07	French	213	1.28
03	Portuguese	1023	6.17	08	Arabic	171	1.03
04	Indonesian	798	4.81	09	Italian	122	0.74
05	Russian	296	1.78	10	Catalan	109	0.66

The growing popularity and growth of open access journals all across the world can be assessed from the fact that from 2003 to 2012 the number of open access journal publishing countries grew from 49 to 120, a growth of 144% [18]**.** The researchers also observed the dominance of Europe as a continent in publishing open access journals (37.14%) across 43 countries, the highest across any continent of the world. The exponential growth of journals in general and open access journals in particular can be owed to manifold growth in research activities all over the world. During the period 2000 through 2009 research articles grew at an average of 30% annually while research journals grew at an average of 18% annually [8]. This considerable difference in the growth of research articles and research journals somewhere provides breeding ground for launch of low quality, dubious, fake and predatory journals as well.

Chemistry is being found as one of the major subject disciplines in which manifold growth is being observed in the introduction of new journals all across the world. During 1910 only 435 research journals were covered by chemical abstract and this number shot up to over 14,000 journals by 1975–1976 [6, 24]. In a similar study researchers found a sharp surge in the research output in the field of chemistry at the global level which resulted in the introduction of new journals during the period 1967–1976 [24]. While studying the nature and growth pattern of library and information Science research journals, researchers [16] identified nearly 1700 journals which double almost every 13.8 years [4].

Indexing of journals in good and popular indexes like SCOPUS and WoS is considered as one of the quality parameters of a research journal. However a good number of research journals all across the world in different subject disciplines are published outside the popular indexing list, which is quite contrary to the standard practices of journal publishing and are not mostly counted and considered while quantifying such documents. In a study while assessing the indexing of Indian Science and Technology research journals in SCI from 1975 to 1988, the researchers found the figures quite discouraging and observed that slight publishing quality improvement can help them find a place among SCI journals [23].

Popularity of OA publishing is gaining momentum among scientific and scholarly community across the world for making research results available to one and all free of cost. Researchers have been advocating from time to time that purpose of undertaking research gets fulfilled only when the same is made available to end

Table 3 Year wise OA journals indexed across continents

S. no	Year	Africa		Asia		Australia		Europe		N. America		S. America		Total	
		Jrls	CG%	Jrls	CG%	Jrls	CG%	Jrls	CG%	Jrls	CG%	Jrls	CG%	Jrls	CG%
	A	B	C	D	E	F	G	G	I	J	K	L	M	N	O
01	2002	–	0	–	0	–	0	21	0	01	0	–	0	22	0
02	2003	2	0	5	0	2	0	108	414	32	3100	03	0	152	591
03	2004	1	− 50	8	60	3	50	69	− 36	12	− 63	88	2833	181	19
04	2005	1	0	10	25	1	− 67	87	26	26	117	27	− 69	152	− 16
05	2006	2	100	10	0	1	0	82	− 6	19	− 27	34	26	148	− 3
06	2007	1	− 50	10	0	3	200	91	11	20	5	47	38	172	16
07	2008	4	300	16	60	2	− 33	173	90	26	30	43	− 9	264	53
08	2009	2	− 50	31	94	3	50	190	10	20	− 23	32	− 26	278	5
09	2010	7	250	48	55	08	167	338	78	42	110	81	153	524	88
10	2011	1	− 86	49	2	04	− 50	306	− 9	46	10	78	− 4	484	− 8
11	2012	7	600	35	− 29	02	-50	302	− 1	37	− 20	99	27	482	0
12	2013	11	57	117	234	08	300	437	45	71	92	134	35	778	61
13	2014	05	− 55	34	− 71	05	− 38	206	− 53	38	− 46	50	− 63	338	− 57
14	2015	05	0	233	585	08	60	656	218	83	118	152	204	1137	236
15	2016	41	720	455	95	08	0	642	− 2	140	69	273	80	1559	37
16	2017	33	− 20	873	92	16	100	850	32	164	17	439	61	2375	52
17	2018	37	12	680	− 22	22	38	879	3	215	31	344	− 22	2177	− 8
18	2019	28	− 24	555	− 18	13	− 41	835	− 5	154	− 28	327	− 5	1912	− 12
19	2020	41	46	578	4	18	38	888	6	216	40	392	20	2133	12
20	2021	23	− 44	282	− 51	08	− 56	731	− 18	145	− 33	132	− 66	1321	− 38
	Total (AACG)	252 (13)	1708 (85)	4029 (201)	1115 (55)	135 (7)	669 (33)	7891 (395)	804 (40)	1507 (75)	3499 (175)	2775 (139)	3214 (161)	16,589 (829)	1030 (52)

Jrls journals, *CG%* corresponding growth percentage, *AACG* average annual corresponding growth

Table 4 Open Access journals published across continents

S. no	Name of the continent	No of journals published	Percentage of B $= \frac{B}{TotalofB} X100$	Journals having APC	Percentage share of $D = \frac{D}{B} x100$	No of journal publishing countries	Percentage share of $F = \frac{F}{TotalofF} x100$	Leading journal publishing country at continental level		Percentage share of $H = \frac{H}{B} x100$
								Name of the country	No of journals	
	A	B	C	D	E	F	G	H	I	
01	Africa	252	1.52	116	46.03	19	15.08	South Africa	113	44.84
02	Asia	4029	24.29	1187	29.46	39	30.95	Indonesia	1850	45.92
03	Australia	135	0.81	35	25.93	03	2.38	Australia	116	85.93
04	Europe	7891	47.57	2826	35.81	41	32.54	UK	1814	22.99
05	North America	1507	9.08	445	29.53	14	11.11	US	929	61.65
06	South America	2775	16.73	134	4.83	10	7.94	Brazil	1635	58.92
	Total	16,589		4742	28.59	126			6457	

Table 5 Twenty leading OA journal publishing Countries across the world

S. no	Name of the country	Continent	No of journals	Journals having APC	Percentage share of $D = \frac{D}{C}x100$	Percentage share
	A	B	C	D	E	F
1	Indonesia	Asia	1850	628	33.95	11.15
2	United Kingdom	Europe	1814	1400	77.18	10.93
3	Brazil	South America	1635	112	6.85	9.86
4	United States	North America	929	399	42.95	5.60
5	Spain	Europe	870	36	4.14	5.24
6	Poland	Europe	741	137	18.49	4.47
7	Iran	Asia	619	161	26.01	3.73
8	Russian Federation	Europe	463	41	8.86	2.79
9	Italy	Europe	441	53	12.02	2.66
10	Switzerland	Europe	436	379	86.93	2.63
11	Turkey	Asia	414	23	5.56	2.50
12	Colombia	South America	409	03	0.73	2.47
13	Ukraine	Europe	377	161	42.71	2.27
14	Romania	Europe	364	66	18.13	2.19
15	Netherlands	Europe	315	202	64.13	1.90
16	Argentina	South America	314	10	3.18	1.89
17	India	Asia	305	79	25.90	1.84
18	Germany	Europe	301	103	34.22	1.81
19	France	Europe	247	27	10.93	1.49
20	Serbia	Europe	197	18	9.14	1.19
21–126	Rest of the world		3548	704	19.84	21.38
	Total		16,589	4742	28.59	

APC article processing charges

users without any difficulty, thereby increasing its impact, usage and visibility, which is the ultimate purpose of undertaking any research activity [1, 3, 10, 20]. In 1992 there were only 5 (five) OA journals and by 2002 this number grew over 1200 OA journals [7]. In a similar study, while assessing the growth of research journals in India from 2002 to 2010 researchers [25] observed that on average research articles in India grow at 5.44%, while research journals grow at 3.29% annually during the same period.

Open access research journals are being published all across the world, but Asian countries are more popular for publishing OA journals. Around 300 journals were published in OA format from India around 2011–2012 by the publishers like Medknow, AIRCC, NISCAIR, and Bio-Info [15] and nearly 175 were hosted or indexed in DOAJ and O-Jgate [21]. Researchers in past have also attempted to explore the

Table 6 Dichotomous aspects related to journal publishing policy

S. no		No of journals	Yes	Percentage of $C = \frac{C}{B}x100$	No	Percentage of $E = \frac{E}{B}x100$
	A	B	C	D	E	F
1	©without restriction to Authors	16,589	8649	52.14	7940	47.86
2	Journal Plagiarism Policy	16,589	8935	53.86	7654	46.14
3	Article Processing Charges	16,589	4742	28.59	11,847	71.41
4	Journal Waiver Policy	16,589	3085	18.60	13,504	81.40
5	Has Other Fees	16,589	390	2.35	16,199	97.65
6	Persistent Article Identifiers	16,589	11,403	68.74	5186	31.26
7	DOAJ Seal	16,589	1473	8.88	15,116	91.12
8	Weather Journal has Print ISSN	16,589	10,048	60.57	6541	39.42
9	Weather Journal has eISSN	16,589	15,159	91.37	1430	8.62

Table 7 Distribution of research journals indexed annually having APC

Year	Total journals	Journals having APC	%age share of journal having APC
2002	22	17	77.27
2003	152	94	61.84
2004	181	72	39.78
2005	152	44	28.95
2006	148	43	29.05
2007	172	47	27.33
2008	264	90	34.09
2009	278	136	48.92
2010	524	157	29.96
2011	484	149	30.79
2012	482	151	31.33
2013	778	241	30.98
2014	338	144	42.60
2015	1137	372	32.72
2016	1559	386	24.76
2017	2375	541	22.78
2018	2177	511	23.47
2019	1912	517	27.04
2020	2133	563	26.39
2021	1321	466	35.28
Total	16,589	4742	28.59

APC Article Processing Charges

Table 8 Time lag between article submission and publication

Average weeks between article submission and publication	No of journals	APC	%age share of journal having APC	Average weeks between article submission and publication	No of journals	APC	%age share of journal having APC
1	21	7	33.33	37	23	8	34.78
2	67	17	25.37	38	34	10	29.41
3	121	25	20.66	39	29	11	37.93
4	742	177	23.85	40	191	35	18.32
5	331	88	26.59	41	13	7	53.85
6	754	245	32.49	42	26	8	30.77
7	235	113	48.09	43	20	7	35.00
8	1562	423	27.08	44	14	2	14.29
9	234	91	38.89	45	41	7	17.07
10	1008	278	27.58	46	12	6	50.00
11	334	261	78.14	47	12	3	25.00
12	2438	569	23.34	48	116	17	14.66
13	351	212	60.40	49	8	4	50.00
14	374	171	45.72	50	89	7	7.87
15	594	226	38.05	51	7	2	28.57
16	1389	367	26.42	52	141	17	12.06
17	168	86	51.19	53	89	16	17.98
18	339	123	36.28	54	4	0	0
19	128	76	59.38	55	1	1	100.00
20	1055	211	20.00	56	1	1	100.00
21	126	62	49.21	57	2	0	0
22	142	56	39.44	59	1	0	0
23	84	36	42.86	60	8	3	37.50
24	1485	276	18.59	63	1	0	0

Table 8 (continued)

Average weeks between article submission and publication	No of journals	APC	%age share of journal having APC	Average weeks between article submission and publication	No of journals	APC	%age share of journal having APC
25	243	51	20.99	64	1	1	100.00
26	213	42	19.72	65	3	1	33.33
27	64	30	46.88	67	1	0	0
28	162	39	24.07	70	1	0	0
29	38	22	57.89	72	2	0	0
30	383	60	15.67	75	1	0	0
31	36	18	50.00	78	1	0	0
32	163	31	19.02	80	2	0	0
33	38	16	42.11	86	1	1	100.00
34	44	21	47.73	88	1	1	100.00
35	84	17	20.24	90	2	0	0
36	137	23	16.79	100	3	0	0

APC article processing charges

OA research journals published in the subject disciplines like Economics, Medicine, Library and Information Sciences etc. [14, 19, 20]. The unprecedented growth of new journals in different subject disciplines across Asian countries has somewhere tagged the region as home of predatory journals as well. Accordingly, researchers [17] in their study while assess the growth of research journals in India found that 15,631 new research journals were launched in India from 2005 to 2014 at an annual growth of 31.44%, with majority 82.36% journals published in English language. However, only 3% of research journals published from India stand indexed in SCOPUS, which is a very miniscule number given the total number of research journals published across India.

With the view to find out the average number of articles published in each volume of an OA research journal the researchers [28] collected data from 387 OA journals and found on average 18 articles are published in each volume of an open access research journals, while [13] analyzed 1213 OA journals and found that on average 42 research articles are published in each volume of an OA research journal. There is a steady increase in the number of research articles published in OA peer reviewed research journals. During the year 2008 around 20% of the total research articles published in peer reviewed journals were published in open access journals [2].

Materials and Methods

The undergoing study is based on secondary data retrieved from the official website of Directory of Open Access Journals (DOAJ) on July 17, 2021, which can be accessed at https://doaj.org/docs/public-data-dump [5]. To validate results and make study more relevant, authentic study is based on the data of last two decades viz., for the period 2002 through 2021. However, the data for the year 2021 is incomplete as the data itself was downloaded on July 17, 2021 as such the journals indexed post July 17, 2021 do not form the part of this study. The data obtained from the website was available in semi-structured form and was structured keeping in view the objectives of the study.

Results

The mathematical computations like addition, subtractions, division, and drawing percentage, etc., were performed using MS Excel. The percentage at all the places has been drawn up to two decimal places and has been rounded off to 100% figure.

In the year 2002, 22 journals were indexed in DOAJ and the number reached to 16,589 Journals during the last two decades at an average of 829.45 journals each year at an average annual corresponding growth of 51.46%. Since the data for the year 2021 was collected up to July 17, hence reflecting a lesser number of journals than 2020. The maximum 14.32% research journals were indexed in the year 2017, followed by 13.12% in 2018 and 12.86% in 2020. The negative corresponding growth in the indexing of journals was observed in the years 2005, 2006, 2011,

2012, 2014, 2018 and 2019, while the negative growth recorded in the year 2021 is primarily for incomplete data. The year 2014 recorded the highest negative growth of (-56.55%), while on average each year the OA journals indexed in DOAJ grew at 51.46%, which is quite exponential. Of the total journals indexed in DOAJ as on date, first 54% journals took 17 years, while it took only 3 years to index the remaining 46% journals.

Pressure to publish on teaching faculty, scientific and research community all across the world has promoted research activity manifold, resulting in producing and publishing more and more research results. The existing journals are facing extreme pressure of receiving over and above the expected number of manuscripts which has resulted in increased rate of rejection of articles by the journals. All this has some where opened the scope for new research journals to be launched and get established. Post 2016 DOAJ witnessed an exponential growth in indexing OA journals and this trend is likely to continue as more and more OA journals are being launched at all levels all across the world. Publishers having business interest are launching more OA journals with Article Processing Charges (APC).

Of the 16,589 journals indexed (11,468, 69.13%) are published in English language, followed by (1394, 8.40%) in Spanish and (1023, 6.17%) in Portuguese. The other leading languages in which more than hundred OA journals are published include, Indonesian, Russian, Persian, French, Arabic, Italian and Catalan. Nearly 96% of the total OA journals across the world are published in 10 leading languages, while the remaining 4% journals are being published in the 44 other languages.

There is no denial in it that English is the most preferred language to communicate at international level and so is English language preferred by the global researchers to publish their research findings as such publishing nearly 70% of OA journals in English language can be termed natural. Journals published in 46 languages constitutes less than 1% share each. The distribution of research journals published in other than English languages are having disproportionate distribution, which is contrary to the sustainable means of journals publishing across languages.

On average each year around 829 OA journals are indexed in DOAJ across the world. Europe is the leading continent to index on average 395 journals each year, which is highest across continents, followed by Asia with 201 journals, South America 139 Journals, North America 75, Australia 07 and Africa 13 journals, which is lowest across the continents. During the last two decades North America registered 1507 OA journals at an Average Annual Corresponding Growth (AACG) of 175%, followed by South 161%, Africa 85%, Asia 55%, Australia 33% AACG and Europe recorded an average annual corresponding growth of 40%, which his lowest among all the continents.

It is evident from the data that distribution of OA journals indexed across continents is quite disproportionate, which again can be termed contrary to the interests of sustainable and equitable growth of OA journals across continents. Europe is the leading continents publishing highest number of OA journals, followed by North America and Asia, while rest of the continents need to improve their numbers.

The majority (7891, 47.57%) OA journals indexed in DOAJ are from Europe, reflecting the journal publishing prowess of European countries, constituting around 50% of the OA journals published across the world, while the remaining 50%

journals are being published across the five remaining continents. Asia publishes around one-fourth of total world OA journals followed by South America (2775, 16.73%) journals. Africa, Australia and North America together are publishing around 12% of the total OA journals indexed.

These days' publishers ask for Article Processing Charges (APC) from researches for publishing their research results and the trend is more prevalent among OA research journals. Of the total OA journals indexed in DOAJ, 28.59% are having APC, however a considerable variation can be found in the APC at continental level. Of the total research journals indexed from Africa 43.06% research journals are having Article APC. Similarly, 35.81% OA journals from Europe, 29.53% from North America, 29.46% from Asia and 4.83% journals from South America have Article Processing Charges.

In all 126 countries were found to be publishing OA journals at an average of 132 journals per country with Europe leading the table with (41, 32.54%) countries followed by Asia (39, 30.95%) and Africa (19, 15.08%) countries. Australia has the lowest (03, 2.38%) countries among all the continents. South Africa is the leading country from Africa publishing the maximum 113 journals constituting 44.84% of the total OA research journals published across Africa. Similarly, Indonesia publishes the highest 1850 journals, constituting 45.92% OA journals published across Asia. Accordingly, Australia (116, 85.93%), UK (1814, 22.99%), US (929, 61.65%) and Brazil (16.35, 58.92%) are the leading countries from Australia, Europe, North America and South America publishing the maximum number of OA journals from the respective continents. The six leading OA journal publishing countries from each continent together publish 6457 journals, constituting 38.92% of the total OA journals indexed in DOAJ.

Of the world's twenty leading OA journal publishing countries, 12 are from Europe, 04 from Asia, 03 from South America and 01 from North America, again reflecting the prowess of European countries in publishing journals and the research results thereof. Indonesia is publishing the highest (1850, 11.15%) of the world's total OA journals. However these figures can be seen contrary to individual research contribution of Indonesia, which is the 45th research contributing country in the world (SCImago, 2020). Brazil the second leading OA journal publishing country in the world is again a bit controversial given its research contribution at the global scene. The twenty leading countries listed in Table-5 are together publishing 78.62% of the total OA journals published across the world.

Nearly 87% OA journals published across Switzerland have APC. Similarly, more than 77% journals published from the United Kingdom and 64% from Netherlands ask for Article Processing Charges form researchers for publishing their research results in their OA journals. Ukraine is one more leading country form the Europe from where nearly 43% OA research journals ask for APC form scientific community. In all 28.59% of research journals indexed in DOAJ were found having APC. Indonesia, the US and the Germany are the other three countries which are having a higher percentage of OA journals having APC. Colombia is the only country among the leading twenty countries which has less than 1% research journals asking for APC.

There has been always a growing controversy around the Research journals seeking Article processing charges from the scientific community. Most of these journals are being looked at as predatory nature, as publishers of these research journals are mostly aimed to make money, with the result most of these journals undermine the quality of research results for the sake of money and are alleged of publishing even substandard research results. Questions are being always raised over the peer review process followed by all such journals, as a good number of OA journals were found to publishing research results within week's period from the date of receipt of the manuscript.

During the data analysis, some dichotomous aspects of the OA journals indexed in DOAJ also surfaced. These dichotomous questions are more often raised by the researchers to ascertain the genuineness of a research journal before submitting research results for publication. Accordingly, of the total journals indexed in DOAJ, 52.14% are without copyright restriction to authors, 53.86% journals follow the plagiarism policy. This also means that nearly 50% OA journals do not believe in plagiarism detection of the manuscripts submitted, which indeed is very serious and contrary to the global research interests. 28.59% research journals have APC, although 18.60% journals also have a waiver policy. Still more, 2.35% research journals also seek other charges, which are mostly hidden and are asked on different counts. Researchers need to aware of all such gimmicks which publishers are playing with the sole aim to make money. In all 4742 OA research journals were found having article processing charges at an average of 1094.47 US dollars per article, ranging from as low as 0.01 $ to as high as 125,000 $.

Digital Object Identifier (DOI) is also known as Persistent Article Identifier (PAI), which in fact is a unique identity assigned to each individual article published online by any journal. Only, 69% journals were found to be having a persistent article identifier. Assigning DOI or PAI is important for all good reasons, especially when there is a deluge of information available online, thereon to locate a particular piece of information having no individual identity is like looking for a particular particle in a heap of straw. Research journals not assigning DOI or any other unique identification number should update their publishing practices by adopting all digital means of publishing which prove helpful in locating the desired piece of information.

It is a very well-known fact that research journals these days are being published in hybrid form, viz., both in print as well as online format, with the result most of the journals indicates both type of ISSN on their journal website or on the print version of their journal copy. Accordingly, of the total journals indexed in 1430 research journals are purely published only in print form as such do not have any eISSN No. while (6541, 39.42%) journals are being published purely in digital form viz. online, while (8618, 51.95%) journals are being published in hybrid format.

In an attempt to reflect the percentage share of journals having APC indexed each year during the last 20 years, it emerged that of the 22 OA journals indexed during the year 2002, (17, 77.27%) journals are having APC, which is highest during the last two decades. Similarly in the year 2003, 61.84% journals indexed are having APC, followed by 48.92% journal in 2009. 22.78% journals having APC indexed

during the year 2017 is lowest percentage of journals having APC indexed during the period of study, while 28.59% is the overall percentage of journals having APC.

On average each open access journal takes 16.60 weeks between submission and publication of an article, the minimum number of weeks taken between the submissions of an article to its publication is one week and the maximum number of weeks taken between the submission and publication of an article is 100 weeks. This considerable difference in the submission and publication of an article tells the tale of differences between the review processes in an open access research journal. It can also be inferred that 16.60 weeks is the average time period between the article submission and its publication, hence can be presumed as an ideal and minimum standard time period between an article submission and its publication. Given the fact, the role of nearly (10,555, 63.62%) OA research journals indexed in DOAJ taking less than 16.60 weeks between article submission and its publication becomes questionable on different counts including undermining the quality of peer review process, plagiarism policy and the APC or any other charges if any involved in the publication of research articles.

Nearly one-third (36%) of the total research journals publishing research results in less than 16.60 weeks of the article submission ask for APC from researchers, which is nearly 8% higher than the acceptable percentage share of journals involving APC viz., 28.59%. However, APC being one of the prime reasons for publishing articles in less than 16.60 weeks of their submission cannot be ruled out and this gets better corroborated by the fact that of the total 4742 journals having APC, 3270 (68.95%) journals are publishing research results in less the 16.60 weeks, while the remaining (1472, 31.04%) journals are taking more than 16.60 weeks from submission to publication of an article. What becomes more questionable is, are all such journals of predatory nature which are having APC and are publishing research results in less than 16.60 weeks of their submission, something which needs further exploration to establish a correlation between the APC and the time period involved between article submission and its publication. By that time researchers can take a cue from the above analysis to see all such journals from the prism of suspicion of being predatory nature involving APC and publishing research results in less than the desired period.

Discussion

Open access publishing has become more or less a global order, as more than 125 countries across the world are actively publishing journals in OA format and in the coming years the number is bound to soar and so will OA journals. Nearly half the OA journals published as on date were introduced from 2017 to 2020 and this exponential growth of introducing new OA research journals is bound to continue at the same pace for next few years or till the time some saturation is attained or some new order is unfolded in publishing research results. Academicians, researchers and other scientific communities are producing research results at an exponential rate and this is bound to push the growth of both Open Access (OA) and Toll Access (TA) research journals. Limited platforms

to publish research results and high article rejection rate is bound further the growth of new research journals in either format. There is a steady increase in the OA research journals published in other than English language. These days emphasis is being paid on publishing research results in regional and local languages as well this again is bound to push the growth of non-English research journals.

Article Processing Charges (APC) sought by nearly one-third of the OA research journals is somewhere becoming the reason to see all such OA research journals with a bit of suspicion of being predatory nature and in the coming days most of the genuine OA journals may do away with the APC's. OA journals provide a good platform to budding researchers to publish their research results, especially by those researchers who are not in a position to pay APC's or those research who do not find sponsors in the shape of funding agency to support their research activity. Australia and Africa are the two continents which lag in publishing OA journals, as such can do more to promote OA journal publishing.

Open Access publishing if on one hand has shown promise to reach out to those who hitherto remained unreached, at the same time OA journals are being questioned and criticized for a range of reasons including peer-review process, thereby involving the danger of producing non-serious and dubious research results as well. This non-seriousness of OA journals gets also somewhat reflected and becomes questionable by the fact that Indonesia if on one hand is the world's 45th ranked research country at the same time is the world's largest OA journal publishing country, constituting 45.92% of the total OA journals published across Asia and 11.15% of the total OA journals published across the world. The disproportionate distribution of OA research journals published across continents has to be more sustainable and equitable. The dominance of Europe in publishing around 50% of the world OA journals again questions the non equitable distribution of OA journals across the world.

Open access publishing is known for granting more visibility and easy accessibility to research results, while the research results accessible though restricted windows or through payment modules have limited visibility and are far from the accessibility of those end users who cannot afford such research results. It is being also argued that research all across the world is being mostly undertaken on public money collected in the shape of taxes and other mediums by the government and its agencies. It is this money which is being provided to research institutions all across the world by their respective governments to undertake research, thereby public has got every right to know about the outcome of their money pushed in scientific activity and the benefit thereof people in general are able to accrue from any scientific or research investigation supported by the public money. Hence the argument is, public should not pay for accessing any scientific or research outcome which itself has been undertaken on their money. All these and many more arguments are being made by the advocators of open access publishing to support the open access movement for the larger and wider benefit of one and all. The two main reasons for the popularity of OA research journals are the visibility of research results published and making same freely accessible to one and all for the larger benefit.

Conclusion

Open Access journals have become increasingly popular among the research and scientific community all across the world. As long as OA journals maintain their publishing standard by adhering all ethical practices, the journals will survive and the moment such standard practices are overlooked the journals may die their own death. There are growing apprehensions among the research and scientific community that a good lot of OA journals are fake, sub-standard, lacking peer-review process, aimed to make money in the name of APC and are of predatory nature, as such it becomes increasingly difficult to ascertain the same. With the result, despite having a range of benefits researchers mostly prefer to publish their research results in journals having TA. Predatory journals are being seen as unethical spin-offs of digital publishing. Undoubtedly OA journals have to do more to keep their readership growing and have to do more than what other mainstream journals do to survive in the research results publishing industry so that researchers may not hesitate to publish their research outcome in an OA journal. The bottom line is OA research journals somewhere still remain a second choice among the researchers to publish their research results and as such still have to do a lot to replace the TA journals to be the first choice among the researchers to publish their research results.

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