Mapping Malaysia's contribution to Gold Open Access: Growth patterns, disparities, and policy implications

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ABSTRACT

This study examines the growth of Gold Open Access (OA) research output in Malaysia through a bibliometric analysis using Web of Science (WoS) data. Over the past decade, Malaysia has seen a significant increase in gold OA publications, ranking 27th globally, 10th in Asia, and first in Southeast Asia. The analysis reveals that Science & Technology and Health Sciences dominate the gold OA landscape, while Arts & Humanities and Social Sciences remain underrepresented. Malaysian researchers predominantly publish their gold OA articles in international journals, with Switzerland-based publishers being particularly prominent. A notable finding is the impact of government restrictions on using research funds for publications with three specific publishers - MDPI, Hindawi, and Frontiers. In 2023, MDPI experienced a 25.4 percent decline in publications by Malaysian researchers, reflecting a shift in publication patterns due to these restrictions. Despite the overall growth, the study highlights a mismatch between the quantity of gold OA publications and their citation impact, raising questions about the broader influence of Malaysian gold OA research. These findings underscore the need for strategies to manage and promote gold OA publishing effectively while addressing the challenges posed by policy restrictions. The insights offer valuable guidance for researchers and policymakers to optimize the benefits of gold OA publishing in Malaysia.

Keywords: Gold Open Access; Bibliometrics analysis; Scholarly publishing; Research output; Publication patterns.

INTRODUCTION

The digital revolution, propelled by advancements in computing, telecommunications, internet expansion, and digital platforms, has profoundly reshaped how information is accessed and shared. This transformation has been instrumental in the rise of open access (OA) publishing, which democratizes knowledge by making research findings freely available online. OA has broken down barriers that historically restricted access to journals and academic publications, such as high subscription costs and limited physical distribution

networks. In the digital age, technology enables seamless dissemination of information, empowering researchers to share their work widely and equitably, fostering greater inclusivity and collaboration in academia.

The definition of “open access” has various perspectives. Among the earliest definitions is the Budapest Open Access Initiative (BOAI) definition, "*free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself* "[1] (Budapest Open Access Initiative, 2002) . UNESCO (2023) broadens the concept of OA beyond scholarly articles, suggesting it can encompass any digital content, including multimedia and even creative works such as novels, music, and films. Additionally, the Directory of Open Access Journals (DOAJ) highlights the importance of clearly defined user rights through copyright licenses for openly available contents (DOAJournals, 2020).

BOAI is a foundational milestone in the OA movement. In its 2002 statement, BOAI not only defined OA, but also outlined a roadmap to achieve it, emphasising the importance of providing unrestricted online access to research publications for all, regardless of background. Short thereafter, this movement was then complemented by the Bethesda Statement on Open Access Publishing in 2003 that went further by specifying how OA should be implemented. In the same year, the Berlin Declaration on Open Access to Knowledge in the Sciences and the Humanities fought for OA to foster scientific and societal progress (Bailey, 2006).

There are two primary OA publishing models: Gold OA and Green OA. Gold OA involves publishing papers in journals or books supported by OA publishers, making them freely accessible to everyone immediately upon publication (Young & Brandes, 2020). According to Zhang and Watson (2017), this model often requires authors to cover costs through Article Processing Charges (APCs), though many publishers are adopting alternative funding models to eliminate these fees. Additionally, some authors choose to publish in traditional subscription-based journals but pay an APC to make their articles publicly available, a practice known as “hybrid Open Access”. In contrast, Green OA allows authors to deposit their research - either as a preprint or the final version - into a repository, typically after an embargo period, making it publicly accessible (Young & Brandes, 2020).

The OA movement has gained traction by scholars, evidenced by the increasing number of articles published over the past decade. Heidbach et al. (2022) report that only around 30 percent of journal articles being freely available to the public in the beginning, but the figure had risen nearly to 50 percent by 2019. This increase is further supported by Huang et al. (2024) , whose study shows an increase in citations by researchers across various institutions and countries contributing to the growing acceptance of OA.

The benefits of OA extend beyond increased accessibility, including significant economic impact. Curcic (2023) estimates that the market for OA publications in 2021 was worth approximately $1.6 billion, representing a noteworthy 15 percent share of the entire academic publishing market. This growth is probably driven by the transition of libraries towards OA as an alternative to traditional information resources. Each year, libraries face increasing journal subscription costs, rising by more than 5 percent, while their annual

[1] https://www.budapestopenaccessinitiative.org/read/

budgets have remained stagnant for over a decade (Piwowar et al., 2019; Shideler & Araújo, 2016). Consequently, the cost-effectiveness of OA allows libraries to continue supporting the learning, teaching, and research needs of their communities.

In Southeast Asia, a promising trend is emerging with the increasing prevalence of OA publications from 2010 to the present, according to statistics from the Directory of Open Access Journals (DOAJ) (DOAJ, 2024). The DOAJ, the primary indexing database for peer-reviewed OA journals, reflects this growth, indexing 38.54 percent more Southeast Asian journals (2,618 in total) as of June 2024 compared to 2020. Malaysia is a prime example of this regional trend, experiencing significant growth in its OA publishing sector alongside other Southeast Asian nations (Syahid, 2020). The number of Malaysian journals listed in the DOAJ has increased from 66 titles in 2020 to 103 titles in 2024, marking an impressive 56.06 percent growth. This progress can be attributed to various factors, including the increasing number of OA journals with their own impact factors and indexing in prestigious databases such as Scopus and Web of Science (WoS), in addition to the benefits of enhanced visibility through free access to research (Masrek & Yaakub, 2015).

Meanwhile, for R&D expenditure, Malaysia ranks second (1.44%) behind Singapore (1.95%) for the region and is 24th overall compared to other countries globally. Along with Singapore, Thailand also features in the list of the top 50 countries for R&D expenditure as a percentage of GDP (International Institute for Management Development, 2019). These allocations are vital for promoting research and innovation. Between 2015 and 2021, the average gross expenditure on R&D (GERD) as a percentage of GDP in Southeast Asian countries (excluding Laos and Timor-Leste) ranged from 0.12 percent to 2.16 percent (World Bank, 2024a).

In light of these trends, the objectives of this study are threefold. First, it aims to track the growth trends of gold OA publications in Malaysia, providing insight into the evolution of the country's research output in this domain. Understanding these trends is essential for assessing Malaysia's progress in making research more accessible and strengthening its position within the global academic community. Second, the study seeks to examine the distribution of gold OA publications across various subject areas in Malaysia, offering valuable insights into which fields contribute most to OA growth and highlighting gaps that need attention. Lastly, the study intends to evaluate the performance of Malaysian public universities in gold OA publishing, providing a benchmark for future improvements in institutional and national OA policies.

LITERATURE REVIEW

The growth of gold OA publishing has been widely studied in various countries, with research exploring the patterns, challenges, and impacts specific to different regions. This literature review focuses on studies that examine gold OA in particular countries or regions, aligning with this study's focus on the growth of gold OA in Malaysia.

In India, Mukherjee (2014) analysed 462 OA journals across the green, gold, and hybrid models. The study found that many Indian authors prefer gold OA over green OA, considering gold OA journals more reliable and trustworthy. Despite the high publication fees, there has been significant growth in gold OA publications in fields such as computer science, pharmacy, and medicine. In contrast, Nazim (2018) provides a different perspective, revealing that the citation impact of Indian gold OA publications does not

correspond to the volume of output. This discrepancy is attributed to the lower quality of publications in some gold OA journals and a general lack of awareness among Indian researchers.

Similar trend is being observed in Europe. As one of the prominent countries in the output of gold OA publications in Europe after Poland, Spain's journey with OA began in 1995 with RELIEVE, the first peer-reviewed OA journal. This commitment is reflected in the significant rise of gold OA publications, from 8 percent in 2011 to 50 percent by 2021, surpassing subscription and green OA models that have seen a decline (McKenna, 2023). Furthermore, research by Torres-Salinas et al. (2016) highlights the significant presence of gold OA, particularly in the Arts and Humanities. However, despite this progress, the study also points out that the average citation impact of Spanish publications remains lower than both the global average and the citation impact of leading European countries. A study by Wenaas and Gulbrandsen (2022) found that in Norway, gold OA has steadily grown across all major higher education institutions, with the exception of the University of Oslo, which has not maintained dedicated funds for gold OA publications. Since 2009, eight out of ten institutions have revised their OA policies to prioritise gold OA. This trend was further reinforced by the introduction of national OA guidelines in 2017, which strongly support gold OA while still allowing researchers the option to choose green OA if needed.

In the United States, the landscape of OA has been shaped by several studies examining the relationship between gold OA publication and funding. Halevi et al. (2023) analysed a ten-year period and found that $6 million was spent on gold OA publications. Interestingly, the study revealed that high expenditure did not correlate with a high number of publications. Some states published a substantial number of gold OA articles while spending significantly less, whereas other states with lower publication output incurred much higher costs. In a separate study focusing on Rowan University, Kipnis and Brush (2023) explored a decade of gold OA publication trends among faculty members. Their findings revealed a significant increase in gold OA publications, particularly in STEM fields, which was largely attributed to the introduction of the Open Access Publishing Fund in 2017.

Comparative analysis between countries in gold OA publications was also translated in several previous studies. Among them is a study by Sivertsen et al. (2019) on four European countries, Finland, Belgium, Norway and Poland. Using the DOAJ data as the main reference, the study found that the four countries showed an increase in gold OA publications across various fields with Norway leading the way compared to the other three countries. In a broader context, Wang et al. (2018) compared gold OA publications covering 15 countries and found that Brazil emerged as the most active country in OA publishing despite a sharp decline in recent years. Meanwhile, China, which had the lowest ratio, showed an increase along with the UK and the Netherlands. This study also found that subjects such as biology, life sciences and computing have a higher percentage of publications compared to physics and chemistry.

In conclusion, this review highlights the growing global trend toward gold OA publishing, with significant progress in countries where funding and institutional policies drive adoption. Certain disciplines have experienced notable growth in OA publications. Despite challenges such as publication costs and citation impact, the shift toward gold OA presents significant opportunities for enhanced research accessibility and visibility, fostering a more open and equitable global academic landscape.

MATERIALS AND METHOD

To gain a comprehensive understanding of Malaysian gold OA publications, this study conducted searches in July 2024 using the WoS citation database. The selection of this database was based on its established reputation for data availability, quality, extensive coverage, and superior user experience (Zhu & Liu, 2020). This approach aligns with the study's objectives of tracking the growth trends of gold OA publications in Malaysia, examining the distribution across various disciplines, and assessing the performance of Malaysian public universities in gold OA publishing.

To identify articles authored by researchers affiliated with Malaysian institutions, the search term “Malaysia” was entered in the country affiliation field within the WoS database. This approach ensured that only publications with at least one author affiliated with a Malaysian institution were included in the results. The search was further refined by publication year, focusing specifically on works published between 2014 and 2023. This ten-year period was chosen to facilitate a thorough examination of trends and developments over time, providing a robust timeframe for analysis. Additionally, this period aligns with those used in similar studies on the subject (Halevi et al., 2023; Mukherjee, 2014; Torres-Salinas et al., 2016), ensuring consistency in the evaluation of long-term trends in OA publishing.

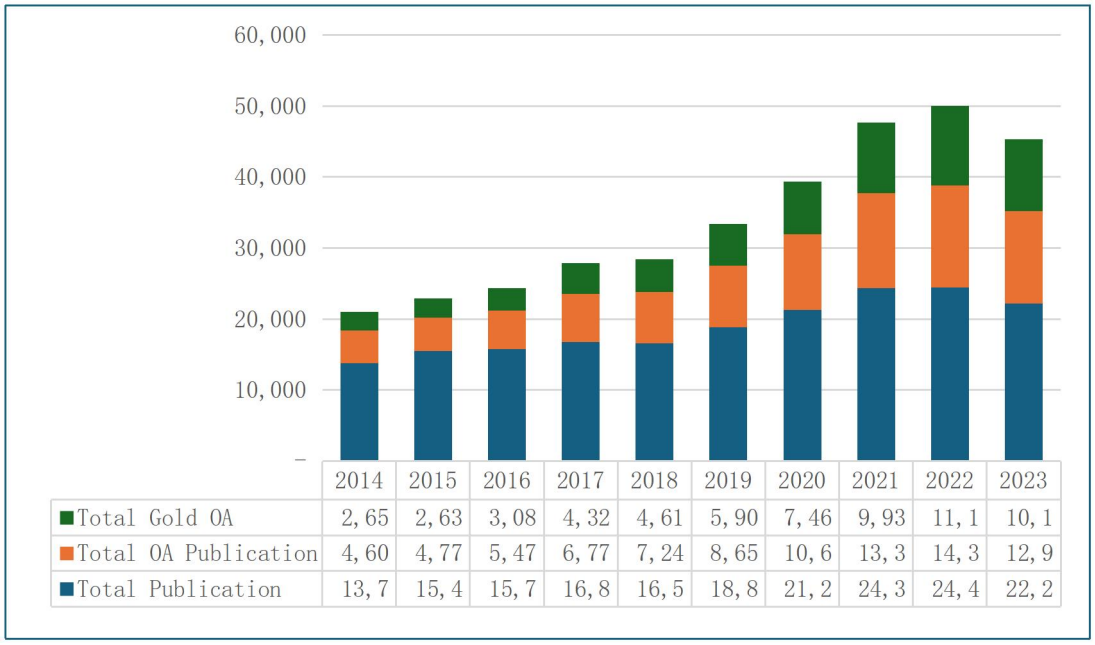
The filtering process further refined the results by focusing exclusively on the “Open Access” category, specifically targeting Gold OA publications. Publications falling under hybrid, bronze, or green OA models were excluded to ensure a precise focus on the gold OA model. Additionally, the search was restricted to articles only, excluding other publication types such as conference papers, book chapters, review papers, and posters, in order to prioritise high-quality, peer-reviewed research articles. This rigorous filtering process resulted in a total of 61,943 gold OA publications, providing a robust dataset for analysis.

RESULTS

Publication Output and Open Access Trends

Malaysia has made significant progress in gold OA publishing over the past decade. As shown in Figure 1, Malaysian research publications in the WoS database have experienced significant growth between 2014 and 2023. In total, Malaysian researchers produced 189,542 articles in the period of ten years. Out of that, 88,889 (46.9%) are OA publication and these included 61,943 gold OA publications. The total number of articles increased steadily from 13,752 in 2014 to 22,211 in 2023, a growth of 61.5 percent. OA publications increased significantly, rising from 4,603 in 2014 to 12,979 in 2023, marking a growth of 181.97 percent. The most notable growth was seen in gold OA publications, which soared by 282.1 percent, from 2,651 in 2014 to 10,130 in 2023, highlighting Malaysia's increasing focus on OA publishing.

While the overall trend for Malaysian research publications is positive, a closer look at the yearly data reveals fluctuations in some years. This up and down trend can be seen for a small number of years, especially 2023 which saw a decrease for all three categories with a drop between 9 to 10 percent compared to 2022.



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total Gold OA	2, 65	2, 63	3, 08	4, 32	4, 61	5, 90	7, 46	9, 93	11, 1	10, 1
Total OA Publication	4, 60	4, 77	5, 47	6, 77	7, 24	8, 65	10, 6	13, 3	14, 3	12, 9
Total Publication	13, 7	15, 4	15, 7	16, 8	16, 5	18, 8	21, 2	24, 3	24, 4	22, 2

Figure 1: Growth of Malaysian Research Publications in the WoS Database (2014-2023)

The annual growth rate for all three categories was measured using the Compound Annual Growth Rate (CAGR) formula[2]. For this analysis, the initial value corresponds to the total number of publications in 2014, and the final value is based on the number of publications in 2023. The exponent 1/t is applied to the quotient, with t representing the 9-year study period. The calculated CAGR indicates a consistent upward trend: 5.47 percent for total publications, 12.21 percent for OA publications, and a notable 16.06 percent for gold OA publications.

Gold OA publications have become a dominant force in the Malaysian research landscape. Starting with 19.28 percent in 2014, gold OA publications contribution to the total number of publications surged to 45.61 percent by 2023. This trend is even more pronounced when looking at OA publications alone. In 2023, gold OA publication comprised a remarkable 78.05 percent of all OA publication. The peak growth years for gold OA were in 2017 with 40.25 percent, followed by 2021 (33.07%) and 2019 (27.93%). Notably, gold OA consistently contributed 69.69% to total OA publications over the entire ten-year period.

On the global stage, Malaysia has made significant progress in adopting gold OA publishing. Among the top 30 most productive countries in gold OA, Malaysia ranks 27th, standing as the only Southeast Asian country in this group. Within Asia, which includes Russia and Taiwan, Malaysia holds the 11th position. These findings are summarised in Table 1. During this period, on average, the gold OA publication rate for Malaysia was 32.68 percent, surpassing the global average of 5.72 percent. Although the trend is generally positive, a closer look shows some instability. Annual data analysis reveals interesting fluctuations in the gap between Malaysian and global gold OA rates. The highest difference is in 2023, at 14.76 percent and the lowest is 2.47 percent in 2015 (see Table 2). Additionally, 2015 also recorded a significant decrease of 3.92 percent compared to the previous year, before the rate started to increase year after year.

[2] $CAGR = \left(\frac{final\ value}{initial\ value}\right)^{\frac{1}{t}} - 1$

Table 1: Top 30 Most Productive Countries in Gold OA Publishing

Rank	Countries	Record Count	% (of 5,366,366)
1	China	1,286,848	23.98
2	United States	914,201	17.04
3	Germany	296,503	5.53
4	England	277,974	5.18
5	Japan	270,404	5.04
6	Spain	237,304	4.42
7	Brazil	233,635	4.35
8	India	226,120	4.21
9	Italy	223,482	4.16
10	South Korea	223,097	4.16
11	France	173,351	3.23
12	Canada	171,171	3.19
13	Australia	159,438	2.97
14	Poland	143,302	2.67
15	Russia	120,204	2.24
16	Saudi Arabia	112,975	2.11
17	Netherlands	109,398	2.04
18	Turkey	103,712	1.93
19	Taiwan	97,551	1.82
20	Iran	95,728	1.78
21	Switzerland	94,656	1.76
22	Sweden	85,575	1.59
23	Egypt	72,599	1.35
24	Pakistan	69,647	1.30
25	Mexico	66,875	1.25
26	South Africa	63,898	1.19
27	**MALAYSIA**	**61,943**	**1.15**
28	Belgium	60,168	1.12
29	Portugal	58,730	1.09
30	Denmark	54,153	1.01

Table 2: Growth Patterns in Total Research Output, OA Research, and share of OA Journal Publications

Year	Malaysia			Global			Percentage difference in gold OA papers: Malaysia vs. Global
	Total no of papers	Total no of gold OA papers	% of gold OA papers	Total no of papers	Total no of gold OA papers	% of gold OA papers	
2014	13,752	2,651	19.28	1,750,392	225,637	12.89	6.39
2015	15,471	2,635	17.03	1,817,506	264,655	14.56	2.47
2016	15,762	3,087	19.59	1,896,167	314,790	16.60	2.98
2017	16,814	4,329	25.75	1,974,401	378,287	19.16	6.59
2018	16,573	4,615	27.85	2,047,339	431,075	21.06	6.79
2019	18,875	5,904	31.28	2,285,176	535,472	23.43	7.85
2020	21,280	7,467	35.09	2,546,617	671,677	26.38	8.71
2021	24,355	9,935	40.79	2,827,882	812,282	28.72	12.07
2022	24,371	11,188	45.91	2,915,943	911,735	31.27	14.64
2023	22,123	10,126	45.77	2,783,233	863,054	31.01	14.76
Total	189,376	61,937	32.71	20,061,423	5,408,664	26.96	5.75

Subject-wise Distribution of Gold OA

Further analysis categorised the top 100 research areas into four main domains: Sciences and Technology, Health Sciences, Social Sciences, and Arts and Humanities. Among these, Sciences and Technology emerged as the leading domain with 48 categories, seven of which dominate in terms of research output. Health Sciences followed with 33 categories, while Social Sciences and Arts and Humanities accounted for 7 and 3 categories, respectively, as detailed in Table 3. This distribution aligns with prior research findings, which indicate that fields like Sciences and Technology, along with Health Sciences, dominate in the Web of Science, while Social Sciences and Arts and Humanities are comparatively underrepresented (Huang et al., 2020; Pranckutė, 2021; Vera-Baceta et al., 2019). Furthermore, 27 research areas were identified with at least 1,000 publications within the ten-year period. Engineering ranked highest with 16,697 publications, followed by Science, Technology, and Other Topics (14,057), Material Science (9,164) and Chemistry (7,116). Environmental Sciences and Ecology completed the top five with 6,417 publications. Additional details on subject categories are presented in Table 4.

Table 3: Distribution of Research Areas in Gold OA across Main Fields of Study

Rank	Study Areas	No of Research Areas
1	Sciences & Technology	48
2	Health Sciences	33
3	Social Sciences	7
4	Art & Humanities	3

Table 4: Malaysia Top Research Areas by Publication Volumes in Gold OA Journals

Rank	Research Area	Total Gold OA	% (of 61943)
1	Engineering	16697	26.96
2	Science Technology Other Topics	14057	22.69
3	Materials Science	9164	14.79
4	Chemistry	7116	11.49
5	Environmental Sciences Ecology	6417	10.36
6	Physics	5614	9.06
7	Computer Science	4984	8.05
8	General Internal Medicine	3644	5.88
9	Business Economics	2848	4.60
10	Energy Fuels	2784	4.49
11	Telecommunications	2658	4.29
12	Pharmacology Pharmacy	2586	4.17
13	Public Environmental Occupational Health	2509	4.05
14	Biochemistry Molecular Biology	2331	3.76
15	Mathematics	2229	3.60
16	Social Sciences Other Topics	1871	3.02
17	Food Science Technology	1605	2.59
18	Research Experimental Medicine	1604	2.59
19	Education Educational Research	1528	2.47
20	Construction Building Technology	1481	2.39
21	Polymer Science	1442	2.33
22	Metallurgy Metallurgical Engineering	1392	2.25
23	Microbiology	1294	2.09
24	Agriculture	1239	2.00
25	Infectious Diseases	1206	1.95
26	Instruments Instrumentation	1177	1.90
27	Biotechnology Applied Microbiology	1134	1.83

Top Journals for Gold OA Publications

Table 5 lists the top 30 journals for gold OA publications by Malaysian researchers (2014–2023). The top five are *PLOS ONE* (3.29%), *IEEE Access* (2.96%), *Sains Malaysiana* (2.7%), *Sustainability* (2.66%), and *Scientific Reports* (2.3%). These findings highlight Malaysian researchers' preference for high-impact multidisciplinary gold OA journals, alongside local journals like *Sains Malaysiana,* reflecting a commitment to global visibility and regional relevance.

Table 5: Top 30 Gold OA Journals Selected by Malaysian Researchers and Their Contribution to Total Gold OA Publications

Rank	Publication Titles	No of Gold OA	% (of 61,943)	JIF (2023)	Country	Publisher
1	*Plos One*	2,036	3.287	2.9	United States	Public Library of Science
2	*IEEE Access*	1,833	2.959	3.4	United States	IEEE
3	*Sains Malaysiana*	1,674	2.703	0.7	Malaysia	UKM Press
4	*Sustainability*	1,647	2.659	3.3	Switzerland	MDPI
5	*Scientific Reports*	1,423	2.297	3.8	England	Nature Pub. Group
6	*Applied Sciences-Basel*	800	1.292	#N/A	Switzerland	MDPI
7	*Polymers*	766	1.237	4.7	Switzerland	MDPI
8	*International Journal of Environmental Research and Public Health*	751	1.213	#N/A	Switzerland	MDPI
9	*Molecules*	726	1.172	4.2	Switzerland	MDPI
10	*Sensors*	679	1.096	3.4	Switzerland	MDPI
11	*Materials*	636	1.027	3.1	Switzerland	MDPI
12	*Energies*	598	0.965	3	Switzerland	MDPI
13	*Heliyon*	547	0.883	3.4	England	Cell Press
14	*Jurnal Kejuruteraan*	534	0.862	0.6	Malaysia	UKM Press
15	*Cureus Journal of Medical Science*	507	0.819	1	United States	Springernature
16	*Journal of High Energy Physics*	455	0.735	5	Italy	Springer
17	*Mathematics*	424	0.685	2.3	Switzerland	MDPI
18	*Symmetry-Basel*	376	0.607	2.2	Switzerland	MDPI
19	*Frontiers In Psychology*	374	0.604	2.6	Switzerland	Frontiers Media SA
20	*Data In Brief*	373	0.602	1	Netherlands	Elsevier
21	*CMC Computers Materials Continua*	363	0.586	#N/A	United States	Tech Science Press
22	*Journal of Fundamental and Applied Sciences*	354	0.572	#N/A	Malaysia	UTM Press
23	*Peerj*	340	0.549	2.3	England	PeerJ Inc
24	*International Journal of Advanced and Applied Sciences*	328	0.53	0.4	Taiwan	IASE
25	*Processes*	322	0.52	2.8	Switzerland	MDPI
26	*Results In Physics*	322	0.52	4.4	Netherlands	Elsevier
27	*Malaysian Journal of Medical Sciences*	311	0.502	1.1	Malaysia	Penerbit USM
28	*Scientific World Journal*	310	0.501	#N/A	United States	Hindawi Ltd
29	*Journal of Materials Research and Technology*	303	0.489	#N/A	Brazil	Elsevier
30	*Biomed Research International*	292	0.471	2.6	England	Hindawi Ltd

In terms of publication countries, eight countries are represented among the top 30 selected journals. Switzerland leads with 12 journal titles, 11 of which are from MDPI, making it the largest publisher. The United States follows with five journal titles, while Malaysia and the United Kingdom share third place with four each. MDPI's prominent role in Malaysian research publications is noteworthy, as it accounts for 19.77 percent of gold OA publications in the country. The number of publications in MDPI journals has steadily increased from 2016 to 2022, as shown in Figure 2.

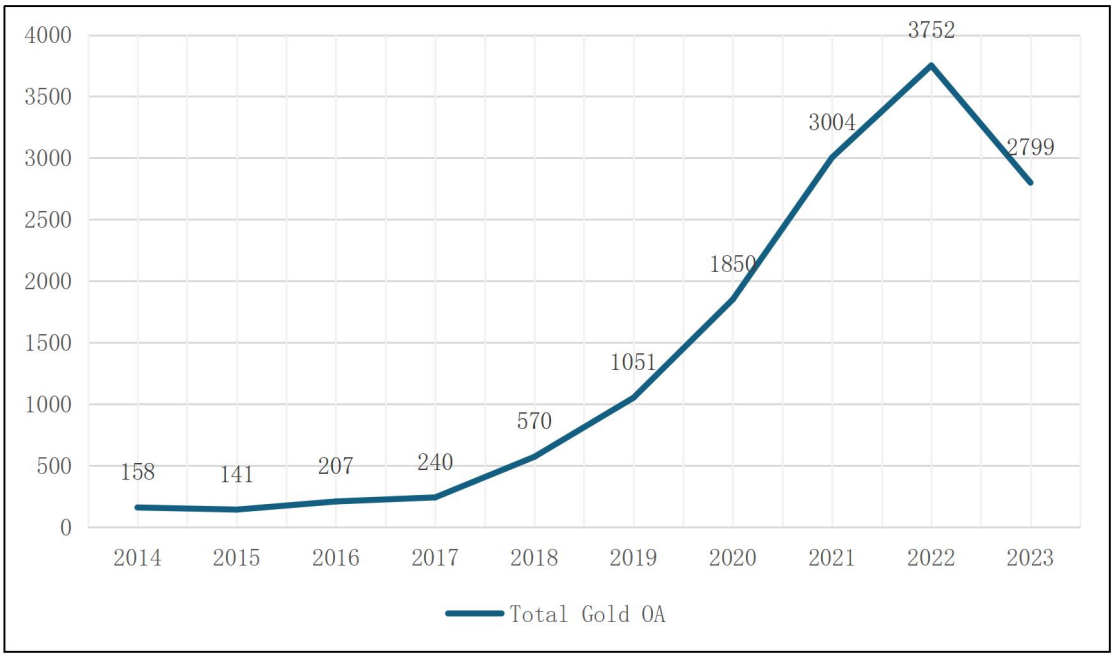


Figure 2: Annual Growth of MDPI Publications in Malaysia's Gold OA Research Output from 2014 to 2023.

Despite its success in establishing itself as a leading publisher in the OA landscape, MDPI has recently faced significant criticism. Critics argue that its peer-review process lacks thoroughness, and its editorial practices have been questioned, with some labeling MDPI as a "gray publisher" due to its combination of both high and low editorial standards, resembling characteristics of a predatory journal (Ioannidis et al., 2023; Oviedo-García, 2021; Siler, 2020). This criticism likely contributed to the 25.4 percent decrease in publications by Malaysian researchers in MDPI in 2023. The downturn is further intensified by the Malaysian government's decision to restrict researchers from public universities from using government funds to publish in MDPI, Hindawi, and Frontiers (Chawla, 2023). Additionally, MDPI's attempts to improve the peer-review process and tighten content scope have led to higher rejection rates, as indicated in their 2023 annual report (MDPI, 2024). Consequently, MDPI's previously dominant position in Malaysian research has begun to decline, signaling a shift in its growth trajectory.

Further analysis of the top 30 publication titles revealed their distribution across journal quartiles. The highest concentration was in Q2, with 8 titles, followed closely by Q1 and Q3, each with 7 titles. Interestingly, 6 publications secured a spot among the top 30 without a quartile score, surpassing Q4, which contained only 2 titles. This could indicate that these publications are influential or well-regarded in their field, despite not having been officially ranked in the traditional quartile system.

Citations Distribution

In comparison to green OA and closed access articles, gold OA articles exhibit a higher proportion of citations in the lower citation ranges. Specifically, 54.23 percent of gold OA articles received between 1-10 citations, and 19.34 percent fell within the 11-25 citation range (Table 6). However, in higher citation brackets, gold OA articles underperform relative to the other access models. Additionally, 13.89 percent of gold OA articles remain uncited, a figure slightly higher than that of green OA but lower than closed access publications. This suggests that while gold OA articles are often more accessible and widely distributed, they may face challenges in achieving sustained high citation impact.

Table 6: Citation Distribution Comparison across Gold OA, Green OA, and Closed Access Articles, Showing the Percentage of Articles within Different Citation Ranges

Citation range	% of Gold OA	% of Green OA	Closed access
Uncited	13.89	10.08	15.11
1-10	54.23	48.57	47.67
11-25	19.34	22.55	19.97
26-50	8.22	11.26	10.33
51-100	3.34	5.19	4.97
101-200	0.77	1.58	1.52
>200	0.22	0.77	0.41

Table 7 presents the citation distribution for articles published in the top five gold OA journals. The data highlights the impact and academic prominence of these journals. *Scientific Reports* stands out with a wide citation distribution, including a significant number of highly cited articles, indicating strong academic visibility and influence. *Plos One* and *IEEE Access* show similar patterns, with most articles in the 1-10 citation range but also a notable presence in higher citation categories, suggesting moderate to high impact in select fields. *Sustainability* shows a large proportion of articles in the 1-10 citation range, indicating good visibility but limited representation in higher citation brackets. Conversely, *Sains Malaysiana* has a higher percentage of uncited or minimally cited articles, reflecting a more regional or niche influence and fewer high-impact publications. Overall, *Scientific Reports* and *IEEE Access* exhibit greater reach and academic impact compared to *Sains Malaysiana* and *Sustainability*.

Table 7: Citation Distribution across the Top Five Gold OA Journals Published by Malaysian Researchers

Citation range	*Plos One*	*IEEE Access*	*Sains Malaysiana*	*Sustainability*	*Scientific Reports*
Uncited	5.50	5.40	24.37	6.38	3.23
1-10	41.18	46.10	67.44	55.92	36.64
11-25	28.50	25.20	7.29	22.77	29.89
26-50	16.07	14.62	0.78	9.71	17.37
51-100	7.27	6.33	0.18	4.43	9.42
101-200	1.08	1.64	0.06	0.79	2.74
>200	0.39	0.49	0.00	0.00	0.70

International Collaboration in Gold OA Publications

Table 8 presents the list of countries most frequently engaging in international collaborations with Malaysian researchers in gold OA publications. The findings show that Saudi Arabia (9.85%), China (8.85%), Pakistan (7.81%), India (7.07%), and United Kingdom

(6.86%) are the top five countries collaborating with Malaysia. This analysis also categorises the top 20 collaborating countries based on the World Bank's income classification (The World Bank, 2024). Among the top 20, half are classified as high-income countries, followed by upper-middle-income (5 countries), lower-middle-income (4 countries), with Nigeria being the sole representative of lower-income countries, ranked 17th. The findings show that Malaysia's gold OA research collaborations are mainly with high-income countries, emphasising the importance of global partnerships in driving the growth of Malaysia's OA output.

Table 8: Top 20 Countries Collaborating with Malaysian Researchers on Gold OA Publications, Categorised by World Bank Income Classification.

Rank	Countries	Record Count	% (of 61,943)	Income Classification System
1	Saudi Arabia	6,100	9.848	High-Income Economies
2	Peoples R China	5,480	8.847	Upper-Middle-Income Economies
3	Pakistan	4,838	7.810	Lower-Middle Income Economies
4	India	4,379	7.069	Lower-Middle Income Economies
5	England	4,246	6.855	High-Income Economies
6	United States	3,898	6.293	High-Income Economies
7	Australia	3,858	6.228	High-Income Economies
8	Indonesia	3,380	5.457	Upper-Middle-Income Economies
9	Japan	2,551	4.118	High-Income Economies
10	Iran	2,296	3.707	Upper-Middle-Income Economies
11	Taiwan	2,161	3.489	High-Income Economies
12	Iraq	2,056	3.319	Upper-Middle-Income Economies
13	Thailand	1,993	3.217	Upper-Middle-Income Economies
14	South Korea	1,962	3.167	High-Income Economies
15	Egypt	1,908	3.080	Lower-Middle Income Economies
16	Germany	1,907	3.079	High-Income Economies
17	Nigeria	1,873	3.024	Low-Income Economies
18	Italy	1,732	2.796	High-Income Economies
19	Bangladesh	1,730	2.793	Lower-Middle Income Economies
20	France	1,681	2.714	High-Income Economies

Beyond global country collaborations, the influence of international institutions, including corporate entities and foreign higher education institutions, was also examined. As shown in Table 9, 22 international institutions contributed over 1,000 publications through collaborations with Malaysian researchers. Monash University leads with a contribution of 3.59 percent, followed by the Egyptian Knowledge Bank (2.95%) and the University of California (2.03%).

Gold OA Publication Contributions by Malaysian Public Universities

Overall, gold OA publications from the 20 public universities in Malaysia accounted for 33.86 percent (61,784) of their total article publications over the past decade (Table 10). Leading the contributions are research intensive universities, with Universiti Kebangsaan Malaysia (UKM) taking first place at 16.92 percent, followed by Universiti Malaya (UM) (16.41%) and Universiti Putra Malaysia (UPM) (14.20%). However, when considering the percentage of gold OA publications relative to each university's total output, Universiti Pertahanan Nasional Malaysia (UPNM) stands out with the highest proportion at 48.22 percent. Universiti Malaysia Sabah (UMS) follows closely with 46.97 percent, while Universiti Malaysia Kelantan (UMK) ranks third at 44.64 percent.

Table 9: Top 22 International Institutions Contributing to Gold OA Publications in Collaboration with Malaysian Researchers (2014-2023)

Rank	Institutions	No of Gold OA	% (of 61,943)
1	Monash University	2,222	3.587
2	Egyptian Knowledge Bank	1,829	2.953
3	University of California	1,257	2.029
4	Chinese Academy of Sciences	1,217	1.965
5	King Saud University	1,205	1.945
6	Centre National De La Recherche Scientifique	1,195	1.929
7	Helmholtz Association	1,118	1.805
8	University System of Ohio	1,107	1.787
9	Universite Paris-Saclay	1,066	1.721
10	Consejo Superior De Investigaciones Cientificas	1,055	1.703
11	UK Research Innovation	1,053	1.700
12	National Kapodistrian University of Athens	1,033	1.668
13	Ohio State University	1,019	1.645
14	University of Wisconsin	1,019	1.645
15	Sapienza University Rome	1,015	1.639
16	University of Illinois	1,015	1.639
17	University of Naples Federico II	1,015	1.639
18	University of Belgrade	1,008	1.627
19	Boston University	1,007	1.626
20	University of Wisconsin Madison	1,004	1.621
21	United States Department of Energy	1,003	1.619
22	Istituto Nazionale Di Fisica Nucleare	1,001	1.616

Table 10: Gold OA Publication Contributions and Proportional Commitment by Malaysian Public Universities

No.	University	Total no of papers	Total no of gold OA papers	% of gold OA papers	% of institution contribution to gold OA
1	Universiti Kebangsaan Malaysia	25,112	10,452	41.62	16.92
2	Universiti Malaya	33,770	10,141	30.03	16.41
3	Universiti Putra Malaysia	22,960	8,773	38.21	14.20
4	Universiti Sains Malaysia	24,474	8,205	33.53	13.28
5	Universiti Teknologi Malaysia	21,490	5,401	25.13	8.74
6	Universiti Teknologi Mara	9,455	3,085	32.63	4.99
7	Universiti Islam Antarabangsa Malaysia	6,865	2,373	34.57	3.84
8	Universiti Malaysia Sabah	4,047	1,901	46.97	3.08
9	Universiti Malaysia Terengganu	4,901	1,767	36.05	2.86
10	Universiti Malaysia Pahang Al-Sultan Abdullah	4,894	1,411	28.83	2.28
11	Universiti Malaysia Perlis	3,705	1,112	30.01	1.80
12	Universiti Malaysia Sarawak	3,086	1,094	35.45	1.77
13	Universiti Tun Hussein Onn	3,497	1,049	30.00	1.70
14	Universiti Sultan Zainal Abidin	2,113	917	43.40	1.48
15	Universiti Utara Malaysia	3,376	900	26.66	1.46
16	Universiti Teknikal Malaysia Melaka	2,759	844	30.59	1.37
17	Universiti Malaysia Kelantan	1,530	683	44.64	1.11
18	Universiti Pertahanan Nasional Malaysia	1,265	610	48.22	0.99
19	Universiti Perguruan Sultan Idris	1,714	564	32.91	0.91
20	Universiti Sains Islam Malaysia	1,452	502	34.57	0.81
Total		**182,465**	**61,784**	**99.75**	**33.86**

DISCUSSION

This study examines Malaysian research output indexed in the WoS from 2014 to 2023, with a particular focus on gold OA articles. The findings suggest that Malaysia is making significant progress in promoting gold OA publications among its researchers. Several factors may contribute to this success. Wang et al. (2018) argue that national policies play a crucial role in advancing gold OA publications. However, no clear national policy was identified in Malaysia specifically addressing this issue. Instead, institutional influences appear to be driving the trend. Supporting this idea, a study by Masrek and Yaakub (2015) on researchers at a Malaysian private university found that career development opportunities within organisations were key motivators for choosing OA publications. Additionally, researchers valued the increased visibility, awareness, and wider readership that OA journals provide.

Numerous studies highlight the positive impact of OA, including gold OA, on citation rates by providing broader readership. Eger et al. (2021) support this view, demonstrating through empirical analysis across multiple disciplines and time periods that gold OA offers citation advantages. In fact, citation metrics improved when journals transitioned to gold OA (Bautista-Puig et al., 2020). However, the current study suggests otherwise. Among the top 100 most cited articles, only five are gold OA, with the highest-cited gold OA article ranked 50th. This suggests that gold OA status does not necessarily correlate with higher citations. This finding is consistent with previous research. For instance, Basson et al. (2021), analyzing WoS data, found that most subject areas in OA publications did not exhibit a clear citation advantage, with only six out of 250 subject areas showing higher citation rates. Similarly, van Leeuwen et al. (2018) suggest that gold OA journals may have a lower citation impact compared to green OA, where authors self-archive their articles in institutional or subject repositories.

According to Cary and Rockwell (2020), the high percentage of collaborations with upper-income countries suggests that financial barriers may be influencing research patterns. The high costs associated with OA publishing may drive researchers to seek partnerships with wealthier nations to share the financial burden. The prominence of collaborations with Saudi Arabia is also notable, as it has consistently recorded the highest level of international collaboration (73.2%) among G20 countries from 2017 to 2021 (Cruz, 2023). Over the past 25 years, research output in Saudi Arabia has grown significantly, outpacing that of other Gulf Coast countries (Al-Marzouqi & Arabi, 2022). This growth can be attributed to the national development strategies for higher education and research, the increased number of universities, and the enhanced support for scholarly activities in the recent years. These factors likely explain the preference for collaboration between Malaysian researchers and Saudi Arabia. Additionally, international collaboration is widely recognised as a key factor influencing the success of publications in high-impact journals (Low et al., 2014). Further studies support this connection, demonstrating that international collaboration is linked to higher citation rates (Onyancha, 2021; Pečlin et al., 2012; Velez-Estevez et al., 2022).

The high rate of gold OA publications among Malaysian public universities is likely influenced by several factors, including the role of institutions as publishers. National publishers, particularly those affiliated with universities, often play a significant role in academic publishing. This is exemplified by Brazilian state research agencies, which fund scholarly publishing programmes to support university-affiliated journals (Collyer, 2018). Similarly, researchers at Malaysian public universities may be inclined to support national

publishers. For instance, UKM significantly contributes to *Sains Malaysiana*, a journal published by the University Press. This journal is among the leading gold OA journals for Malaysian researchers, thereby increasing the university's publication output. Despite *Sains Malaysiana* being one of the leading gold OA journals with high publication numbers, it has lower citation counts compared to other four journals publishing Malaysian OA articles. Notably, *Scientific Reports*, ranked fifth, exhibits a higher citation distribution than the other journals. Larivière et al. (2016) discussed that high publication volume does not necessarily correlate with high citation counts per article. This illustrate that even journals with many published articles can struggle with low visibility or influence in the research community.

Three of the Malaysian public universities with the highest percentage of gold OA publications are relatively young and smaller institutions. This suggests that these universities may be using gold OA publishing as a strategy to enhance visibility and boost citations. By prioritising gold OA, they could be aiming to attract talented researchers, increase their citation impact, and improve their global reputation. While this is a plausible hypothesis, further research is needed to verify the correlation between university size and the rate of gold OA publication.

MDPI has become a dominant OA publisher in both Malaysia and global publishing landscape. In Malaysia, it accounts for nearly 20 percent of the country's gold OA publications, while globally, MDPI expanded rapidly, increasing its output from 1,514 publication in 2008 to a staggering 165,330 by 2020 (Shu & Larivière, 2024) . Despite its rapid growth, MDPI has faced significant criticism regarding its credibility. It was initially listed on Beall's list of potential predatory publishers, but was later removed following a campaign by MDPI targeting various managerial staff at the University of Colorado to have the publisher delisted (Beall, 2017). Additionally, MDPI was downgraded by the Norwegian Register for Scientific Journals, Series, and Publishers, before being reinstated in 2020 (Oviedo-García, 2021). It was also flagged by the Chinese Academy of Sciences as 'risky' journals (Lee, 2021) . The Ministry of Higher Education Malaysia has restricted public university researchers from using government funds to publish in MDPI, along with Hindawi and Frontiers (Chawla, 2023). This shift signals a broader change in Malaysia's academic publishing landscape, reflecting growing concerns over the credibility of these OA publishers. It highlights the risks faced by these publishing platforms and underscores the need for new strategies to address these challenges and ensure the integrity and sustainability of academic publishing in the country.

CONCLUSIONS

This study examines the growth of OA publications in Malaysia over a ten-year period, from 2014 to 2023. Understanding OA publishing in developing countries is crucial, as much of the research is publicly funded, and economic uncertainties can significantly impact national research and development (R&D) landscapes (Gonzalez-Brambila et al., 2016). Malaysia provides a unique case due to the interplay of socio-economic, cultural, and institutional factors that may influence the adoption of OA publishing. Notably, research specifically addressing gold OA within the Malaysian context remains limited, making this investigation particularly timely and valuable. The analysis reveals positive trends, indicating that Malaysia is making significant strides toward embracing OA publications, particularly gold OA. The steady annual increase in gold OA publications suggests that this trend is likely to continue in the coming years, potentially accelerating

the dissemination and accessibility of Malaysian research to a global audience. This growing commitment to OA could enhance the visibility of Malaysian scholarship, fostering greater international collaboration and recognition in the global academic community.

Despite the observed growth, the study has several limitations. Although this study did not specifically examine the citation impact in depth, the findings suggest that the citation impact of Malaysian gold OA articles remains relatively low compared to other publications. The highest-cited gold OA article only ranks 50th overall, indicating a disconnect between the volume of publications and their citation impact. Additionally, this study relied exclusively on data from the WoS database, which, while a robust platform for bibliometric analysis, may not capture the full spectrum of gold OA publications in Malaysia. Other databases, such as Scopus and OpenAlex, which cover a broader range of journal subject areas, could reveal different trends. Pranckutė (2021) notes that WoS tends to prioritise publications in natural sciences, engineering, and biomedicine, often overlooking the arts, humanities, and social sciences. Moreover, it has been criticised for potential geographic and linguistic biases, which may lead to an underrepresentation of gold OA publications in Malaysia (Tennant, 2020). Future research would benefit from incorporating a broader range of databases or combining multiple databases to provide a more comprehensive view of the growth of gold OA in Malaysia. Additionally, studies could explore other OA models to assess Malaysia's broader commitment to OA. Future investigations could also compare OA trends among Southeast Asian countries or with leading nations in OA publishing, offering insights into regional and global dynamics in research on open science.

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CONFLICT OF INTEREST

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AUTHOR CONTRIBUTION

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