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OPEN ACCESS PUBLICATIONS OF UNIVERSITI SAINS MALAYSIA: A BIBLIOMETRIC ANALYSIS

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ABSTRACT

Open Access (OA) is the new publishing model that allows unrestricted access and reuse of research outputs. OA accelerates discovery in the sense that researchers can freely read and build on new findings based on other research. While the public seems to welcome more involvement in OA among academics, many researchers are still discussing about the challenges they face when publishing with OA journals including the issue of article processing charge (APC) and the quality of these journals. This paper examines several aspects related to OA publications such as publication productivity, citation impact, subject coverage, and publishing cost of Universiti Sains Malaysia (USM) based on SCOPUS data from 2013 to 2015. The findings show that the School of Medical Sciences, Physics and Pharmacy dominated the OA publications. This indicates that science-based researchers are highly inclined towards publishing in OA when compared to non-science researchers. The top three OA journals in are Plos One (multidisciplinary), Acta Chrystallographica Section E (chemistry) and Electronic Journal of Geotechnical Engineering (engineering, geology). Most of the authors tend to publish in Q3 journals (43%), followed by Q2 (28%), Q1 (16%) and Q4 (13%). However, with regards to citation impact per paper (average), every paper in the Q1 journal received 6.25 citations, followed by Q2 (2.8 citations), Q3 (1.33 citations) and Q4 (0.87 citation). The APC of OA publication range from RM0 to RM15,000 per paper. The study provides useful insights about OA publications of USM researchers which can guide other researchers who wish to engage with OA. Further studies should be conducted by interviewing authors to further explore the OA research funding and strategy in choosing OA journals to publish in and the motivation in publishing in OA.

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Keywords: Bibliometric; Open access; Research productivity; Research impact; Academic publishing

ABSTRAK:
Akses terbuka atau Open Access (OA) adalah model penerbitan baharu iyang memberi akses tanpa had dan penggunan semula hasil penyelidekan.OA mempercepatkan penemuan dimana penyelidek boleh membaca secara bebas dan membina dapatan baharu berdasarkan penyelidekan lain. Walau pun masyarakat mengalu-alukan penglibatan dalam OA dikalangan ahli akademik, ramai penyelidek masih berbincang mengenai cabaran yang mereka hadapi apabila menerbit dalam jurnal OA termasuk isu caj penerbitan article atau article processing charge (APC) dan kualiti jurnal sebegini. Kertas ini mengkaji beberapa aspek berkaitan penerbitan OA seperti produktiviti penerbitan, impak sitasi, liputan subjek dan kos penerbitan Universiti Sains Malaysia (USM) berdasarkan data SCOPUS dari 2013 hingga 2015. Dapatan kajian menunjukkan Pusat Pengajian Sains Perubatan, Fizik dan Farmasi mendominasi penerbitan OA. Ini menunjukkan penyelidek berasaskan sains lebih cenderung untuk menerbitkan dalam OA jika dibandingkan dengan penyelidek bukan-berasaskan sains. Tiga jurnal OA teratas adalah didalam Plos One (pelbagai disiplin), Acta Chrystallographica Section E (kimia) dan Electronic Journal of Geotechnical Engineering (kejuruteraan, geologi). Kebanyakan pengarang cenderung menerbit dalam jurnal Q3 (43%), diikuti dengan Q2 (28%), Q1 (16%) and Q4 (13%). Tetapi, apabila merujuk kepada impak sitasi per kertas (purata), setiap kertas dalam jurnal Q1 journal menerima 6.25 sitasi, diikuti dengan Q2 (2.8 sitasi), Q3 (1.33 sitasi) and Q4 (0.87 sitasi). APC bagi penerbitan OA adalah dalam julat RM0 hingga RM15,000 per kertas. Kajian ini memberi pandangan berguna mengenai penerbitan OA penyelidek USM yang boleh membantu penyelidek lain yang ingin berjinak-jinak dengan OA. Kajian lanjut perlu dilakukan dengan menemubual pengarang bagi meneroka dengan lebih mendalam dapatan penyelidekan OA dan strategi pemilihan jurnal OA untuk penerbitan dan motivasi menerbit dalam OA.

Kata kunci: Bibliometrik; Akses terbuka; Produktiviti penyelidikan; Impak penyelidikan; Penerbitan akademik

INTRODUCTION

Open access (OA) journals that began in the 1990s (Mashroofa & Senewiratne, 2016), has changed the landscape of scholarly publishing and has been vastly developed since 2002. Different authors defined OA differently. According to Suber (2012), an OA philosopher, noted that ‘open access is digital, online, and

free of most copyright and licensing restrictions. Thus, the basic idea of OA publications is to remove access barriers and enable readers to access it free of cost. It gives authors and their works more visibility, readership and citations, and thereby increase impact of their research (Mashroofa & Senewiratne, 2016). There are two routes to OA namely the gold and the green. The Gold route deals with publications in OA journals which are peer reviewed and are accessible through internet without charges, and Green route to OA is self-archiving and delivered by repositories (Suber, 2012). In general, approximately 15% of articles in OA are self-archived. To achieve 100% OA comprehensively, researchers' institutions and funders need to mandate self-archiving, as done presently (Gargouri, 2010).

The OA scenario in Malaysia has been practiced immensely particularly in higher educational institutions through self-archiving using institutional repositories. Currently, many institutional repositories exist in both the public and private universities and some has maintained good ranking in webometrics (Zainab, 2010). In Universiti Sains Malaysia (USM), the repository, known as Repository@USM serves as the main repository for storing a variety of electronic information materials such as articles from academic journals, books, theses, examination papers, research reports, photographs and others. It provides free access to the users and can be used freely for research and learning at the University. It also plays an important role to ensure continuity of intellectual property in the USM community. Instead of just a repository, the new paradigm of OA is publishing and sharing the information and knowledge without barriers.

RESEARCH OBJECTIVES

1. To identify the research productivity of USM authors with regards to publishing in OA journals.
2. To explore the scientific impact of USM's OA publications.
3. To identify the cost involved in publishing with OA journals.

RESEARCH QUESTIONS

1. What are the characteristics of OA publication productivity among USM authors?
2. What is the scientific impact of USM's OA publications?
3. How much does it cost for USM authors to publish in OA journals?

RESEARCH METHODOLOGY

Publication Data

SCOPUS is one of the largest citation databases of peer-reviewed academic materials especially journal articles. Therefore, all publications were selected and derived from this database. The affiliation "university sains malaysia" is used for searching publications in SCOPUS. The list of publications were then

filtered by years from 2013 until 2015. The selection of document type was "Article" for the purpose of this study. The "Article" in SCOPUS means publication in an academic journal. The number of publications can be changed according to the frequency of indexing of the database from time to time. Hence, the publication data from this study were derived in November 2016.

SCImago Journal & Country Rank (SJR) is the platform to measure the scientific evaluation and influence of scholarly journals around the world. SJR also offers the indicator to any journal in the category of OA. Therefore, the list of publications from SCOPUS were merged with SJR to identify OA publications that match the journal title. However, one more step is required to identify the exact OA publication by inspecting the data in the list one by one because some of the OA journals in SJR are Gold OA based on the payment of a specific fee by the author for the article to be published. Consequently, some publications in the list were not OA even though they are listed in a Gold OA journal.

Microsoft Excel was the main tool used to analyse data in this study. After identifying all the publication data to be analysed, two methods were used namely by using manual counting and the pivot table and chart. These methods were applied to study the distribution of authors, schools, and journal titles.

Citation Data

For each publication, the citation data was extracted from SCOPUS, Web of Science and Google Scholar. All the citations were counted one at a time from each platform and were determined by total citations in the period of collection of the publication data.

Subject Coverage

SJR is a platform to determine the subject for each publication. The subject is based on the journal title. There are two types of subject in SJR - subject areas and subject categories. The study selected subject categories as it is more specific than subject areas.

Publishing Cost

The article processing charges (APC) for each publications were gathered from the Directory of Open Access Journals (DOAJ) and the publisher's website. Some of the OA journal were not indexed in DOAJ. Therefore, the information of APC were obtained from the publisher's website. The method used for this was manual searching and counting.

LITERATURE REVIEW

Citation Impact

Literature review on the issues of OA in recent years has gained pervasive use of the scientific evolutions due to the major changes in the way of publishing research results. Lawrence (2001) investigated the citation impact of articles and have been reported to receive higher citation rates compared to non-OA. Another related literature from Bernius and Hanauske (2009) stated that their simulation of the citation network found methods for an author to increase the citations when switching to OA. It suggests that the results of the simulation support empirical data regarding the increase in citations of articles published under an OA paradigm.

However, another related literature encountered a different view regarding OA that has no impact on the quantity of citations in the principal year after publication. These findings were based on a randomized controlled trial of 11 journals published by the American Physiological Society (Davis, 2008). Therefore new measures of research utilization and impact is needed for OA publication, including citation and download counts, growth curves, and latencies; co-citation numbers; authority ranks, semantic indices and numerous other online performance indicators. These will be usable for navigation and evaluation as well as for analysing and predicting research headings and impacts (Hajjem, 2006).

A comparison study was conducted in utilizing the article usage data, citation and altmetric data for Nature Communications publication between OA and non-OA articles. From the point of view of static comparison, OA articles are highly considered than non-OA papers. OA articles could pull in support and consistent consideration, even after a long period of distribution. Interestingly, for the non-OA articles, most consideration occurs in the initial 30-day time span (1 month). The OA advantage exists for citation, as well as for article utilization. Compared with shorter time frame consideration for non-OA papers, OA is preferred as article utilization for lengthy era (Wang, 2015).

Publishing Cost

Publishing cost are among the main concerns when dealing with OA. Van Noorden (2013) highlights in his papers that most open access publishers charge fees that are much lower than the industry's average revenue, although there is a wide range between journals. The largest open access publishers BioMed Central and PloS, charge USD1,350 to USD2,250 to publish peer-reviewed articles in many of their journals. In a survey published last year, economist Bo-Christer Björk of the Hanken School of Economics in Helsinki and psychologist David Solomon of Michigan State University in East Lansing looked at 100,697 articles published in 1,370 fee-charging open access journals active in 2010, and

found that charges ranged from USD8 to USD3,900. Higher charges tend to be found in hybrid journals, in which publishers offer to make individual articles free in a publication that is otherwise pay walled. Outsell estimates that the average per-article charge for open access publishers in 2011 was USD660. In addition, the reason that OA publishers have lower costs is simply that they are newer, and publish entirely online, so they do not have to conduct print runs or set up subscription paywalls.

Therefore, the following related literature regarding adoption of OA related costs is highlighted in this case study. DeGroff (2016) reported that recently, the Open Access Good Practice (OAGP) in a community-led support programme aims to produce a wide range of outputs to develop and share best practices when implementing OA workflows, systems and procedures across UK higher education institutions. The OAGP has adopted the new process to manage OA related cost as stated by Sonja Haerkoenen, Scholarly Publications Manager at Cardiff University (DeGroff, 2016) and encouraged institutions to share best practice for reporting and managing APCs. As a result, staff at Cardiff is planning to implement a different way of reporting and accounting for the APC payments, which will save time and therefore reduce administration costs. Open access librarian, Liz Holliday from the University of Bath, confirmed Haerkoenen's mentions that the functional cost analysis of the APC payment process undertaken by the project partners 'allowed the four GW4 institutions to understand the costs and effort in each functional area of the payment processes'. Teplitzky (2016) states that researchers support the utilization of numerous subsidizing sources to pay APCs, although they feel that the university ought to offer more prominent contributions. The finding shows there were two variants that researchers perceived that the university ought to help with less financing. Researchers also felt that the university ought to offer monetary support for its OA policy to acknowledge the university's commitment in supporting the publications become more visible.

Subject Coverage

Lawrence (2001) mentioned that the citation impact of conference articles in computer science reported higher citation rates for OA texts compared to non-OA articles. Similar findings were reported by Odlyzko (2002) in mathematics and Kurtz (2005) in astrophysics. Harnad (2004) also measured the impact of OA articles across all disciplines and across time by sampling 12 years of publication for 14 million papers in the Institute for Scientific Information (ISI). The findings reveal a citation advantage of OA across all fields.

Serrano-Vicente (2016) noted that the choice to distribute in OA journals is firmly identified for academic reward and professional acknowledgement. In

science, technology and medicine, publishing in journals encourage academic professions and many of the journals are OA. Researchers in these areas are more inclined to publish their work in OA journals. In the humanities and sociology, there are relatively few high-quality OA journals. Researchers in these regions either deposit their research in the repository for institutional reasons or to accomplish greater visibility and citations. Thus, the finding from this study can further investigate and elaborate either science-based researchers are more inclined towards publishing in OA when compared to non-science researchers.

FINDINGS AND DISCUSSION

The data were analysed in the scientific method as a methodological basis in developing the analysis of results. The study applied some bibliometric indicators to describe the results considered as simple description. After the study of the journals, which were derived from SCOPUS from 2013 until 2015, 1801 article titles were found as OA publication and were analysed to several scopes.

Distribution of Authors

Figure 1 shows the top 20 authors known as academic staff in USM who had published their articles in OA journals. The data shows that most of the top 20 authors who published in OA journals are from the field of science. However, Ramayah T. who majors in management, is one of the top 20 authors from the field of non-science. Thus, this indicates that science-based researchers are more inclined towards publishing in OA when compared to non-science researchers.

The total number of authors who published in OA journals increased drastically from 25 authors in 2013 to 1106 authors in 2014. In 2015, the total number of authors decreased to 989. MacKenzie-Cummins (2012) found that about 26% of the authors published with an OA publisher for their journal articles. Many researchers were unaware of the concept of OA or, if they have heard of it, they remain largely ignorant of its implications.

In 2013, Fun H.K. had the highest number of published articles with 28 articles published in OA, followed by Ibrahim D. with seven articles and Mohamed A.R and Lee Y.Y. sharing the same number of published articles at six articles each.

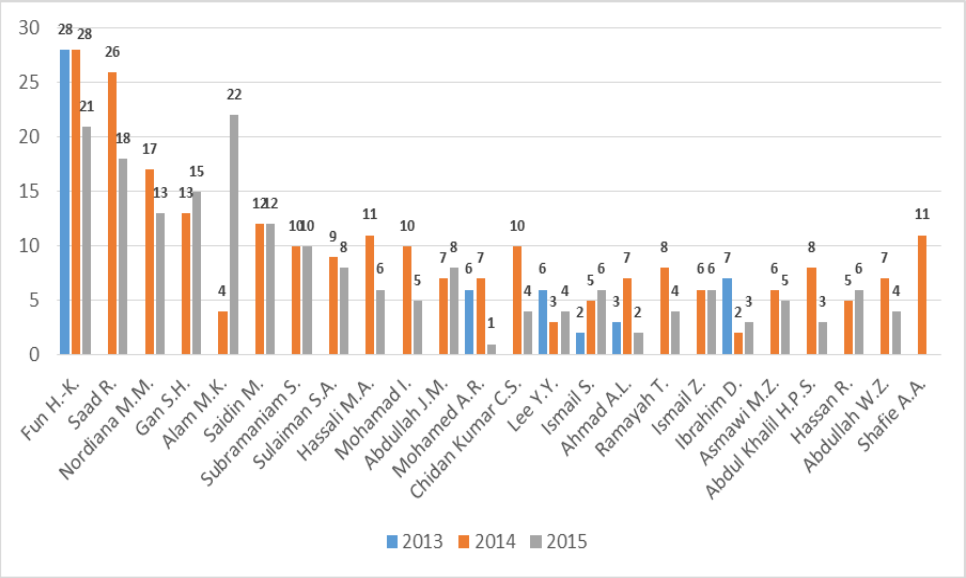


Figure 1: Top 20 authors who published in OA (2013-2015)

In 2014 and 2015, Fun H.K. was again the author who the highest number of published articles in OA (28 articles in 2014, 21 articles in 2015), followed by Saad R. (26 articles in 2014, 18 articles in 2015) and Nordiana M.M. (17 articles in 2014, 13 articles in 2015). Based on this study, Fun H.K. was the top author who published articles in OA journals from 2013 to 2015 with 77 articles.

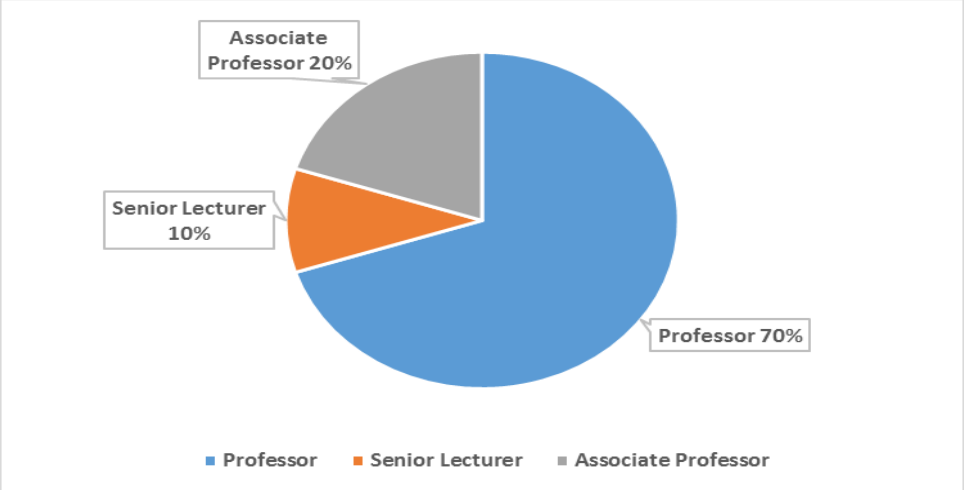


Figure 2: Categories of top 20 authors who published in OA (2013-2015)

From Figure 2, the study also classified the author by categories of academic staff. Professor, for instance, is the largest percentage that published articles in OA journals (70%), followed by Associate Professor (20%) and senior lecturer (10%). In other words, the Professors dominate the OA publication among USM academic staff and there is a vast difference between the publications by Professors and Associate Professors.

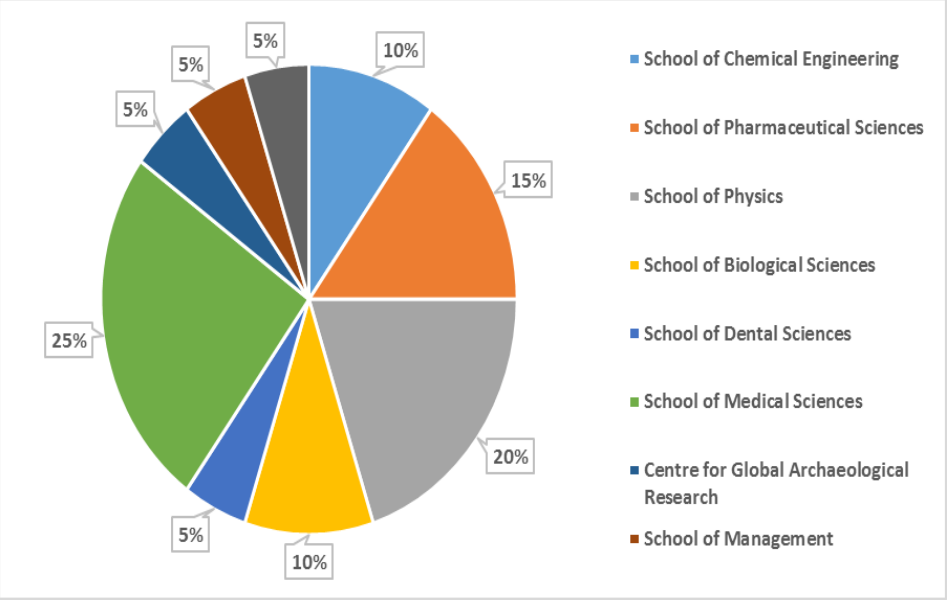


Figure 3: Schools of top 20 authors published in OA (2013-2015)

Distribution of Schools

Figure 4 shows the top 20 schools/centers that had OA publications from 2013 to 2015. Overall, most of the Schools from the field of science either pure science or applied science are moving towards OA publishing. As shown in Figure 4, the data shows that the School of Medicine is ranked at number one among the 20 other Schools. It shows that the School of Medical Sciences has produced 893 publications in OA journals. The difference between the School of Medical Sciences and the School of Physics is 317 publications. This difference is likely due to the need for dissemination of medical information to the public as mentioned by Grouse (2014). Medical research yields important and valuable information that benefits the people of the world. Furthermore, OA is particularly valuable for developing countries where limited financial resources have historically deprived health care professionals or the latest medical information.

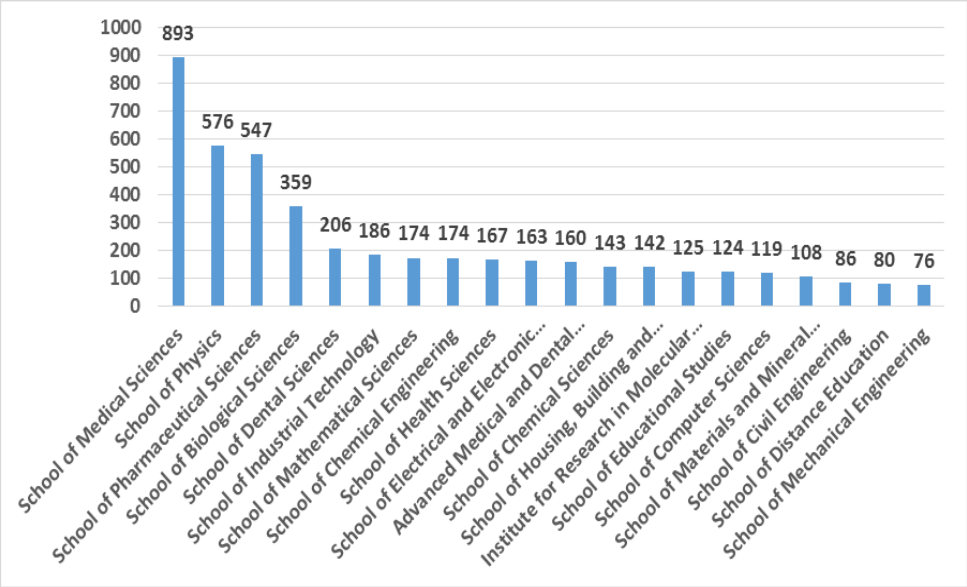


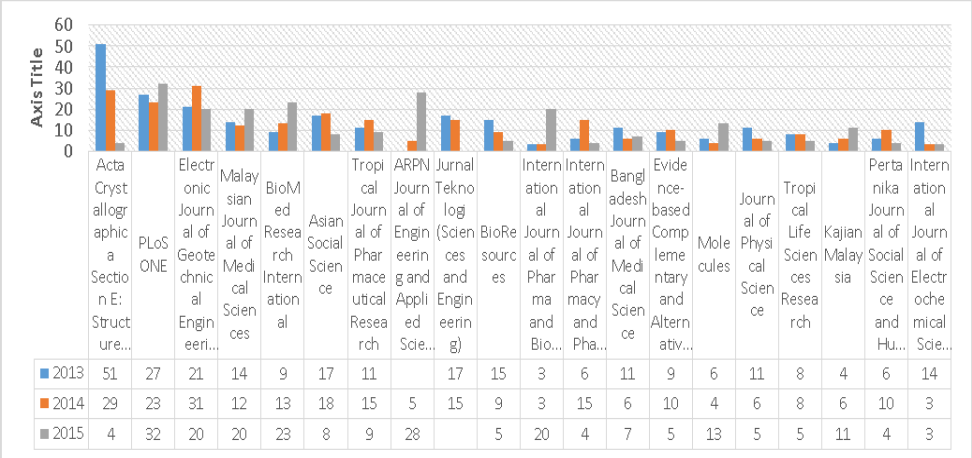
Figure 4: Top 20 schools/centres published in OA (2013-2015)

Distribution of Subjects and Journal Titles

Figure 5 shows the top 20 journal titles published in OA from 2013 to 2015. The study found 454 journal titles from 1801 publications, whereby, the top three journal titles are Acta Crystallographica Section E: Structure Reports Online (84 publications), PloS One (82 publications) and Electronic Journal of Geotechnical Engineering (72 publications). On the other hand, the Malaysian Journal of Medical Sciences, which ranked at number four (46 publications), has shown disparity on numbers of publications with Electronic Journal of Geotechnical Engineering (72 publications), which is at the third rank, with 26 publications. Researchers illustrate that perceived journal's reputation; perceived visible advantage; perceived topical relevance; perceived career benefits; and awareness and familiarity have a relationship with intention to publish in OA journals stated by Masrek and Yaakub (2015).

Figure 5 shows that the majority of journal titles are from the fields of science, technology, and engineering respectively except for three titles, which are, from the field of the social sciences. The impact factor for these journals are gradually increasing (Poltronieri, Bravo, Curti, Ferri, & Mancini, 2016). They are either in Quartile 1, 2, 3 or 4. Moreover, the data illustrates the publication trend of USM researchers pertaining to their awareness and consistency for choosing OA as the publishing platform. In 2013, the total numbers of OA journals were 221 and increased to 228 in 2014. A slight decrease occurred in

2015 when 12 journal titles were not listed anymore and only 216 journal titles were available. In fact, APC, citations and quartiles may become the researchers' consideration before choosing the journal for publishing their articles.



	Acta Crystallographica Section E: Structure...	PLoS ONE	Electronic Journal of Geotechnical Engineeri...	Malaysian Journal of Medical Sciences	BioMed Research International	Asian Social Science	Tropical Journal of Pharmaceutical Research	ARPN Journal of Engineering and Applied Scie...	Jurnal Teknologi (Sciences and Engineering)	BioResources	International Journal of Pharma and Bio...	International Journal of Pharmacy and Pha...	Bangladesh Journal of Medical Science	Evidence-based Complementary and Alternativ...	Molecules	Journal of Physical Science	Tropical Life Sciences Research	Kajian Malaysia	Pertanika Journal of Social Science and Hu...	International Journal of Electrochemical Scie...
2013	51	27	21	14	9	17	11		17	15	3	6	11	9	6	11	8	4	6	14
2014	29	23	31	12	13	18	15	5	15	9	3	15	6	10	4	6	8	6	10	3
2015	4	32	20	20	23	8	9	28		5	20	4	7	5	13	5	5	11	4	3

Figure 5: Top 20 journal titles published in OA (2013-2015)

The study identified 81 subject categories in 2013 with 632 publications. The following year shows a growth in subject categories with 95 subject categories and 628 publications by USM researchers. However, in 2015, it decreased to 90 subject categories with 542 publications. Figure 6 illustrates the top 20 subject categories of publications in OA from 2013 to 2015. The three highest number of publications according to subject categories are agriculture, chemistry and engineering. In 2013, those three subject categories had 148 publications but the number of publications decreased to 115 publications. In 2015, a trend occurred where only 99 publications were published in OA according to the top three subject categories.

Even though most of the subject categories of OA journals are from the field of science and engineering, researchers from the arts and humanities categories had taken the opportunity to commence with OA with 73 publications in their subject category. Another subject category with similar trend is from the cultural studies with 34 publications. According to Ismail, Napiah and Ismail (2013), many articles in their study were published in the field of science as there are more science subjects in USM rather than non-science subjects. However, nowadays it may be due to the new agenda driven by the USM top management where their aim is to have STEAM (science, technology, engineering, art, mathematic) rather than only STEM (science, technology, engineering, mathematic) (USM TV, 2017).

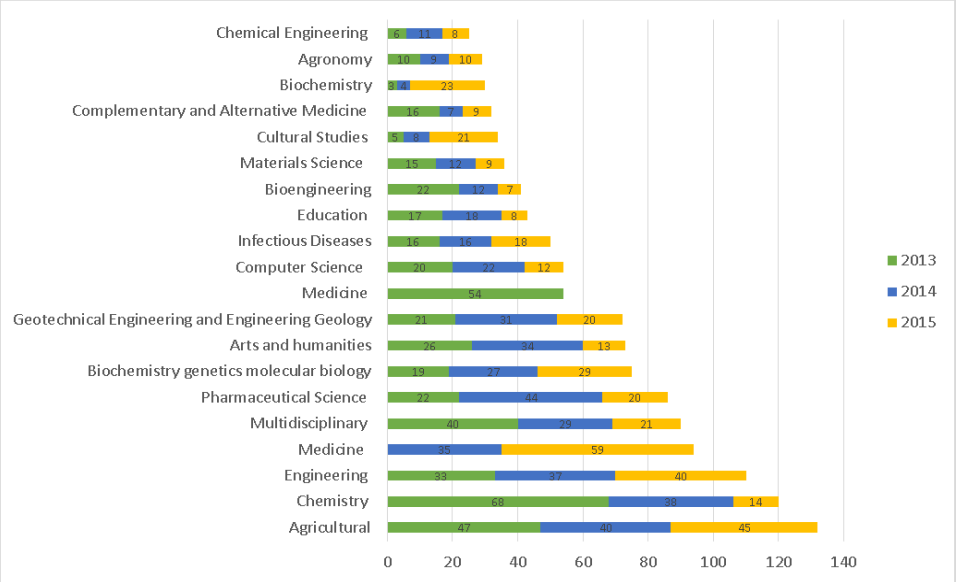


Figure 6: Top 20 subject categories published in OA (2013-2015)

Distribution of Citations and Quartiles

Journals are categorized into four different tiers, namely quartile 1 (Q1), quartile 2 (Q2), quartile 3 (Q3) and quartile 4 (Q4), which apparently is supposed to indicate their quality or tier in ranking. This is done based on the number of citations and the Impact Factor (IF) of the journal concerned. Q1 denotes the top 25% of the IF distribution, Q2 for middle-high position (between top 50% and top 25%), Q3 middle-low position (top 75% to top 50%), and Q4 the lowest position (bottom 25% of the IF distribution)

Table 1: USM OA publications, citations and average (2013-2015)

Quartile	No. Article	Citation	Average Citation Per Article
Quartile 1	297	1855	6.25
Quartile 2	496	1389	2.80
Quartile 3	778	1063	1.37
Quartile 4	230	200	0.87

There is a positive relation between the quartiles and the number of citations received (Table 1). Based on the case study at USM, the articles published in high quartile get more citations when compared to those in the lower quartile. In terms of impact based on average citation per article, it is found that for every article published in quartile 1, it obtains 6.25 citations. this is followed by quartile 2 (2.8 citations), quartile 3 (1.37 citations) and quartile 4 (0.87 citation). Therefore, researchers are strongly advised to publish their articles in a higher quartile in order to obtain more impact in the form of citations.

Another study by Napiah and Abrizah (2016) explored publication productivity and impact of 50 top Malaysian scientists in publishing with quartile 1 journals. The study revealed that publication in Q1 correlates with quality and thus increases the scientific impact (citation), one may conclude that the amount of citations received would be mechanically inherited by the journal's importance or where it has been published.

Based on Figure 7, this study found that most of the USM authors who published their papers as OA prefer to publish in Q3 journals (43%), followed by Q2 (28%), Q1 (16%) and Q4 (13%).However, there is no evidence on why it occurred, unless an interview is done to explore the reasons.

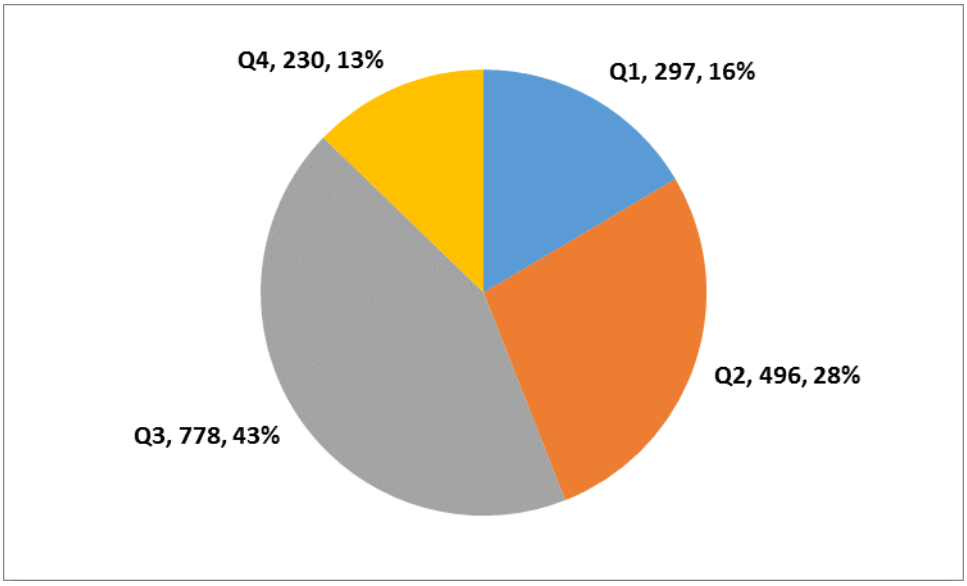


Figure 7: USM OA publications based on quartile (2013-2015)

In the academic world, scientific impact of a scientific writing always refers to citations that it received. In the case of USM OA publication, it is found that the

articles published in higher quartiles have more impact. From Figure 8, there were 297 articles published as OA in Q1, and managed to obtain 1855 citations. Another 496 articles published in Q2 with 1389 citations, followed by Q3 with 778 articles and 1063 citations. Meanwhile, the number of citation for articles in Q4 is much lower (200) compared to the number of articles (230). In other words for every article published in quartile 4 received less than one citation on average.

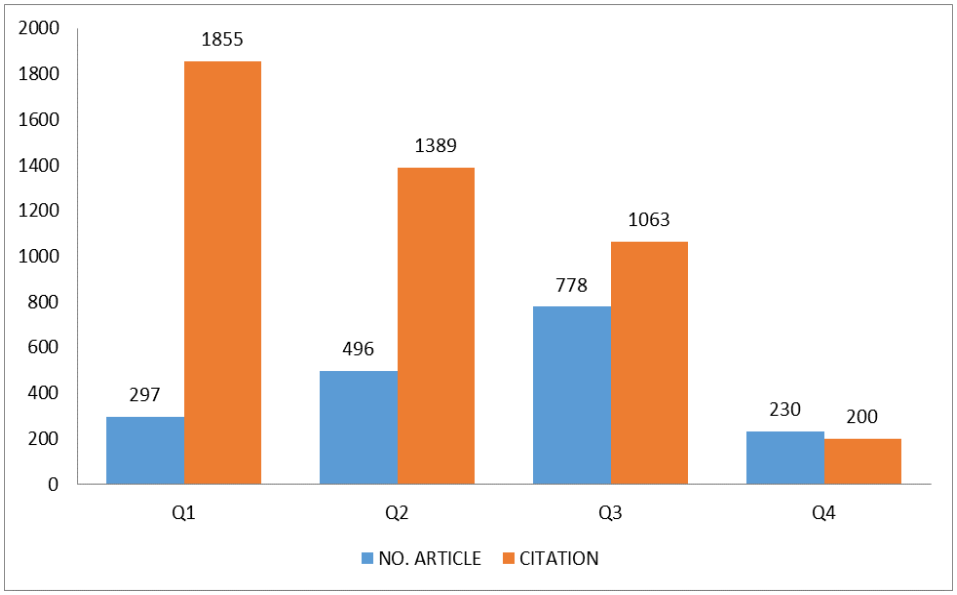


Figure 8: USM OA publications and citations (2013-2015)

Table 2: USM OA publications, citations and citation per article based on three citation databases (2013-2015)

Databases	Publication	Citation	Citation Per Article
SCOPUS	1801	4507	2.50
WOS	816	2426	2.97
Google Scholar	1708	7449	4.36

Out of 1801 OA articles under study extracted from SCOPUS, 816 articles appeared in Web of Science and 1708 were indexed by Google Scholar. In terms of scientific impact, Google Scholar received the highest number of

citations (7449) which equals to 4.36 citations per article on average. However, even though the Web of Science has a smaller number of publications and citations, it is found that it has a slightly higher citation per article (2.97) as compared to SCOPUS (2.50).

Article Processing Charges for Open Access Journals and its Expenses

There were enigmatic studies that showed who were the researchers and which universities have the highest numbers of published papers in OA journals, as well as which universities have high spending from public funds for APC. However, a study by Solomon and Björk (2012) showed that whenever researchers want to publish an article in any journals listed in DOAJ, they would need to spend an average of USD904 or MYR 3,797 for APC per paper. Moreover, the researchers in the field of biomedicine who intend to publish an article in OA journals would need to pay a high APC. The APC could reach more than USD1,500 or MYR 6,300 although the cost of online publishing could actually could be broken down to USD 100 or MYR 420. However, it depends on the extra costs invested by the publishers for each papers which combines additional activities for the learned society that patronage the journal as well as system development and maintenance (Van Noorden, 2013).

Nevertheless, USM as a public funded university, persist to investigate the general APC cost of OA journals under the USM researchers' budget especially from 2013 to 2015. It is important that USM works efficiently in budget spending and put a good value for research activities in the aspect of OA publishing expenses in the future. Hence, the study has been executed by analysing the APC statement of 1,801 articles written by USM researchers in 427 OA journals throughout the journals' website (Table 3). However, not all OA journals provide transparent APC statement on their journal's website (1,514 articles). There were still 287 articles written by USM researchers published in OA journals. However, USM researchers had spent about USD 1,153,107.14 or MYR 4,843,049.98 for all the articles published in OA journals in three conservative years. It also showed that the total average of each paper cost USM USD640.25 or MYR 2,689.09 and a majority of the USM researchers spent the lowest APC between USD0 to USD237.85 or MYR 999.

Meanwhile, there were more variant discoveries about USM's APC expenditure as specific details were studied. The study managed to trace the total cost of APC for a number of OA articles written by USM researchers based on SCImago subject categories, OA journal title names, USM authors and USM schools.

Table 3: Total cost of APC for USM OA publications (2013-2015)

APC Model	APC Range (MYR)	Total Article Titles	Total APC (MYR)	Average APC For Each Article (MYR)
Gold/Hybrid	9000 and above	143	1,368,371.32	9,569.03
	6,000 to 8,999	294	2,146,283.98	7,300.29
	3,000 to 5,999	132	574,353.69	4,351.16
	1,000 to 2,999	344	561,276.9	1,631.61
	1 to 999	352	192,764.09	547.63
Green	0	249	0.00	0.00
	unknown	287	-	-
	TOTAL	1,801	4,843,049.98	2,689.09

First, a majority of USM researchers who published articles in OA journals were based on the science subject categories (Figure 9). The most active USM researchers who published OA journal articles were from the field of medicine research with a total of 151 articles. The APC costs USM about USD 77,847.06 or MYR 326,957.65. On the other hand, the most expensive APC paid by USM was for the agriculture's researchers totalling USD 136,955.71 or MYR 575,214.00. However, it was recorded as the second highest published OA articles with 136 articles. The second highest APC paid by USM were for the biochemistry genetics molecular biology's researchers. It cost USM a total of USD 122,852.22 or MYR 515,979.29. Surprisingly, a huge gap was recorded in terms of publication outputs. The number of articles written by the researchers in OA journals in the subjects of biochemistry, genetics and molecular biology were only 78 articles. This shows that USM researchers need to pay a high APC when publishing in OA journals for biochemistry, genetics and molecular biology when compared to others. It costs USM an average of USD 1,575.03 or MYR 6,615.12 to publish one article in the stated subject category of OA journals.

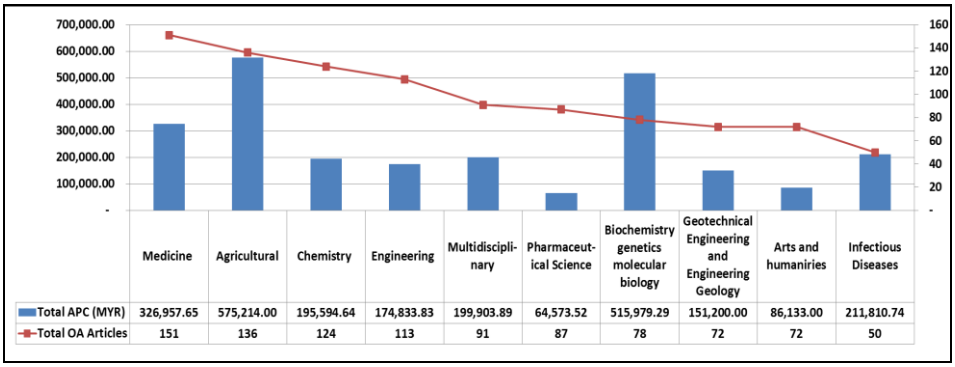


Figure 9: Total cost of APC for USM OA publications according to top 10 subject categories in SCImago (2013-2015)

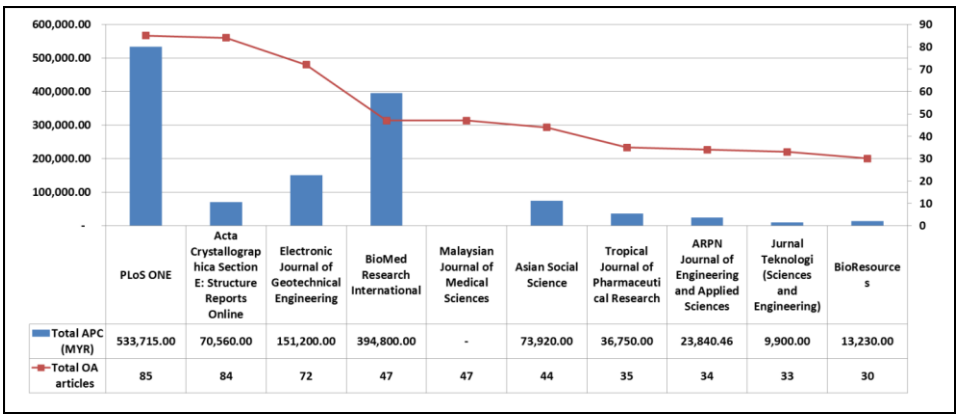


Figure 10: Total cost of APC for USM OA publications according to top 10 journal titles (2013-2015)

USM researchers highly favour publishing OA articles in PLoS One (85 articles) compared to other OA journals with a total APC cost of USD 127,075 or MYR 533,715 (Figure 10). Moreover, the study also found that USM researchers paid a high APC to *BioMed Research International* compared to the other journals which cost USD 94,000 or MYR 394,800 from 2013 to 2015. However, among the top 10 highest number of articles published by USM researchers based on journals showed that one journal has zero APC. This is the *Malaysian Journal of Medical Sciences*.

Figure 11 shows the top 10 authors who published articles in OA journals. Gan S.H. was the top among USM authors who paid a high APC to publish OA articles (USD67,223.75 or MYR 282,339.75). Fun H.K. successfully published the highest number of publications (78 articles) with an average APC cost of

USD606.85 or MYR 2,548.78 per article compared to other top 10 authors. As shown in Figure 12, USM researchers from the School of Medical Sciences had the highest published articles in OA journals (394 articles) aligned with the highest paid for APC compared to other USM schools with total amount USD 439,037.36/MYR 1,843,956.91. The School of Pharmaceutical Sciences (246 articles) had total cost of APC paid at USD 236,316.11/MYR 992,527.66.

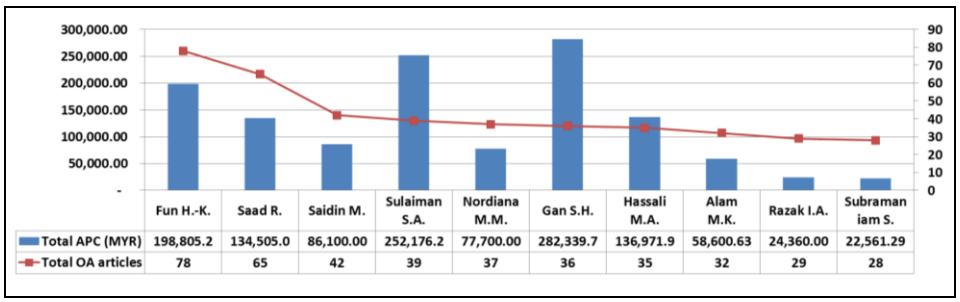


Figure 11: Total cost of APC for USM OA publications according to top 10 authors (2013-2015)

Based on the results USM should now reconsider the need to provide funds for OA publishing on a more specific conditions based on subject categories, journal title names, authors' background and school's name. The finding shows that budgeting can be more efficient based on the stated allocation criteria. USM could map the funding on criteria that are more specific. For instant, USM researchers from biochemistry, genetics and molecular biology do require a large amount of funding to support APC for publishing OA articles in those subject journals. However, this study is limited to Q1 and Q2 journals in these subject categories.

The United Kingdom (UK) Open Access Implementation Group (2012) (UK-OAIG) asserted that regardless of the cost of APC, the efficient process systems of APC is a crucial issue in the OA publishing landscape so that it would provide wider values of OA publishing. The UK-OAIG recommended authors, research funders, universities and publishers for a greater standardization to facilitate more efficient process flows between themselves especially focusing on countering the issues on the development, implementation and adoption of good intermediary services for the better value of payment of APCs.

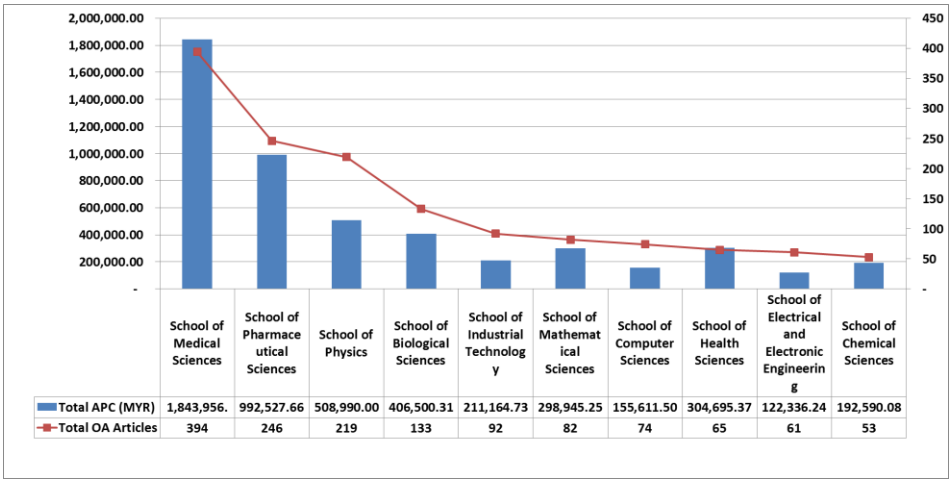


Figure 12: Total cost of APC for USM OA publications according to top 10 schools/centres (2013-2015)

RECOMMENDATIONS

From the analysis that has been done, the following recommendations are made:

1. Measure the social impact of USM publications to know how their research can benefit the public.
2. Further investigate the motivations of authors in publishing in OA journals through interview.
3. University has to promote OA in a number of ways such as:
   i. Mandates stipulating that USM researchers have to publish their works funded by public funder in OA journals and focusing on Q1 and Q2.
   ii. Mandates stipulating that USM researchers have to deposit their 'pre-print' and 'post-print' to Repository@USM.
   iii. Provide dedicated funds for the payment of APCs in gold or hybrid journals.
   iv. Introduce the *Sanggar Sanjung Award* for researcher that publish their works in OA with high impact.
   v. Negotiate with more publishers to obtain 15% discount for APC such as the agreement with BioMed Central Supporter.

CONCLUSION

The OA practice is growing in its popularity and necessity. This paper examined several aspects in relation to OA publication such as publication productivity, citation impact, subject coverage, and publishing costs as well as offer some insights into the trend of USM's OA publication. It can be said that USM's OA publication is growing and has made important contributions towards the growth of total publications. This practice will make USM researchers' productivity

more visible and accessible, thus increasing the impact of their research. Therefore, as an Apex University, USM has to embrace OA publishing to increase competitiveness in University rankings.

REFERENCES

Bernius, S. and Hanauske, M. 2009. *Open Access to Scientific Literature - Increasing Citations as an Incentive For Authors to Make Their Publications Freely Accessible.* Paper presented at the Hawaii International Conference on System Sciences.

Davis, P. M., Lewenstein, B. V., Simon, D. H., Booth, J. G. and Connolly, M. J. L. 2008. Open access publishing, article downloads, and citations: randomised controlled trial. *BMJ*: 337.

DeGroff, H. 2016. Open access and knowledge sharing: reflections on the Pathfinder projects and Open Access Good Practice initiative. *Insights*, Vol 29, no. 2: 133–139. doi: http://doi.org/10.1629/uksg.301

Gargouri, Y., Hajjem, C., Larivière, V., Gingras, Y., Carr, L., Brody, T. and Harnad, S. 2010. Self-selected or mandated, open access increases citation impact for higher quality research. *PloS One*, Vol 5, no. 10: e13636.

Grouse, L. 2014. Open access medical publications. *Journal of Thoracic Disease*, Vol. 6, no. 6: e133.

Hajjem, C., Harnad, S. and Gingras, Y. 2006. Ten-year cross-disciplinary comparison of the growth of open access and how it increases research citation impact. eprint arXiv:cs/0606079

Harnad, S. and B.Tim. 2004. Comparing the impact of open access (OA) vs. non-oa articles in the same journals. *D-Lib Magazine*, Vol. 10, no. 6.

Ismail, M. I., Napiah, M. K. M. and Ismail, A. H. 2013. *Universiti Sains Malaysia Research Publication: A Bibliometric Study*. Paper presented at the ASIA-Pacific Library and Information Education and Practice (ALIEP) 2013, Pullman Khon Kaen Raja Orchid Hotel, Khon Kaen City, Thailand.

Kurtz, M. J., Eichhorn, G., Accomazzi, A., Grant, C., Demleitner, M. and Murray, S. S. 2005. Worldwide use and impact of the NASA Astrophysics Data System digital library. *Journal of the American Society for Information Science and Technology*, Vol. 56, no. 1: 36-45. doi:10.1002/asi.20095

Lawrence, S. 2001. Free online availability substantially increases a paper's impact. *Nature*, Vol. 411, no. 6837: 521-521.

MacKenzie-Cummins, P. 2012. Research Show Growing Awareness and Uptake of Open Access Publishing by Authors. Diperoleh dari: https://www.intechopen.com/news/research-show-growing-awareness-and-uptake-of-open-access-publishing-by-authors

Mashroofa, M. M. and Senewiratne, W. 2016. Open access initiatives and institutional repositories: Sri Lankan scenario. *Annals of Library and Information Studies (ALIS)*, Vol. 63, no. 3:182-193.

Masrek, M. N. and Yaakub, M. S. 2015. Intention to publish in open access journal: The case of Multimedia University Malaysia. *Procedia - Social and Behavioral Sciences,*Vol. 174: 3420-3427. doi:http://dx.doi.org/10.1016/j.sbspro.2015.01.1013

Napiah, M. K. and Abrizah, A. 2016. *Publishing in the First Quartile: A Case of 50 Malaysian Prolific Scientists*. Paper presented at the International Conference on Libraries, University of Malaya, Kuala Lumpur.

Odlyzko, A. 2002. The rapid evolution of scholarly communication. *Learned Publishing,* Vol. 15: 7-19. doi:10.1087/095315102753303634

Poltronieri, E., Bravo, E., Curti, M., Ferri, M., and Mancini, C. 2016. Open access publishing trend analysis: Statistics beyond the perception. *Information Research,* Vol. 21, no. 2.

Serrano-Vicente, R., Melero, R. and Abadal, E. 2016. Open access awareness and perceptions in an institutional landscape. *The Journal of Academic Librarianship,* Vol. 42, no. 5: 595-603.

Solomon, D. J. and Björk, B.C. 2012. A study of open access journals using article processing charges. *Journal of the American Society for Information Science and Technology,*Vol. 63, no. 8:1485-1495. doi:10.1002/asi.22673

Suber, P. 2012. *Open Access*. Cambridge: The MIT Press.

Teplitzky, S. and Phillips, M. 2016. Evaluating the impact of open access at berkeley: results from the 2015 survey of Berkeley Research Impact Initiative (BRII) funding recipients. *College & Research Libraries,* Vol 77, no. 5.

United Kingdom Open Access Implementation Group. 2012. *The Potential Role for Intermediaries in Managing the Payment of Open Access Article Processing Charges (APCs)*. Diperoleh dari: http://repository.jisc.ac.uk/4949/

USM TV. 2017. *Perutusan Naib Canselor 2017*. Diperoleh dari: https://www.youtube.com/watch?v=VNxrK2JGaBs

Van Noorden, R. 2013. The True cost of science publishing. *Nature,* Vol. 495, no. 7442): 426-429.

Wang, X., Liu, C., Mao, W. and Fang, Z. 2015. The open access advantage considering citation, article usage and social media attention. *Scientometrics,* Vol. 103, no. 2:555-564.

Zainab, A. 2010. Open Access repositories and journals for visibility: Implications for libraries. *Malaysian Journal of Library & Information Science,* Vol. 15, no. 3: 97-119.