
Analysis of DOAJ-Registered Open Access Journals in Asian Countries

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ABSTRACT

This study aims to understand the characteristics of Asian OA journals and to identify differences by the countries. 3,103 DOAJ-registered OA journals from 21 Asian countries as of 2020 were selected and analyzed from various perspectives using correspondence and correlation analysis. The results revealed that Indonesia had the most DOAJ-registered open access journals, followed by Iran and India. An APC was not charged by 70% of journals, but this varied greatly by country. Meanwhile, as a result of comparing DOAJ-registered Asian journals with international citation database listed journals, 11% of journals were listed on Scopus and only 2.6% and 0.1% were listed on SCIE and SSCI, which represents less than half of the global level. In addition, although there are many free to read local journals in China, Japan, and Korea, the number of OA journals registered in DOAJ is relatively small. Therefore, it is difficult to say that the progress of OA in local journals is fast even if the country's global research competitiveness is high.

1. Introduction

OA methods include so-called "green OA" published in paid journals but open accessed through OA archives, and hybrid methods published in paid journals but published with an article processing charge (APC). However, the most representative method is the so-called "gold OA" method, which involves publication in OA journals listed in the Directory of Open Access Journals (DOAJ). The DOAJ is a reliable OA journal directory that supports free access to scientific discovery by registering and presenting OA journals according to international standards. As of 2022, the DOAJ had 18,109 journals registered in 130 countries.

In the West, which has been reinforcing the APC-based gold OA policy, a new subscription model is being applied to support the sustainable OA business model. In addition, the European Union's cOAlition S consortium has promulgated the principle of Plan S to implement immediate OA to public funded research results. DOAJ registration has become a major requirement for academic journals to publish research results conducted with public funds, since Plan S requires free access

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to research results through journals that guarantee a high level of OA service.

In contrast to the situation in Western countries, almost academic journals in Asian countries are not easy to access and find them. This problem not only accelerates the knowledge gap between developed and developing countries but also becomes an obstacle when attempting to develop a global blueprint through scientifically discovered knowledge in any field. In such a situation, the DOAJ can have great value as a path to complementing the global knowledge flow by accessing open research results published in developing countries.

Against this background, this study aims to use the DOAJ to analyze OA journals in Asian countries. In particular, by analyzing the APC, and international citation index listing rates of journals, this study aims to understand the characteristics of OA journals in Asian.

2. Literature review

Asian countries are expanding their OA journals that are based on government support and subsidies, unlike Western countries which are mainly published and distributed by commercial publishers. A total of 3,103 OA journals are registered in the DOAJ in Asian countries, excluding the Arab world. Indonesia registers by far the highest number of journals, followed by Iran. Rather than adopt the APC business model used in the West, Asian countries publish OA journals as a condition of receiving subsidies from the government or universities. Since the publication of academic journals has become a major indicator of university evaluation, active scientific publication centering on universities is being conducted. Here, we take a closer look at Asian OA infrastructure in major countries.

Although hundreds of free to read journals are known to be in service in China, (Shen, 2017), only 121 journals were registered with DOAJ in 2020. This is because there are many journals that have not adopted copyright transfer agreements and CC licenses, or have difficulty transitioning to the OA model under commercial agreements. CNKI, Wanfang, and Chongqing VIP Information are the three major aggregators in China, which are granted non-exclusive or exclusive distribution rights by the publishers. They dominate Chinese scholarly resources with their excellent integrated service infrastructure, which contrasts with the poor service of individual journal publishing institutions (Shen, 2017). Similarly in Korea, academic journals are freely released with support from universities and governments, but there are also a number of journals that are not registered in the DOAJ. There are 1,066 open service journals registered in the Korea Open Access Journals database, but around 100 journals are registered with the DOAJ. This is because, as in China, there are many journals that are difficult to convert to gold OA due to contracts with commercial aggregators such as DBPIA and KISS. There is no clear policy to support gold OA, but discussions on support policies to induce OA publishing are starting with the recently announced NRF OA 2021 (Plan) (Joung et al., 2020). Meanwhile, in Japan, NACSIS-ELS, an e-journal platform, publishes 2.8 million articles in 1,000 journals, and J-STAGE hosts about 2,865 journals in 2019. However, as of May 2019, only 2.3% (65) of journals declare CC license and just 36 journals registered up to DOAJ. However, after the announcement of Plan S, journals on J-STAGE have been encouraged to register

on DOAJ, and registration is also regarded as a countermeasure to prevent predatory journalization (Japan Science and Technology Agency, 2019). Lastly, let's take a look at Indonesia, which has the most OA journals registered in DOAJ. 1,673 Indonesian journals are registered in DOAJ. Since most Indonesian journals are published by universities, they are mainly operated through government subsidies or institutional funding and use a unified electronic journal publishing platform such as Open Journal Systems (OJS). Moreover, 75% of the journals do not charge APCs, with the remaining 25% charging up to \$150. ARJUNA (Akreditasi Jurnal Nasional), a national journal accreditation body, certifies journals on the basis of strict standards, contributing to the ranking of the highest DOAJ registration in the world (Mathias, 2018).

In addition, let's take a look at previous studies that analyzed open access journals using DOAJ as a source. First, Pandita (2013) analyzed OA journals registered with the DOAJ from 2002 to 2012 and found that Europe ranked highest in contributions, followed by North America and Asia. They said that in Asia, India ranked highest for registered journals, followed by Turkey, Iran, and Japan. In addition, there are also studies that analyze the current status of OA journals in specific countries (Nashipudi & Ravi, 2015) and subject areas (Poorna et al., 2012; Shah et al., 2018). Second, studies focusing on APC in open access journals are as follows. According to Morrison (2018), as of 2018, 29% of journals were charging APCs, registered in 37 different currencies. The researchers noted that the update cycle of the DOAJ metadata for the APC amount was not provided clearly, so that the currency and reliability of the data required supplementation. Príncipe (2019) identified Brazilian and Portuguese journals charging an APC, classified them by subject, and investigated the amounts charged. In Brazil, only a handful of journals use APC, with agriculture and medicine comprising the majority. Príncipe also reported that APC charges are high for journals focused on internationalization through translation into other languages. Third, studies that explored the rate of listing in the international citation database were also published. Björk and Korkeamäki (2020) analyzed the proportion of OA journals in 18 academic disciplines of Scopus. It was reported that the agricultural field had the highest number, at 27%, and the business administration field had the lowest, at 7%. Bierman (2019) analyzed the international journal citation index listing rate of OA journals in the field of engineering. The study found that 87% of the cases were indexed in at least one of Compendex, Web of Science, Inspec, and Scopus. Marchitelli et al. (2017) reported that only 1,130 out of all DOAJ journals were indexed in Scopus or Journal Citation Reports (JCR). Looking at specific figures, only 10% were registered in the JCR, and 23% were registered in Scopus. The researchers also noted that most of those adopting the APC model were highly cited OA journals.

3. Method of study

This study aims to understand the characteristics of Asian OA journals and to identify differences that may appear between countries by analyzing the APC and international citation index database listing rates by country. To this end, 3,103 OA journals from 21 Asian countries as of 2020, excluding the Arab world, were selected, and related metadata as of 2020 were extracted. The detailed research

method is described below.

First, 3,103 Asian countries' OA journals were compiled by country, language, registration year, seal grant. In addition, the subject areas of the journals were examined, and whether there were differences in subject area by country was visually confirmed through correspondence analysis. Correspondence analysis is a multidimensional scale method that visualizes relationships by plotting row and column values in a two-dimensional space.

Second, the proportion of journals' APC demands was distinguished by country, and the APC average and median were identified. Currencies other than USD, such as the CNY (Yuan Renminbi), IDR (Rupiah), INR (Indian Rupee), and IRR (Iranian Rial), were converted to USD using the exchange rate as of June 2020.

Third, the proportion of Asian countries' journals listed in the international citation index database was examined. Since the DOAJ does not collect information on journal impact factors by default, the task of comparing journals between the DOAJ and JCR/Scopus lists was performed. A total of 3,103 titles of DOAJ-registered Asian journals were compared with 40,386 Scopus, 9,394 SCIE (Science Citation Index Expanded), 3,496 SSCI (Science Citation Index), and 1,843 A&HCI (Arts and Humanities Citation Index) titles to determine whether OA journals were included in the major international citation index databases. This work was mechanically processed with KUTOOLS FOR EXCEL (<https://www.extendoffice.com/download/kutools-for-excel.html>) using the ISSN (International Standard Serial Number) and EISSN (Electronic International Standard Serial Number) provided to the journal. After the comparison, the difference in the JCR/Scopus listing ratio by country was also confirmed. In addition, a Pearson correlation analysis was performed to determine whether countries with high OA journal registrations have a high international citation index database listing rate.

4. Analysis results

4.1 Analysis of OA Journals in Asian countries

The total number of OA journals in Asian countries was 3,103 as of June 2020 (Table 1). By country, Indonesia has 1,673 journals, accounting for 53.9% of all Asian journals, followed by Iran (538) and India (290). China, Japan, and Korea, where the publication volume of international academic papers is high, do not show high ranking in the number of OA journal registrations. In addition, 68.5% of the journals used English as the official language, with the rest using their own national language. Indonesian was second in terms of language, unsurprising given that Indonesia has the largest number of registered journals.

Table 1. Distribution of countries and languages

OAJ by Country			Language					
Country	Num. of OAJ	Percent	Country	Num. of OAJ	Percent	Language	Num. of OAJ	Percent
Indonesia	1,673	53.9	Nepal	20	0.6	English	2,127	68.5
Iran	538	17.3	Hong Kong	19	0.6	Indonesian	716	23.0
India	290	9.3	Singapore	17	0.5	Persian	229	7.4
South Korea	130	4.2	Sri Lanka	16	0.5	Chinese	22	0.7
China	121	3.9	Philippines	11	0.4	none	3	0.1
Malaysia	71	2.3	Mongolia	4	0.1	Korean	2	0.1
Pakistan	64	2.1	Kazakhstan	4	0.1	Thai	2	0.1
Japan	36	1.2	Kyrgyzstan	3	0.1	French	1	0
Thailand	31	1.0	Azerbaijan	2	0.1	Russian	1	0
Taiwan	31	1.0	Viet Nam	2	0.1	SUM	3,103	100.0
Bangladesh	20	0.6	SUM	3,103	99.9			

Second, looking at the number of journals registered by period, it appears that the number of journals increased rapidly between 2015 and 2018 (Fig. 1). This seems to be the influence of Indonesia, where many journals were registered in 2017, and it seems that many journals were also registered in Iran and India at this time.

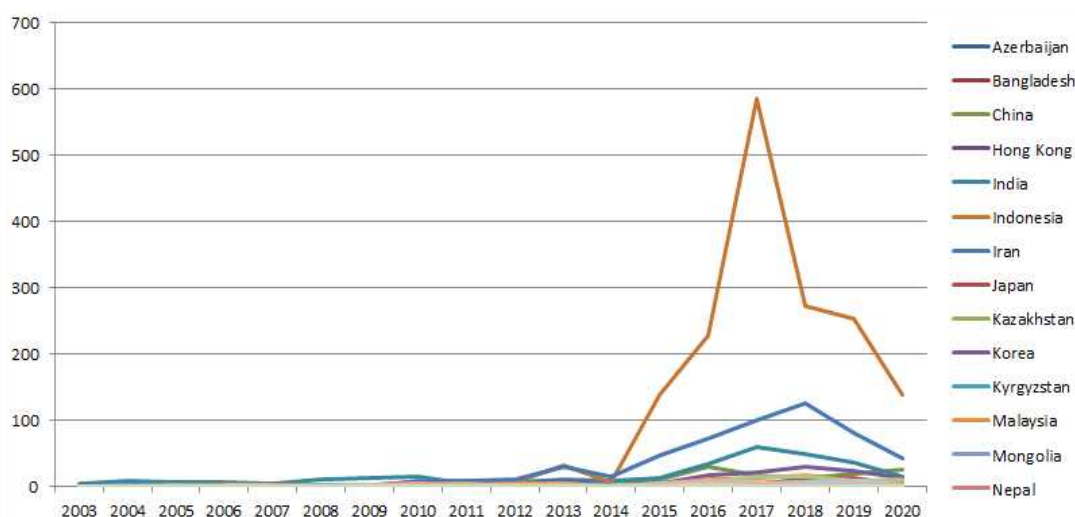


Fig. 1. Number of registered journals by period

Third, looking at the seal grant statistics, it can be seen that 99.4% of journals have not been granted, and only 0.6% of journals have been granted a seal. Only 20 journals have been granted a seal, including 5 in China, 3 in Korea, 2 each in India, Iran, Japan, and Singapore (Table 2).

To receive a DOAJ seal, the DOI and metadata must be substantial, and the content must be preserved under a long-term preservation program. In addition, permission for reuse of content under a license, such as the CC-BY, must be granted, and authors should be able to own the copyright to their own works without restriction. Looking at Asian journals with a seal, many journals have been published by Springer Nature, a major international publishing company, and are preserved for a long time through LOCKSS, CLOCKSS, and Portico. In addition, the journals are highly influential journals listed in the international citation index database such as WOS, Scopus.

Table 2. DOAJ seal granted status by country

Country	DOAJ Seal
China	5
Korea	3
India	2
Japan	2
Iran	2
Malaysia	2
Singapore	2
Indonesia	1
Bangladesh	1
Sum	20

Third, when looking at the subject area of the journals, it is noteworthy that nearly 30% of the journal subject areas are social sciences, followed by medicine and the natural sciences (Table 3). It is known that OA journals are generally dominated by the biomedical field, but the journals registered in the DOAJ by Asian countries show a social science bias. Because 44% (742) of Indonesian journals, which account for 53% (1,673) of the total Asian journals, are in the social sciences. Let's look at the results of visualizing the relationship between the subject areas of journals by country through correspondence analysis. Fig. 2 showing 95% of the cumulative two-dimension explanatory power was calculated by creating a country-journal cross-tabulation and then performing a correspondence analysis based on this. If you look at the middle of the map, there is natural science, and there is a technical field slightly above it. Many countries, such as Japan, China, and Malaysia, are around in this area. This means that many countries are participated in the publication of OA journals in the fields of natural and applied sciences. By contrast, medical science is located on the left side of the map, and Korea, India, Iran, and Nepal are nearby. These countries can be interpreted as having a relatively large portion of OA journals in the medical field. Finally, on the right side of the map are the humanities and arts and social sciences fields, and some countries, such as Indonesia, Pakistan, and Taiwan, are located around them. These countries thus have more OA journals in the humanities, arts, and social sciences fields than in other fields.

Table 3. OA journals by subject area of country

Country	Art and Humanity	Social Science	Natural Science	Technology	Medicine	Sum
Azerbaijan	0	1	0	1	0	2
Bangladesh	0	1	9	2	8	20
China	2	3	31	44	41	121
Hong Kong	2	1	6	3	7	19
India	6	10	26	17	231	290
Indonesia	301	742	280	209	141	1,673
Iran	54	83	104	75	222	538
Japan	8	4	8	8	8	36
Kazakhstan	0	0	3	0	1	4
Korea	4	16	17	16	77	130
Kyrgyzstan	0	1	0	1	1	3
Malaysia	10	13	17	24	7	71
Mongolia	0	1	2	0	1	4
Nepal	0	1	5	1	13	20
Pakistan	11	18	11	7	17	64
Philippines	4	2	1	1	3	11
Singapore	1	4	5	5	2	17
Sri Lanka	0	3	6	1	6	16
Taiwan	2	13	4	7	5	31
Thailand	2	5	8	11	5	31
Viet Nam	1	0	0	1	0	2
SUM	408 (13.1%)	922 (29.7%)	543 (17.5%)	434 (14.0%)	796 (25.7%)	3,103

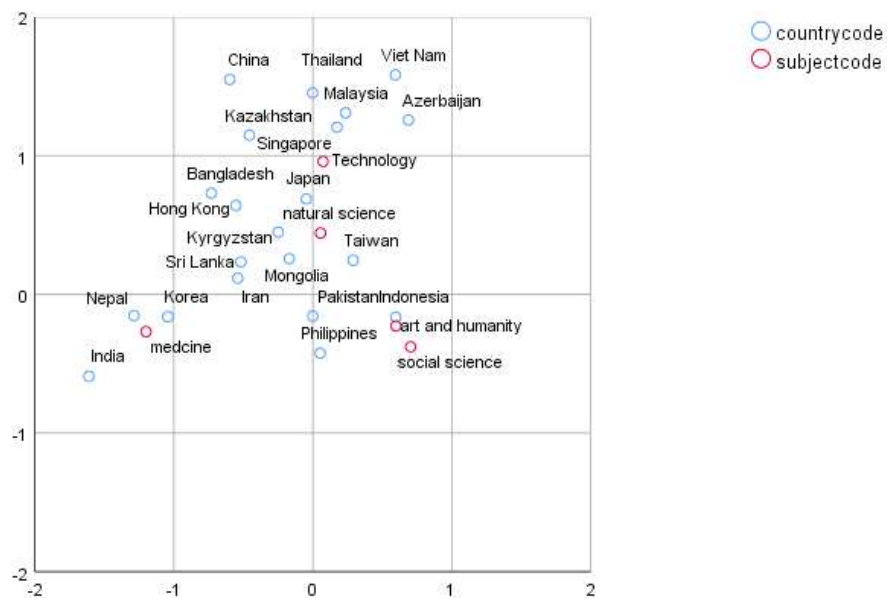


Fig. 2. Relations between country and subject area

4.2 APC analysis

The results of analyzing APC information on the 3,103 OA journals are show that only 28.6% of them have an APC (Table 5). The APC average was calculated at 157.6 USD (Table 4), which was calculated by converting each country’s currency to USD. Since the mean showed a large standard deviation (SD=325.35), the percentile was calculated to check the price range where the APC price was most distributed. As a result, 439 journals (49.5%) had charges under 50 USD, and the median was calculated at 53 USD, which is lower than the mean average. Since there are a few journals that charge high prices, the mean average value was higher. Therefore, we checked the journals that had a high-priced APC of over \$2,000. Five journals were found to charge high prices; *NPG Asia Materials* had the highest APC, at 4,530 USD. There was a slight difference between the amount posted on the journal’s website, \$3,790+VAT (the Americas, China, and Japan), and the amount registered in the DOAJ. The DOAJ metadata also includes submission fees other than an APC. It was found that 117 journals charge submission fees, of which 84 charge both an APC and submission fee and 33 charge just a submission fee. Additional costs for images and colors, types and lengths, discounts for developing countries, and different prices were also set by some journals, so the data collected here are only for reference.

Table 4. APC average

APC max	APC min	Average	Median	Standard Deviation
USD 4,530	0	USD 157.6	USD 53	325.35

Table 5. APC charge rate by country

Country	APC			SUM	Country	APC			SUM
	Yes	No	No-info			Yes	No	no-info	
Azerbaijan	0	2	0	2	Malaysia	10	61	0	71
	0.0%	100.0%	0.0%	100.0%		14.1%	85.9%	0.0%	100.0%
Bangladesh	6	14	0	20	Mongolia	1	3	0	4
	30.0%	70.0%	0.0%	100.0%		25.0%	75.0%	0.0%	100.0%
China	49	72	0	121	Nepal	1	19	0	20
	40.5%	59.5%	0.0%	100.0%		5.0%	95.0%	0.0%	100.0%
Hong Kong	11	8	0	19	Pakistan	19	44	1	64
	57.9%	42.1%	0.0%	100.0%		29.7%	68.8%	1.6%	100.0%
India	84	206	0	290	Philippines	0	11	0	11
	29.0%	71.0%	0.0%	100.0%		0.0%	100.0%	0.0%	100.0%
Indonesia	499	1173	1	1673	Singapore	5	12	0	17
	29.8%	70.1%	0.1%	100.0%		29.4%	70.6%	0.0%	100.0%
Iran	120	418	0	538	Sri Lanka	1	15	0	16
	22.3%	77.7%	0.0%	100.0%		6.3%	93.8%	0.0%	100.0%
Japan	17	19	0	36	Taiwan	7	23	1	31
	47.2%	52.8%	0.0%	100.0%		22.6%	74.2%	3.2%	100.0%

Country	APC			SUM	Country	APC			SUM
	Yes	No	No-info			Yes	No	no-info	
Kazakhstan	2	2	0	4	Thailand	5	25	1	31
	50.0%	50.0%	0.0%	100.0%		16.1%	80.6%	3.2%	100.0%
Korea	50	80	0	130	Viet Nam	0	2	0	2
	38.5%	61.5%	0.0%	100.0%		0.0%	100.0%	0.0%	100.0%
Kyrgyzstan	0	3	0	3	Total	887	2212	4	3103
	0.0%	100.0%	0.0%	100.0%		28.6%	71.3%	0.1%	100.0%

The difference in APC by country is worth examining. First, let us look at countries with many journals requesting an APC. More than 40% of the registered journals from China, Hong Kong, and Japan etc. were found to request APCs. Journals distributed through international journal publishers, such as Springer Nature, Wiley, and Elsevier, often requested APCs. These journals included *NPG Asia Materials Springer* (Japan), *CNS Neuroscience & Therapeutics* (China), and *Genomics, Proteomics & Bioinformatics* (China). Journals published and distributed through international journal publishers, such as Wiley, Elsevier, and Nature, require an APC of 1,624–4,530 USD. Conversely, there are countries with a low rate of requesting APCs, such as India, Indonesia, and Iran. More than 70% of registered journals from these countries did not require an APC. This is because it is difficult for local journals that are not highly influential to require a high APC. Authors are willing to pay a high APC only to journals with a high impact. On the other hand, when grouping is based on the APC average by country (Table 6), Japan and Singapore have the highest charge, at 900 USD or higher. Those with an APC average of 500 - 900 USD were China and Hong Kong, those with an APC average of 300 - 500 USD were Korea and Taiwan, and India and Malaysia had an APC average of 200 - 300 USD. An APC average of below 150 USD was found in Thailand, Pakistan, Kazakhstan, Nepal, and Sri Lanka. In the case of Indonesia, which has the largest number of journals registered in the DOAJ, only 29.8% requested an APC, and even when requesting it, the average level was low, at 54.3 USD.

Table 6. APC average by country

APC (USD)				APC (USD)			
Country	Average	N	SD	Country	Average	N	SD
Japan	1,087.2	17.0	1,048.6	Pakistan	135.6	19.0	142.9
Singapore	995.2	5.0	525.5	Kazakhstan	127.5	2.0	173.2
China	586.5	49.0	557.1	Nepal	125.0	1.0	.
Hong Kong	578.9	11.0	506.0	Sri Lanka	100.0	1.0	.
Korea	354.8	50.0	324.1	Mongolia	75.0	1.0	.
Taiwan	317.9	7.0	245.6	Iran	68.4	120.0	171.7
India	232.8	84.0	324.1	Bangladesh	62.7	6.0	42.8
Malaysia	206.8	10.0	93.0	Indonesia	54.3	499.0	49.8
Thailand	161.6	5.0	89.7	Total	157.5986	887	325.35113

4.3 JCR/Scopus listing rate

Finally, let us take a statistical look at the degree of Asian OA journals' inclusion in the JCR/Scopus and examine the listing rate of journals by country and the relationship between the listing rate and the number of OA journals.

First, we collected information on whether journals registered in the DOAJ were included in JCR and Scopus. As of June 2020, only 12.1% were listed in either Scopus or JCR (Table 7). Looking at each citation index, Scopus has 360 Asian OA journals, 11.6% of the total. JCR consists of the SCIE, SSCI, and A&HCI for academic works. In the SCIE, 80 (2.6%) OA journals are listed, in the SSCI there are three (0.1%), and in the A&HCI, only one. Compared with the study by Marchitelli (2017), who reported that 10% and 23% of DOAJ journals are listed in JCR and Scopus respectively, it was found that the numbers of Asian countries' open access journals listed in the JCR/Scopus is less than half the global level.

Table 7. JCR and Scopus listing rate

International citation Index DB listed		Num. of OAJ	Percent
Listed or not	not_listed	2,726	87.9
	listed	377	12.1
Scopus	not_scopus_listed	2,743	88.4
	scopus_listed	360	11.6
WOS	A&HCI	not_a&hci_listed	3,102
		a&hci_listed	1
	SSCI	not_ssci_listed	3,100
		ssci_listed	3
	SCIE	not_scie_listed	3,023
		scie_listed	80

Second, let us look at the differences in the listing of international citation index database of each country (Table 8). 87 journals from India were indexed on either Web of Science (JCR) or Scopus, 77 from Iran, and 64 from Korea. However, each country's proportion of OA journals listed in the JCR/Scopus varies, ranging from 0% to 49.2%. 64 journals registered in Korea have highest proportion account for 49.2%. It means that nearly half of the Korean journals registered in DOAJ are also listed in either Web of Science (JCR) or Scopus. The country with the next highest listing ratio was the Taiwan with 45.2%.

Table 8. Number of OA journals listed in either Web of Science (JCR) or Scopus by country

Country	Number of listed OAJ	Index DB listing ratio of DOAJ registered journals
India	87	30.0%
Iran	77	14.3%
Korea	64	49.2%
China	35	28.9%
Indonesia	29	1.7%
Malaysia	17	23.9%
Japan	13	36.1%
Taiwan	14	25.2%
Thailand	9	29.0%
Pakistan	8	12.5%
Singapore	6	35.3%
Bangladesh	4	20.0%
Hong Kong	4	21.1%
Philippines	4	36.4%
Sri Lanka	3	18.8%
Nepal	2	10.0%
Mongolia	1	25.5%

Thirdly, we examine whether there is a relationship between the international research competitiveness of Asian countries and the number of DOAJ registered journals. Among Asian countries, China, Japan, India, and Korea rank high in the competitiveness ranking due to the large number of international papers published and cited. These countries are improving their research competitiveness by increasing the amount of submissions to influential international journals rather than local journals. By analyzing the correlation between the number of OA journals by countries and the number of papers listed in the citation index database, it is possible to see how much attention is paid to inducing OA in local journals in countries pursuing international research competitiveness.. A Pearson correlation analysis between the number of DOAJ-registered journals and the listing ratio of the either Web of Science (JCR) or SCOPUS , $r=.116$, showed no significant correlation. This means that even though the number of OA journals is high for a country, it does not affect the number of journals listed in international citation index database. In other words, a large number of OA journals are not registered with the DOAJ in countries with high international research competitiveness. Using the scatter plot in Fig. 3, we can try to understand the relationship between the publication volume of Web of science listed journal articles by country and the number of journals registered in the DOAJ. The map shows that most of the countries have small Web of Science documents and small OAJ registrations, so they are concentrated in the lower left corner. However, China, which has a far greater number of international academic papers, is located in the upper left corner of the map, and Japan, India, and Korea are scattered beneath it. These countries show high publication volumes of international academic journals, but the transition cases to OA of local journals are low, which is why they are located on the left side of the map. If we look

at Indonesia, the number of OA journals is high. Indonesia is located in the lower right corner of the map, and Iran also shows a shape extending to the right from the cluster in the lower left corner. As a result of promoting strong OA in local journals, these countries show superior DOAJ registration performance. They also show the opposite characteristics of China and Japan, which have high international publication volumes. In summary, in Asian countries, the number of OA journals registered in the DOAJ and the volume of international publications are irrelevant. Rather, it can be concluded that the OAJ registration rate in countries with a large number of international papers is relatively low.

Table 9. Relationship between the Index DB listing ratio and number of OA journals

		Journal	Indexed percent
Journal	Pearson Correlation	1	.116
	Sig. (2-tailed)		.616
	N	21	21
Indexed percent	Pearson Correlation	.116	1
	Sig. (2-tailed)	.616	
	N	21	21

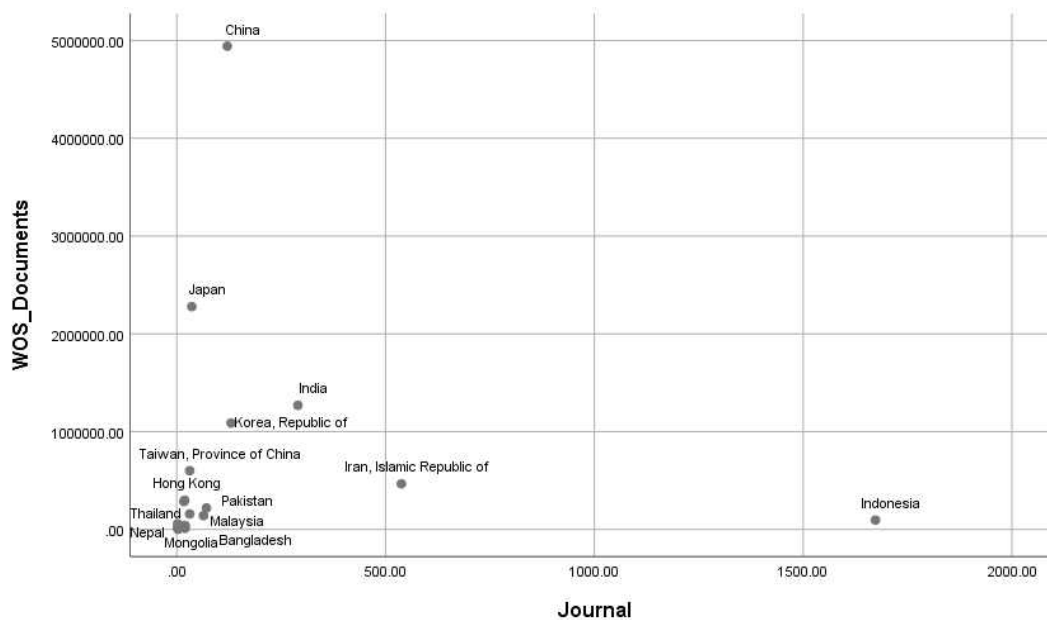


Fig. 3. Relationship between the number of OA journals and Web of Science output (1980-2019)

5. Discussion and conclusion

The answers to the research questions presented in this study can be summarized as follows. First, there are 3,103 Asian OA journals registered in the DOAJ, with Indonesia predominating, followed by Iran and India. English is the main language used, accounting for 68% of journals, and the social sciences are the main subject area, due to the influence of Indonesia. The proportion of subject areas in OA journals varies according to country. Most countries have many OA journals in the fields of natural and applied sciences, but Indonesia and Pakistan have many journals in the humanities, arts, and social sciences, and Korea, India, and Iran have many journals in the medical field.

Second, 70% of the journals do not charge an APC. In the case of journals that charge an APC, the average amount was 157 USD and the median value was 53 USD, with large differences by country. When an OA journal is funded by a national or institutional subsidy, many do not charge an APC. By contrast, there are journals that require a high APC in Japan and China, where many academic journals are distributed through international commercial publishers. High-income countries such as Singapore, Japan, China, Hong Kong, Taiwan, and Korea have relatively high APC averages, while some developing countries have low average amounts.

Third, countries with a large number of DOAJ registrations do not necessarily have a large number of international academic publications. Rather, China, Japan, and Korea, which do not have a large number of DOAJ-registered journals, have far more international academic output. Another notable finding is, whereas 23% of total DOAJ journals are listed in Scopus, the numbers of Asian countries' open access journals listed in SCOPUS is only 12%. The Web of Science (JCR) listing rate is worse. JCR listing rate in Asian open access journals is 3% or less, which is very low compared to the global average of 10%.

In the process of seeking answers to the research questions, this study discovered two important facts: First, unlike in the West, Asian countries tend to publish journals through government or university subsidies. Some Asian journals published by international publishers have been charging high APCs, but most Asian countries' OA journals do not. There is a limit to the extent to which local journals with a low impact can pursue the APC model. That is why many OA journals receive subsidies or publish hard copies to collect subscription fees. However, the recent decrease in the number of print subscribers poses a great challenge to this model, and the subsidy model is unlikely to persist indefinitely, so journals may have to consider various other operating models in the long run.

Second, it was found that many journals in Asian countries are distributed free of charge on their own open platforms but are not registered in the DOAJ. In, China, Korea and Japan, many journals are openly provided free of charge without a CC license. These countries showed a low number of DOAJ registrations despite having a high number of international academic paper publications and strong research competitiveness. The three East Asian countries are providing open services for many academic journals through their own open platforms, such as KOAT, J-STAGE, etc. but only some journals have been converted to OA and registered with the DOAJ. The reason is likely to require in-depth analysis, but it appears to be due to the double access by contract

with the domestic commercial aggregator or the copyright transfer agreement with the author not being signed. In any case, the reasons vary for each journal, but it is very difficult to find and access OA journals internationally if they are distributed for free only on their own platform. In addition, local OA journals in Asia have a very low rate of listing in the International Citation Index Database, making global discovery of research results difficult. Therefore, it is urgent to establish an international access route through inducing registration of international index databases including DOAJ. It is necessary to facilitate the discovery of journals in major Asian countries, such as the cooperation project to promote DOAJ registration at the national level.

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