Gold Route Open Access Journals in Engineering and Technology: Analysis of Research Impact and Implications for Scholarly Communication

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Abstract

This study examines the research impact of gold open access (OA) journals in engineering and technology. A total of 37 gold route journals that request article processing charges (APC) and 66 other OA journals without APC (i.e., platinum OA) in the field were found in the Directory of Open Access Journals and used for the study. The publishers, APC charges, and the year each journal was added to DOAJ were identified and included in this study. An informetric approach was used to extract research impact indicators (citations, paper productivity, cite/paper, cite/journal, and h-index) of journals. Findings revealed that the publishers of the APC journals were dominated by commercial publishing companies, producing over 60% of the journals. Article processing charges ranged from \$7.60 to \$3,471.50, with an average of \$727.00. Gold route open access (APC) journals performed better than open access non-APC OA journals, since they produced 51.2% of the papers, 71.8% of the total citations, and 65.1% of the total h-index. There was a weak positive correlation between the APC amount of the gold route journals and their research impact.

Introduction

The past one and a half decades has witnessed a revolution in scholarly communication with the emergence of open access publishing. Librarians had earlier drawn the attention of the global scientific community to dwindling library budgets and the skyrocketing cost of research literature, leading to what was generally regarded as the serials crisis ([Guédon 2004](#); [Beall 2013](#)). Journal publishers appeared to be more interested in the economics of scholarly publishing with regard to high profit margin than providing wider access to research literature. With internet powered publishing opportunities, there was an increasing interest in resolving the challenges of

the serials crisis. This led to the meeting of the Open Society Institute in 2001, which gave birth to the Budapest Open Access Initiative (BOAI) (see <http://www.budapestopenaccessinitiative.org/read>). This was described as the “first internationally focused formal statement to articulate a comment to open access” (Peekhaus & Proferes 2015). BOAI provided different open access models, namely, gold route, which often requires payment of article processing charges, and green route, which involves self-archiving in research or institutional/research repositories (Sanchez-Tarrago & Fernandez-Molina 2009; Peekhaus & Proferes 2015). The global estimate of open access journals is about 28,000 in all fields, publishing about 2.5 million articles annually with about 20% of the journals using the gold route model (Harnad 2015).

Open access publication models, namely, gold, green, and hybrid (publication of gold open access and subscribed articles within the same journal), provide different publication options for scholars (Antelman 2004; Craig et al. 2007; Turk 2008; Tenopir et al. 2017). While the gold and hybrid routes allow the authors to pay article processing charges (APC) as a way of bearing the cost of access to the general public, the green route allows the authors to self-archive their publications in research or institutional repositories or use social media outlets, such as researchgate.net and academic.edu, to share content to the wider scientific community. But, Tenopir et al. (2017) raised concern about the cost of maintaining the institutional repositories and other related challenges in green route open access publishing. There is also a set of established society journals with stable subscription funds, which provide free access to their publications directly or after a period of six months to one year (Laakso et al. 2011). Many other toll-access journals, including top journals in different fields, allow self-archiving of their publications using the green OA. Naturally, open access is believed to enhance wider access and reading of research papers (Laakso et al. 2016) and by extension increase citations and impact of the papers. Harnad et al. (2004) have described citation impact as the “degree to which its findings (research publications) are read, used, applied, built upon, and cited by users to further research and applications.” That is why many publishers are increasingly adopting OA. Similarly, many journals that were originally subscription based have begun to adopt hybrid publication model as a result of pressure from stakeholders, monetary subsidies, and other related issues (Laakso et al. 2016). About 2,400 subscription based journals moved to OA in 2011, and this represents over one third of the journals found in the Directory of Open Access Journals (DOAJ) (Laakso & Bjork 2012). Recent developments indicate that many publishers are increasingly flipping their journals by adding OA options to their publications. For instance Laakso et al. (2016) posited that Hindawi flipped all its journals to open access to avoid competition arising from major publishers.

Often APC is paid by funding bodies who have commissioned the research. Otherwise, authors must pay, if they desire free access and wider visibility of their papers. Usually, the possible considerations for authors’ choice of gold route open access include but are not limited to cost to the authors, mandate from the employer or funding body, visibility of the article, and the open access policy of the journal (Bjork 2012). The campaign for open access publishing resulted in many existing journals transitioning to gold route OA (Guédon 2004; Laakso et al. 2016), while others opted for hybrid publication outlets, so as to join the new publication platform that BioMedical Central and Public Library of Science (PLOS) pioneered in 2002. Other journals adopted hybrid publication as a form of gradual transition to the mainline gold-route publishing.

Studies indicate that over the years the number of hybrid open access journals have increased tremendously ([Laakso et al. 2011](#); [Shamash 2016](#)), but it has not translated to a significant number of articles published using the gold route platform ([Bird 2010](#); [Bjork 2012](#)). Many have, however, accused the gold-route model as being costly, risky, and inefficient, and, therefore, authors must be cautious of publishing through the gold route ([Guédon 2004](#); [Bjork 2012](#); [Beall 2013](#)). Although there have been author page charges that helped fund some society journals' publishing over the years, the major concern with APC is its extremely high cost, which many authors find difficult to pay. According to Bjork ([2012](#)), the cost of publishing in some of the journals is as much as \$3,000, and, therefore, only 1 to 2% of eligible authors can publish articles using this model. This is a source of concern to authors and research funders, as observation from DOAJ shows that many journals hosted in it request article processing charges.

DOAJ (see <https://doaj.org/>) was launched in 2002 during the First Nordic Conference on Scholarly Communication ([Stenson 2011](#)). Since then, DOAJ hosts a number of open access journals from many countries all over the world under the Creative Commons Attribution license (<https://creativecommons.org/licenses/by/2.0/>), which permits sharing and adapting content for any purpose, even for commercial uses. The last two decades witnessed an increase in publication of open-access journals funded through article processing charges from authors ([Fox & Hanlon 2015](#)) or through funding from agencies and organizations. This has provided free access to research literature and created wider visibility and readership to authors. As of November 10, 2016, when the data for this research was extracted, there were 9,250 journals and 6,450 searchable journals at article levels with 2,333,303 articles from 128 countries in DOAJ. This showed a remarkable increase from 1,825 journals as reported by Solomon and Bjork ([2012a](#)). There are 1,767 journals with APC and 3,685 non-APC journals in DOAJ at the time of this study.

The focus of this study is on engineering and technology, and these fields were considered because of the critical role they play in the overall technological development of any nation and even globally. History has also shown the application of science and technology drives sustainable development ([Mashi et al. 2014](#)). Hence, countries that have attained a high level of technological development have better human development indicators ([UNDP 2018](#)). In recognition of this the G7 Academies Statement ([2017](#)) urged the G7 countries to invest more in science and technology because of their capacity to drive sustainable socio-economic development. They are also fields that require current information, such as that found in the journal literature.

Consequently, it is very important to investigate issues related to scholarly communication in the discipline. Since there are several open access publication routes for researchers in the discipline, it should be of interest to interrogate economics of these routes in relation to their scholarly impact.

The concern is how the demand of APC affects researchers who may not have enough funds to pay as a result of low income and very slim opportunities to attract research grants. Harnad ([2015](#)) has also expressed the challenges of institutions that pay for APC and at the same time subscribe to toll access journals to meet the needs of the users. Authors such as Wray ([2016](#)) and Beall ([2013](#)) are, therefore, concerned about the value they get from APC journals compared to

non-APC open access journals. What other additional advantages accrue to the author to justify such payment?

Purpose of the study

The purpose of this study is to examine the research impact of gold route APC OA journals in relation to the article processing charges the journals request. Specifically, the study intends to

1. Identify APC engineering and technology journals and their charges
2. Identify publishers of APC journals in engineering and technology
3. Determine and compare the productivity and impact of APC and non-APC journals
4. Determine the relationship between APCs and research impact
5. Examine the trends in the growth of APC journals in Engineering and Technology

Literature Review

Though adoption of open access publishing has increasingly grown over time, earlier concern has been that OA often focused on articles rather than journals, since the papers are published independent of the journals ([Guédon 2004](#)). With self-archiving, the article becomes pre-eminent, while the journal only serves as a brand that provides information on papers that were peer-reviewed and those that were not. Though, there are variations in the two publication routes, Guédon ([2004](#)) remarked that they are complementary to each other rather than being in competition. However, the gold route model publishing presents to the publishers an attractive offer capable of increasing profit margin in academic publishing. Guédon ([2008](#)) has alluded to the economics of scholarly publishing when he remarked that some of the established publishers have created a form of elite club which dominates scholarly publishing, making it extremely difficult to admit neophytes. It is even becoming more monopolistic when university ranking bodies drive their ranking indicators from Web of Science and Scopus, which are dominated by journal portfolios from established publishers, such as Emerald, Elsevier, Springer, and Taylor & Francis, among others ([Guédon 2008](#); [Solomon & Bjork 2012b](#)). With this development, it is imperative to understand that very few scientists can or desire to publish in some of these journals using the gold-route option. This is evident from the study of Tenopir et al. ([2017](#)), which reported that respondents surveyed were willing to pay APCs not exceeding \$100, which is far lower than what many of the gold route journals charge. Shamash ([2016](#)) reported that, for the past two years, the average APC has increased by 6%, which is far above the cost of inflation in many countries. The concern here is the fear of established publishers hijacking the gold route publication model for the purpose of maximizing profit.

Consequently, some studies have attempted to investigate adoption of APC by journals and their publishers. A study by Walters and Linvill ([2011](#)) examined 663 journals hosted in DOAJ in six fields of biology, computer science, economics, history, medicine, and psychology, and found that 29% of journals that charged APC produced 50% of the articles produced. The average APC was \$1,109 with a median of \$1,300. McVeigh and Pringle ([2005](#)) reported that 27% of the 174 medical journals in the Web of Science were open access and another 14% were hybrid journals. A comprehensive Study of Open Access Publishing (SOAP) conducted by Dallmeier et al. ([2010](#)) collected data on 2,823 active English-language journals hosted in DOAJ and identified

14 large publishers with 80% of journals requesting APC. Another study by Solomon and Bjork (2012b) found that the major sources of funding for APC publications above \$1,000 were through research grants and institutional affiliations. There are also variations in the response of authors across disciplines and geographical areas, as authors from high-income countries with research funding respond more positively to APC than those from low-income countries.

Given the high publication charges of some journals, authors are often careful in their choice of journals when submitting their papers. Swan and Brown (1999 and 2004) found that factors that authors consider while choosing journals for their paper submission were readership (wider reach to researchers within and outside the discipline) and quality of journals, while Coupé (2004) remarked that authors equally consider the possibility of rejection of the papers. A related study by Schroter et al. (2006) identified research impact, reputation, readership, speed of publication, and quality of peer review as major considerations of authors in the choice of journals in submitting their papers. All these fall under the framework of Bjork and Holmström's (2006) 29 factors aggregated into four groups: infrastructure, readership, prestige, and performance.

Because of the article processing charges, there appears to be slow growth in the gold route OA publishing as reported in the study of Dallmeier et al. (2010), which revealed that Springer's gold route option had grown from 0% in 2004 to 1% in 2009; while the study of Bjork (2012) revealed that OA articles from journal portfolios from American Physical Society from 2007 to 2010 constituted only 0.3%, and Elsevier recorded less than 1% of sponsored articles in their gold route model, and this accounted for less than 0.1% of its total revenue in 2012. Bjork therefore concludes that the hybrid experiment has failed to add a significant number of OA articles through the gold route.

It is, therefore, contentious whether gold route OA has any relative value in scholarly communication. Wray (2016) has argued that there was no benefit in gold route OA considering the huge charges from publishers. Although several studies found citation advantage to open-access publishing (Antelman 2004; Metcalfe 2006; Craig et al. 2007; Turk 2008; Wagner 2010; Davis 2011), only a few of them have shown evidence of citation advantage through gold route OA publications (Shin 2003; Eysenbach 2006). According to Wray (2016), the supposed citation benefit reported by Sotudeh et al. (2015) was an artifact of the method used in measuring impact, as such citation advantage was absent in humanities and social sciences. Apart from this, Beall (2013) contended that the entrance of predatory journal publishers cast serious doubt on the success of gold route open access model. Other recent studies alluded to the danger of predatory open access journals in remarking that the major interest of such journals was mainly article processing charges rather than the scholarly peer review mechanism of reputable journals (Shen & Bjork 2015; Webster & Butler 2014; Christopher & Young 2015).

Others studies have equally questioned the quality control mechanism in OA publishing. Harnad (1998) underscored the need for peer review process in science and insisted that works must undergo peer review so that other researchers would rely on the paper for further research. Beall (2013) argued that the ability to pay APC is now a major determinant in accepting papers rather than the quality of the paper, usually determined through peer review mechanism, resulting in many referring to OA publishing as "pay to say." Beall (2013) remarks that misconduct, such as piracy and plagiarism (including self-plagiarism), have been confirmed by searching plagiarized

passages on the Internet, and these peer review related issues have begun to cast doubt on whether some research results are procedurally scientific.

Given these problems associated with gold route open access, researchers are worried about the fate of the open access movement in achieving free access to research literature. Harnad (2015) had argued that the best way to optimize a 100% open access is a self-archiving mandate to populate various institutional and research repositories all over the world. Ezema (2011) had earlier highlighted the need for development of institutional repositories, particularly in developing countries, for wider visibility of research outputs. A related work (Ezema & Ugwu 2013) also underscored the relevance of creating electronic theses and dissertations to provide wide access to primary research findings of African origin.

Methods

This study adopted a descriptive informetric approach and extracted data from DOAJ with several indicators related to this study. DOAJ has a built-in search mechanism capable of filtering journals by title, subject, type of OA route, publishers, country of publication, and year added to the database, among other metadata. At the time of this study there were 104 engineering and technology journals listed in DOAJ, out of which 37 request article processing charges, while 67 do not. Hybrid journals were excluded from the journals used for the analysis, because article-level deference is beyond the scope of the methodology employed in the study. The details about the journals used for the study and their status in the major international indexing bodies are provided in [Appendix 1](#).

The journal titles were entered into Harzing's Publish or Perish (PoP) software ([Harzing 2007](#)) to extract relevant data for measurement of research impact. Google Scholar was used to extract informetric data of the journals, namely the total number of papers, total number of citations, number of citations per paper, number of citations per year, and h-index for a five-year period. The extracted data was manually cleaned to remove duplicate citation data and incorrect citations. One of the non-APC journals (*EAI Endorsed Transactions on Wireless Spectrum*) was not recognized by the Publish or Perish software, so, it was dropped from the list and only 66 non-APC journals and 37 APC journals were used for this analysis. Data on citation indicators of the journals were exported to Microsoft Excel to determine their research impact. These journals were searched in two other major indexing bodies, namely, Web of Science (WoS) and Scopus, for comparison of their research impact. Unfortunately, the search yielded very low results, as only three of the journals were indexed in WoS and 11 in Scopus.

The article publication charges paid for each of the journals was obtained from the DOAJ web site and converted to US dollars using the exchange rate available online at the time of the study. The correlation of the research impact of the journals was based only on the data from Google Scholar, because of the very low presence of the journals in WoS and Scopus. The SPSS statistical package was used to determine the correlation between APC (in US dollars) and the research impact measured by h-index, citation counts, and number of papers published by the top twenty gold route OA (APC) journals. The same statistical software was used to investigate the correlation of h-index between APC and non-APC titles.

Results

Of the 37 APC journals studied, *Microsystems & Nanoengineering* has the highest APC of \$3,471.50 and *Journal Keteknikan Pertanian* has the lowest (\$7.60), with an average APC of \$727.00. [Appendix 1](#) provides a list of the APC charges of each journal. It is important to observe that the journal with highest APC is not among the top twenty ranked gold route journals, and the high ranked APC journals have relatively lower charges than other low ranked journals.

Table 1. Publishers of gold route (APC) journals

Publishers	Number of Journals	%
Hindawi	10	27.0
Elsevier	5	13.5
Springer	3	8.1
MDPI	2	5.4
Taylor & Francis	2	5.4
BioMed Central	1	2.7
Other institutional publishers	14	37.9
Total	37	100

Publishers of gold route open access journals are presented in Table 1, showing that commercial publishers (Hindawi, Taylor & Francis, Elsevier, Springer, and MDPI) account for over 60% of all the titles (see [Appendix 2](#) for a list of APC journals and their publishers). Fourteen institutional publishers have one journal each.

Table 2. Research impact of gold route (APC) and Non-APC journals (N = 103)

Type of OA Journal	Number of Journals	Total Papers	Paper/journal	Total Citations	Cite/Journal	Cite/Paper	Total H-Index	Mean H-Index
Gold route (APC)	37	12403	335.2	51454	1390.7	4.2	351	9.5
Non-APC Journals	66	11812	178.0	20199	306.1	1.7	338	5.1
Total	103	24215		71653			689	

A comparison of the research impact of APC and non-APC open access journals is presented in Table 2. Evidently, APC journals have greater research impact despite there being fewer than non-APC journals. Similarly, the APC journals published more articles than non-APC journals. More surprisingly, APC journals received 71.8% of the total citations. Therefore, in terms of citations, cite per paper, and cite per journal, APC journals are performing better, and the mean h-index is higher, than non-APC journals.

The growth of open access journals in engineering and technology has been very slow, but the growth rate is higher with non-APC than APC OA, as can be seen in Table 3. DOAJ began hosting two journals in 2002. In 2009, it recorded a growth rate of 4.4% until 2013, when there was a growth rate of 13% for APC journals, with the highest growth rate of 27% in 2015. The non-APC journals, however, have their highest growth rate of 46% in 2015.

Table 3. Trends in adoption of open access journals as reflected in DOAJ

Years	APC	% APC titles	Non-APC	% of non-APC titles	Total APC and non-APC titles	% of all OA titles
2016	9	24.3	20	29.9	29	25.4
2015	10	27.0	31	46.3	41	44.7
2014	2	5.4	3	4.5	5	4.4
2013	5	13.5	2	3.0	7	6.1
2012	1	2.7	4	6.0	5	4.4
2011	1	2.7	2	3.0	3	2.6
2010	0	0	1	1.5	1	0.9
2009	3	8.1	2	3.0	5	4.4
2008	0	0	0	0	0	0
2007	2	5.4	0	0	2	1.8
2006	1	2.7	1	1.5	2	1.8
2005	0	0	1	0	1	0.9
2004	1	2.7	0	0	1	0.9
2003	0	0	0	0	0	0
2002	2	5.4	0	0	2	1.8
Total	37		67		104	

The result of the correlation of the amount paid for article processing charges (APC), valued in US dollars, and research impact of the journals measured by number of papers published, citation counts, and h-index is shown in the correlation matrix (see Table 4). Interpretation of correlation

coefficient (r) was determined using Rumsey (2010), which provides that r value close to 0.30 is weak, 0.50 is moderate, 0.70 is strong, and 1 is perfect correlation. The correlation between APC and number of papers published is weak and not significant ($r = 0.275$, $p > 0.05$), but APC has a significant positive, but weak, correlation with citations ($r = 0.366$, $p < 0.05$). In the same way, APC has a significant positive but weak correlation with the h-index of the journals ($r = 0.392$, $p < 0.05$.) The implication of this finding is that the amount of the article processing charge has very little relationship with the research impact of the journals.

Table 4. Spearman's rho correlation matrix of APC and journal research impact

		APC (in US\$)	Papers	Cites	H-index
APC	Correlation Coefficient	1.000	.275	.366*	.392*
	Significance (2-tailed)	-	.099	.026	.016
Papers	Correlation Coefficient	.275	1.000	.800**	.753**
	Significance (2-tailed)	.099	-	.000	.000
Cites	Correlation Coefficient	.366*	.800**	1.000	.951**
	Significance (2-tailed)	.026	.000	-	.000
H-index	Correlation Coefficient	.392*	.753**	.951**	1.000
	Significance (2-tailed)	.016	.000	.000	-
N		37	37	37	37
*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).					

Discussion

Findings of this study provide greater understanding of the scholarly implications of the gold route open access publication model. With more non-APC open access model journals in engineering and technology, one would have expected minimal article processing charges from gold OA journals, but many of the journals collect more than \$1,000, with an average APC of \$727. These charges are extremely high and do not reflect the income of many scholars, particularly in the developing countries, where the average monthly salary is usually less than \$1,000. This is why many studies have leveled criticisms against high APC for many gold route OA journals (see Cozzarelli et al. 2004; Dallmeier et al. 2010). These charges may also account for the reluctance of institutions and authors to pay, as has been reported by Harnad (2015). With this development, the philosophy behind the open access movement is jeopardized, because a large majority of authors are excluded from the opportunity of publishing in journals of their choice once they cannot afford APC.

It is not surprising that commercial publishers dominate gold route open access publishing, given the economics of academic publishing. Previous studies (Walters & Linvill 2011; Solomon & Bjork 2012a) have often associated gold route (APC) open access publishing with commercial

publishers who are interested in increasing profit margin. Already, a lot of the journals are hybrid journals, where authors have option of paying APC for open access or publish without open access. This development relates to the concern of Guédon (2008), when he accused commercial publishers of creating an elite club that takes advantage of authors' interest in publishing in higher impact open access journals, where their papers are freely shared among colleagues across the globe for wider readership and greater research impact. As can be observed, almost half of the journals in this study are published by Hindawi, Elsevier, and Springer. (Guédon 2008; Bjork 2012; Solomon & Bjork 2012b) have earlier identified these established companies as pioneers of APC gold route open access publishing, and they have continued to popularize it ever since.

In the field of engineering and technology, APC journals have greater research impact than their non-APC counterparts in all the research indicators, such as number of papers published, citations, h-index, and citations per paper. Findings revealed that even though the gold route APC had fewer journals, they published over 50% of all papers and generated over 70% of the total citations. This is in line with earlier studies (Shin 2003; Eysenbach 2006). Though, open access publishing implies that all the journals are freely available on the Internet, providing equal opportunity for visibility and access, many readers would be more interested in accessing journals from established publishing companies and indexed in major international databases such as Web of Science and Scopus. A close observation of the performance of the journals revealed that the top twenty journals are published by established commercial publishing companies, where many authors usually submit their papers. A content analysis of papers published in these journals may provide a better insight in the quality of papers published in both OA types.

This study also shows that engineering and technology journals have a slow growth rate in open access publishing with only two journals in 2002 and increasing slowly until 2015 and 2016. This is contrary to the reported rapid growth of OA publishing in a study by Laakso et al. (2011), but supports the findings of Dallmeier et al. (2010), which attributed the slow growth to high APC; and it could also be that the growth of APC journals varies according to disciplines.

Although findings reveal a correlation between article processing charges and research impact of the journals, the effect size is relatively small. This is contrary to the belief of many authors who pay APC to increase their research impact. This assumption has been reflected in several studies that identify research impact and reputation of the journals as major considerations in selection of publication outlets of their papers (see Bjork & Holmström 2006; Schroter et al. 2006). This finding increases the contentious nature of research impact of APC journals, which Wray (2016) has questioned. Although Shin (2003) and Eysenbach (2006) found citation advantage of APC over non-APC journals, the studies failed to show whether this advantage correlates with the article processing charges of the journals and how significant is the correlation. The concern here is whether the introduction of APC by publishers has any scholarly benefits. Beall's (2013) argument that the major concern of gold route publishing is the ability to pay rather than the scholarly quality of the papers should be taken very seriously. Researchers should also worry about the level of peer review mechanism of gold route OA journals, which Harnad (1998) and Beall (2013) have questioned.

Implications for Scholarly Communication and Open Access Movement

The enthusiasm to embrace the open access movement by the global scientific community as a solution for the serials crisis in libraries has been underscored by a number of scholars ([Dallmeier et al. 2010](#); [Ezema 2011](#), [Ezema & Onyancha 2016](#); [Walters & Linvill 2011](#)). However, the introduction of APC by some publishing companies excludes a large majority of authors from contributing to the scholarly communication process. The major interest of authors is to widely disseminate their research findings to colleagues using reputable and widely circulated journals. Though it is yet to be established whether interest in APC is mainly for higher profit margin, publishers could be swayed by the high charges to the detriment of quality assurance. Such could also increase the possibility of ignoring some quality research papers.

Many are interested in the open access movement, because it tries to bridge the knowledge gap and digital divide between the advanced countries and the developing countries ([Peekkhaus & Proferes 2015](#); [Fox & Hanlon 2015](#)). Studies have shown that research and knowledge production in developing countries, particularly in Africa, is comparatively low ([Ezema 2010](#); [Gaillard 2010](#); [Nwagwu 2013](#)), but the gold route OA publishers are increasingly reducing research productivity of low-income countries through high APC. Though some publishers may grant a waiver of the charge, when authors apply, these waivers may not be forthcoming. It has been shown that gold route OA is usually funded by grants from organizations and institutions ([Solomon & Bjork 2012b](#)), but research funding in low-income countries is rare or completely absent. Considering the income of such researchers, few authors can afford the high charges of many gold route journals. The obvious implication is that quality research papers from these disadvantaged authors may never be published in gold route OA, where they are likely to receive higher research impact, and this perpetuates low knowledge production in low-income countries and robs the global research community of quality papers that would have contributed to the advancement of scientific knowledge.

For years, libraries have borne the burden of providing research literature to their teeming users, and that is why librarians were concerned about the serials crisis in late 1990's and early 2000's. The expectation is that with the open access initiative, this financial burden on libraries will be reduced, but the introduction of APC journals appears to have compounded the problem. The so-called hybrid journals accept APC from authors and institutions, and, this notwithstanding, libraries still pay subscription fees for users to access articles in the same journals. This double payment denies many institutions and libraries funds that could have been channeled to other areas to satisfy the demands of the users for their research.

The philosophy behind the Budapest Open Access Initiative is to provide free availability of information, which by extension implies the publication of such information for wider visibility and access. The concern here is that APC appears to be a constraint to the free flow of information and erodes the philosophy of open access. Scholars have already observed that it is an attempt to create an opportunity for established publishers to monopolize academic publishing (see [Beall 2013](#); [Bjork 2012](#); [Harnad 1998](#); [Harnad 2015](#)) racking up millions of dollars at the expense of authors and funding agencies. This negates all that the open access movement represents, and there is a need to create awareness on the dangers of APC on scholarly communication and the open access movement. This is why authors, libraries, institutions, and professional associations should give serious consideration to self-archiving articles in

repositories, as has been recommended by a number of studies ([Ezema 2011](#); [Harnad 1998](#); [Harnad 2015](#)). This green route option provides a good alternative for authors; and since some of the toll access journals allow for archiving of articles, Harnad ([2015](#)) posits that with self-archiving mandates from institutions and organizations, there would be 100% open access to research literature, if authors would ignore the antics of gold route open access publishers.

Conclusion

Open access publishing is an attempt to promote free access to information to the global scientific community. This paper has attempted to contribute to the debate on open access publishing with a focus on the research impact of gold route open access journals in relation to article processing charges, which the journals request from author and funding bodies. In engineering and technology, a greater proportion of OA journals that request APC are published by established publishing companies who can charge more than \$2,000. Though APC journals have greater research impact as seen in the findings, the research impacts of the journals do not seem to justify the high APC charges from the publishers, since there are only weak correlations between the charges and the research impact metrics, such as citations and h-index, and no significant correlation in terms of number of papers published. The increasing number of APC journals over the years should, therefore, be a source of concern, given the high charges as it appears to be antithetical with the philosophy of open access movement and scholarly communication. This therefore, justifies the need for increased awareness of the danger of gold route open access publishing for the global scientific community. If free flow of information in line with the open access movement must be guaranteed, the gold route open access model should be discouraged and researchers should be encouraged to freely disseminate their research outputs through self-archiving in repositories and other available channels.

References

- Antelman, K.** 2004. Do open-access articles have a greater research impact? *College & Research Libraries* 65(5):372-382. DOI: [10.5860/crl.65.5.372](#).
- Beall, J.** 2013. Predatory publishing is just one of the consequences of gold open access. *Learned Publishing* 26:79-84. DOI: [10.1087/20130203](#)
- Bird, C.** 2010. Continued adventures in open access: 2009 perspective. *Learned Publishing* 23(2):107-116. DOI: [10.1087/20100205](#)
- Bjork, B.-C.** 2012. The hybrid model for open access publication of scholarly article: A failed experiment? *Journal of the American Society for Information Science and Technology* 63(8):1496-1504. DOI: [101002/asi.22709](#).
- Björk, B.-C., & Holmström, J.** 2006. Benchmarking scientific journals from the submitting author's viewpoint. *Learned Publishing* 19(2):147-155. DOI: [10.1087/095315106776387002](#)

- Christopher, M.M. & Young K.M.** 2015. Awareness of “predatory” open-access journals among prospective veterinary and medical authors attending scientific writing workshops. *Frontiers in Veterinary Science* 2:1–11. DOI: [10.3389/fvets.2015.00022](https://doi.org/10.3389/fvets.2015.00022).
- Coupé, T.** 2004. What do we know about ourselves? On the economics of economics. *KYKLOS* 57(2):197–216. DOI: [10.1111/j.0023-5962.2004.00250.x](https://doi.org/10.1111/j.0023-5962.2004.00250.x)
- Cozzarelli, N., Fulton, K. & Sullenberger, D.** 2004. Results of a PNAS author survey on an open access option for publication. *Proceedings of the National Academy of the Sciences* 101(5):1111. DOI: [10.1073/pnas.0307315101](https://doi.org/10.1073/pnas.0307315101).
- Craig, I.D., Plume, A.M., McVeigh, M.E., Pringle, J. & Amin, M.** 2007. Do open access journals have greater citation impact? A critical review of the literature. *Journal of Informetrics* 1:239–248. DOI: [10.1016/j.joi.2007.04.001](https://doi.org/10.1016/j.joi.2007.04.001)
- Dallmeier-Thiessen, S., Goerner, B., Darby, R., Hyppoelae, J., Igo-Kemenes, P., Kahn, D., Lambert, S., Lengenfelder, A., Leonard, C., Mele, S., et al.** 2010. Open access publishing—models and attributes, SOAP project report, Max Planck Society Digital Library. Retrieved from: <http://edoc.mpg.de/478647>.
- Davis, P.M.** 2011. Open access, readership, citations: A randomized control trial of scientific journal publishing. *FASEB Journal* 25:2129–2134. DOI: [10.1096/fj.11-183988](https://doi.org/10.1096/fj.11-183988).
- Eysenbach, G.** 2006. Citation advantage of open access articles. *PLoS Biology* 4(5):e157. DOI: [10.1371/journal.pbio.0040157](https://doi.org/10.1371/journal.pbio.0040157).
- Ezema, I.J.** 2010. Trends in electronic journal publishing in Africa: An analysis of African Journal Online (AJOL). *Webology* 7(1). Available at <https://webology.org/data-cms/articles/20200515040154pma74.pdf>.
- Ezema, I.J.** 2011. Building open access institutional repositories for global visibility of Nigerian scholarly publication. *Library Review* 60(6):473–485. DOI: [10.1108/00242531111147198](https://doi.org/10.1108/00242531111147198).
- Ezema, I.J. & Onyancha, O.B.** 2016. Status of Africa in the global open access directories: Implications for global visibility of African scholarly research. *Fourth CODESRIA Conference On Electronic Publishing: Open Access Movement and the Future of African Knowledge Economy*, Dakar, Senegal March 30 – April 1, 2016. Available at https://www.codesria.org/IMG/pdf/ezema_onyancha.pdf.
- Ezema, I.J. & Ugwu, C.I.** 2013. Electronic theses and dissertations in Nigeria university libraries: Status, challenges and strategies. *Electronic Library* 31(4):493–507. DOI: [10.1108/EL-08-2011-0118](https://doi.org/10.1108/EL-08-2011-0118).
- Fox, M. & Hanlon, S.M.** 2015. Barriers to open access uptake for researchers in Africa. *Online Information Review* 39(5):698–716. DOI: [10.1108/OIR-05-2015-0147](https://doi.org/10.1108/OIR-05-2015-0147).

G7 Academies 2017. *New economic growth: The role of science, technology, innovation and infrastructure*. Retrieved from <http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-23-gs2017-5.pdf>.

Gaillard, J. 2010. The characteristics of R&D in developing countries. *Science, Technology and Society* 15:77–111. DOI: [10.1177/097172180901500104](https://doi.org/10.1177/097172180901500104).

Guédon, J.-C. 2004. The “green” and “gold” roads to open access: The case of mixing and matching. *Serials Review* 30(4):315–328. DOI: [10.1080/00987913.2004.10764931](https://doi.org/10.1080/00987913.2004.10764931).

Guédon, J.-C. 2008. Mixing and matching the green and gold roads to open access – Take 2. *Serials Review* 34(1):41–51. DOI: [10.1080/00987913.2008.10765151](https://doi.org/10.1080/00987913.2008.10765151).

Harnad, S. 1998. The invisible hand of peer review. *Nature*. DOI: [10.1038/nature28029](https://doi.org/10.1038/nature28029).

Harnad, S. 2015. Optimizing open access policy. *Serials Librarian* 69(2):133–141. DOI: [10.1080/0361526X.2015.1076368](https://doi.org/10.1080/0361526X.2015.1076368).

Harnad S., Brody T., Valliáres F., Carr L., Hitchcock S., Gingras Y., Oppenheim C., Stamerjohanns H. & Hilf E.R. 2004. The access/impact problem and the green and gold roads to open access. *Serials Review* 30(4):310–314. DOI: [10.1080/00987913.2004.10764930](https://doi.org/10.1080/00987913.2004.10764930).

Harzing, A. W. 2007. Publish or perish. Available at <https://harzing.com/resources/publish-or-perish>.

Laakso, M., & Bjork, B.-C. 2012. Anatomy of open access publishing: A study of longitudinal development and internal structure. *BMC Medicine* 10:124. DOI: [10.1186/1741-7015-10-124](https://doi.org/10.1186/1741-7015-10-124).

Laakso, M., Solomon, D. & Bjork, B.-C. 2016. How subscription-based scholarly journals can convert to open access: A review of approach. *Learned Publishing* 29:259–269. DOI: [10.1002/leap.1056](https://doi.org/10.1002/leap.1056).

Laakso, M., Welling, P., Bukvova, H., Nyman, L., Björk, B.-C., & Hedlund, T. 2011. The development of open access journal publishing from 1993 to 2009. *PLoS ONE* 6(6):e20961. DOI: [10.1371/journal.pone.0020961](https://doi.org/10.1371/journal.pone.0020961).

Mashi, S.A., Inkani, I.I. & Yaro, A. 2014. An appraisal of the role of science and technology in promoting national development efforts in Nigeria. *International Journal of Engineering and Science* 3(2):56–67. Available at <http://www.theijes.com/papers/v3-i2/Version-3/G032030056067.pdf>.

McVeigh, M.E. & Pringle, J.K. 2005. Open access to the medical literature: How much content is available in published journals? *Serials* 18(1):45–50. DOI: [10.1629/1845](https://doi.org/10.1629/1845).

Metcalfe, T.S. 2006. The citation impact of digital preprint archives for solar physics papers. *Solar Physics* 239:549–553. DOI: [10.1007/s11207-006-0262-7](https://doi.org/10.1007/s11207-006-0262-7).

- Nwagwu, W.E.** (2013). Open access initiatives in Africa – Structures, incentives and disincentives. *The Journal of Academic Librarianship* 19(1):3–10. DOI: [10.1016/j.acalib.2012.11.024](https://doi.org/10.1016/j.acalib.2012.11.024).
- Peekkhaus, W. & Proferes, N.** 2015. How library and information science faculty perceive and engage with open access. *Journal of Information Science* 41(5):640-661. DOI: [10.1177/0165555155587855](https://doi.org/10.1177/0165555155587855).
- Rumsey, D.J.** 2010. *Statistical Essentials For Dummies*. New York, John Wiley.
- Sánchez-Tarragó N. & Fernández-Molina J.C.** 2009. The open access movement and Cuban health research work: An author survey. *Health Information and Libraries Journal* 27:66-74. DOI: [10.1111/j.1471-1842.2009.00852.x](https://doi.org/10.1111/j.1471-1842.2009.00852.x).
- Schroter, S., Tite, L., Hutchings, A. & Black, N.** 2006. Differences in review quality and recommendations for publication between peer reviewers suggested by authors or by editors. *Journal of the American Medical Association* 295(3):314–317. DOI: [10.1001/jama.295.3.314](https://doi.org/10.1001/jama.295.3.314).
- Shamash, K.** 2016. *Article Processing Charges (APCs) and Subscriptions: Monitoring Open Access Costs*. Bristol: JISC.
- Shen, C. & Björk, B.-C.** 2015. Predatory open access: A longitudinal study of article volumes and market characteristics. *BMC Medicine* 13(230):1-15. DOI: [10.1186/s12916-015-0469-2](https://doi.org/10.1186/s12916-015-0469-2).
- Shin, E.-J.** 2003. Do impact factors change with change of medium? A comparison of impact factor when publication is by paper and through parallel publishing. *Journal of Information Science* 29(6):527–533. DOI: [10.1177/01655551503296009](https://doi.org/10.1177/01655551503296009).
- Solomon, D.J. & Bjork, B.-C.** 2012a. A study of open access journals using article processing charges. *Journal of the American Society for Information Science and Technology* 63(8):1485–1495. DOI: [10.1002/asi.22673](https://doi.org/10.1002/asi.22673).
- Solomon, D.J. & Björk, B.-C.** 2012b. Publication fees in open access publishing: Sources of funding and factors influencing choice of journal. *Journal of the American Society for Information Science and Technology* 63(1):98-107. DOI: [10.1002/asi.21660](https://doi.org/10.1002/asi.21660).
- Sotudeh, H., Ghasempour, Z., & Yaghtin, M.** 2015. The citation advantage of author-pays model: The case of Springer and Elsevier OA journals. *Scientometrics* 104:581–608. DOI: [10.1007/s11192-015-1607-5](https://doi.org/10.1007/s11192-015-1607-5).
- Stenson, L.** 2011. The development of Directory of Open Access Journals. *Sciecominfo: Nordic-Baltic Forum for Scientific Communication* 7(1):1-4. Available from <http://journals.lub.lu.se/index.php/sciecominfo/article/view/4912>.
- Swan, A., & Brown, S.** 1999. 'WHAT AUTHORS WANT:' The ALPSP research study on the motivations and concerns of contributors to learned journals. *Learned Publishing*. 12(3):170-172. DOI: [10.1087/09531519950145742](https://doi.org/10.1087/09531519950145742).

Swan, A., & Brown, S. 2004. Authors and open access publishing. *Learned Publishing* 17:219–224. DOI: [10.1087/095315104323159649](https://doi.org/10.1087/095315104323159649).

Tenopir, C., Dalton, E., Christian, L., Jones, M.K., McCabe, M., Smith, M. & Fish, A. 2017. Imagining a gold open access future: Attitudes, behaviors, and funding scenarios among authors of academic scholarship. *College & Research Libraries* 78(6):824–843. DOI: [10.5860/crl.78.6.824](https://doi.org/10.5860/crl.78.6.824).

Turk, N. 2008. Citation impact of open access journals. *New Library World* 109(1/2):65–74. DOI: [10.1108/03074800810846010](https://doi.org/10.1108/03074800810846010).

United Nations Development Programme. 2018. *Human Development Indices and Indicators 2018 Statistical Update*. New York: UNDP. Available from http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf.

Wagner, A.B. 2010. Open access citation advantage: An annotated bibliography. *Issues in Science and Technology Librarianship* 60. DOI: [10.5062/F4Q81B0W](https://doi.org/10.5062/F4Q81B0W).

Walters, W.H. & Linvill, A.C. 2011. Characteristics of open access journals in six subject areas. *College & Research Libraries* 72(4):372–392. DOI: [10.5860/crl-132](https://doi.org/10.5860/crl-132).

Webster, J. & Butler, B. 2014. The good, the muddle and the predatory: Open access journals in marine & aquatic sciences. Presented at the *40th IAMSLIC Conference*, Noumea, New Caledonia September 2014.

World Bank. 2017. *World Development Indicators 2017*. Washington, DC: International Bank for Reconstruction and Development. Available from <http://hdl.handle.net/10986/26447>.

Wray, K.B. 2016. No evidence for citation benefit for Author-Pay Open Access Publications in social sciences and humanities. *Scientometrics* 106:1031–1035. DOI: [10.1007/s11192-016-1833-5](https://doi.org/10.1007/s11192-016-1833-5).

Appendix 1

Open Access Journals in Engineering and Technology with APC Charges and Research Impact

	Journals	ISSN	Date added to DOAJ	APC	Papers	Cites	Cites/ paper	Cites/ year	h-index
1	Mathematical Problems in Engineering	1024-123X	2002	\$2,000	4,057	14,304	3.5	2,860.8	49
2	Materials	1996-1944	2009	1400CHF (\$1,428)	2715	25,113	9.2	5,022.6	47
3	Beilstein Journal of Nanotechnology	2190-4286	2012	Non-APC	827	5,965	7.21	1,193	36
4	Landtechnik	0023-8082	2015	Non-APC	1,403	2,131	1.5	426.2	20
5	Advances in Natural Sciences: Nanoscience and Nanotechnology	2043-6262	2011	Non-APC	420	2,222	5.3	444.4	20
6	Applied Sciences	2076-3417	2012	500CHF (\$510)	310	1,388	4.5	277.6	19
7	The International Archives of the Photogrammetry, Remote Sensing and Spatial Information	1682-1750	2015	Non-APC	1,865	2,910	1.6	582	18
8	Engineering Applications of Computational Fluid Mechanics	1994-2060	2015	\$1,500	259	1,272	4.9	254.4	17
9	Journal of Environmental Health and Engineering	1735-1979	2006	€600 (\$666)	80	659	8.2	131.8	15
10	International Journal of Rotating Machinery	1023-621X	2002	\$600	180	803	4.5	160.6	14
11	Latin American Journal of Solids and Structures	1679-7817	2005	Non-APC	135	836	6.2	167.2	13
12	Bioresources and Bioprocessing	2197-4365	2015	Non-APC	76	223	2.9	111.5	12
13	Theoretical and Applied Mechanics Letters	2095-0349	2016	\$1,000	415	883	2.1	176.6	12
14	Case Study in Thermal Engineering	2214-157X	2015	\$500	102	566	5.6	188.7	12

15	Engineering, Technology & Applied Science Research	2241-4487		€140 (\$155.4)	153	390	2.6	78.0	11
16	Advances in Civil Engineering	1687-8086	2009	\$600	460	874	2.0	174.8	11
17	Australian Educational Computing	0816-9020	2015	Non-APC	80	243	3.0	48.6	10
18	Paladyn: Journal of Behavioral Robotics	2081-4836	2015	Non-APC	68	363	5.3	72.6	10
19	ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences	2194-9042	2015	Non-APC	356	524	1.5	131	10
20	Journal of Modern Transportation	2095-087X	2007	€1,000 (\$1,110)	174	472	2.7	94.4	10
21	Journal of Control Science and Engineering	1687-5249	2015	\$600	243	517	2.1	103.4	10
22	Journal of Engineering	2314-4904	2013	\$600	182	515	2.8	128.8	10
23	Drinking Water Engineering and Science (DWES)	1996-9457	2009	Non-APC	54	154	2.9	30.8	9
24	Advances in OptoElectronics	1687-563X	2007	\$600	103	362	3.5	72.4	9
25	International Journal of Science and Engineering	2086-5023	2012	Non-APC	656	616	0.9	123.2	8
26	Journal of Engineering Research and Technology	2312-2307	2014	Non-APC	21	545	26.0	109	8
27	Case Studies in Engineering Failure Analysis	2213-2902	2015	\$500	96	250	2.6	83.3	8
28	Journal of Industrial Engineering	2314-4882	2013	\$600	54	177	3.3	35.4	8
29	Nano Convergence	2196-5404	2015	Non-APC	52	163	3.1	54.3	7
30	Advances in Radio Science ARS	1684-9965	2004	€150 (\$166.5)	235	334	1.4	66.8	7
31	Mehran University Research Journal of Engineering and Technology	0254-7821	2016	3,000PKR (\$28.5)	378	295	0.8	59	7

32	Chinese Journal of Engineering	2314-8063	2013	\$600	897	626	0.7	125.2	7
33	Atmospheric Measurement Techniques Discussion	1867-8610	2009	€1,000 (\$1,110)	308	337	1.1	67.4	7
34	Turkish Journal of Computer and Mathematical Education	1309-4653	2015	Non-APC	127	192	1.5	38.4	6
35	Tecnura	0123-921X	2012	Non-APC	606	252	0.4	50.4	6
36	Jurnal Teknik ITS	2301-9271	2015	Non-APC	714	355	0.5	88.8	6
37	Metrology and Measurement Systems	2300-1941	2015	Non-APC	81	160	1.0	32	6
38	Revista Producao Online	1676-1901	2006	Non-APC	262	269	1.0	53.8	6
39	Sensing and Bio-Sensing Research	2214-1804	2016	\$750	87	160	1.8	80	6
40	The Journal of Engineering	2051-3305	2013	\$1,150	183	116	0.6	38.7	6
41	Ciencia y Tecnologia	1390-4051	2016	Non-APC	58	82	1.4	16.4	5
42	Journal of Daylighting	2383-8701	2015	Non-APC	13	19	1.5	9.5	5
43	Telematika	1829-667X	2016	Non-APC	442	113	0.3	22.6	5
44	Texto Livre: Linguagem e Tecnologia	1983-3652	2015	Non-APC	133	71	0.5	14.2	5
45	Journal of Hebei University of Science and Technology	1008-1542	2015	Non-APC	355	344	1.0	68.8	5
46	Revista Venezolana de Ciencia y Tecnologia de Alimentos (RVCTA)	2218-4384	2015	Non-APC	106	90	0.9	18	5
47	Technologies (Basel)	2227-7080	2014	Non-APC	35	99	2.8	33	5
48	Advances in Science and Technology Research Journal	2080-4075	2015	Non-APC	216	156	0.7	39	5

49	Vestnik Volgogradskogo Gosudarstvenno Universiteta. Seria 10. Innovacionnaa Deatel'nost'	2305-7815	2015	Non-APC	225	93	0.4	18.6	5
50	Ingenieria y Ciencia	1794-9165	2012	Non-APC	240	106	0.4	21.2	5
51	Journal of Technology and Science Education	2013-6374	2011	Non-APC	104	106	1.0	21.2	5
52	Bioengineering (Basel)	2306-5354	2014	Non-APC	33	61	1.9	20.3	5
53	Journal of Quality and Reliability Engineering	2314-8055	2013	\$600	35	80	2.3	26.7	5
54	Journal of Engineering and Technological Sciences	2337-5779	2015	\$100	136	126	0.9	25.2	5
55	Journal of Solid State Lighting	2196-1107	2015	€1,000 (\$1,110)	36	115	3.2	23	5
56	Journal of Agricultural Machinery	2228-6829	2016	1,000,000 IRR (\$32)	75	89	1.2	17.8	5
57	Bibechana	2091-0762	2016	Non-APC	135	65	0.5	13	4
58	Journal of Mechatronics, Electrical Power, and Vehicular Technology	2087-3379	2013	Non-APC	138	86	0.6	17.2	4
59	Journal of Applied Biotechnology Reports	2322-1186	2015	Non-APC	52	12	0.2	6	4
60	Quantum Measurements and Quantum Metrology	2299-114X	2015	Non-APC	10	37	3.7	12.3	4
61	Evropejskij Zurnal Tehniki I Dizajna	2308-6505	2016	Non-APC	39	123	3.2	41	4
62	ComTech	2087-1244	2016	Non-APC	442	41	0.1	8.2	4
63	Cogent Engineering	2331-1916	2014	\$1,250	105	86	0.8	43	4
64	Frontiers in Built Environment	2297-3362	2015	\$1,900	23	53	2.3	53	4
65	International Journal of Manufacturing Engineering	2356-7023	2014	\$600	33	46	1.4	15.3	4

66	Journal Energi Dan Manufaktur	2302-5255	2016	Non-APC	101	27	0.3	5.4	3
67	Scietia cum Industria	2318-5279	2015	Non-APC	37	9	0.2	3	3
68	Tecnologia em Metalurgia Materiais e Mineracao (TMM)	2176-1515	2016	Non-APC	192	38	0.2	7.6	3
69	Tecno Logicas	0123-7799	2013	Non-APC	211	82	0.4	16.4	3
70	Al-Qadisiyah Journal for Engineering Science	1998-4456	2016	\$50	19	299	15.7	59.8	3
71	Civil and Environmental Engineering	1336-5835	2016	€60 (\$66.6)	69	28	0.4	5.6	3
72	Microsystems & Nanoengineering	2055-7434	2016	£2,650 (\$3,471.5)	20	34	1.7	34	3
73	Journal of Rehabilitation in Civil Engineering	2345-4423	2016	Non-APC	34	16	0.5	5.3	2
74	Drinking Water Engineering and Science Discussions	1996-9473	2009	Non-APC	13	12	0.9	2.4	2
75	International Journal of Electronics, Mechanical and Mechatronics Engineering	2146-0604	2015	Non-APC	6	8	1.3	1.6	2
76	Jurnal Tribologi	2289-7232	2016	Non-APC	12	15	1.25	7.5	2
77	Cadernos de Prospeccao	1983-1358	2010	Non-APC	257	33	0.1	16.5	2
78	Multidisciplinary Journal for Education, Social and Technological Sciences	2341-2593	2015	Non-APC	42	10	0.2	5	2
79	REEC: Revista Electronica de Engenharia Civil	2179-0612	2016	Non-APC	76	24	0.3	4.8	2
80	Epistemos	2007-4530	2016	Non-APC	6	14	2.3	2.8	2
81	Bionatura	1390-9347	2016	Non-APC	29	19	0.7	3.8	2
82	Nauka I Tehnika (Science Technique)	2227-1031	2016	Non-APC	9	17	1.9	3.4	2

83	Revista Chilena de Derecho y Tecnologia	0719-2584	2015	Non-APC	41	16	0.4	4	2
84	Case Studies in Fire Safety	2214-398X	2015	\$500	22	24	1.9	10.3	2
85	Journal of Applied Engineering Sciences	2247-3769	2015	€40 (\$44.4)	97	20	0.2	5	2
86	Jurnal Spektran	2302-2590	2015	\$50	54	26	0.5	5.2	2
87	International Journal of Engineering and Technology Innovation	2223-5329	2015	Non-APC	7	1	0.1	0.2	1
88	EAI Endorsed Transactions on Security and Safety	2032-9393	2016	Non-APC	2	6	3.0	6	1
89	International Journal of Advances in Intelligent Informatics	2442-6571	2015	Non-APC	2	6	3	6	1
90	IF-Sophia	2358-7482	2016	Non-APC	4	1	0.3	1	1
91	Journal of Dental Biomaterial	2383-3971	2015	Non-APC	5	2	0.4	0.5	1
92	Engaging Science, Technology, and Society (ESTS)	2413-8053	2016	Non-APC	12	8	0.6	2.7	1
93	Inge@UAN	2145-0935	2015	Non-APC	77	5	0.1	1	1
94	Jurnal Teknosain: Jurnal Ilmiah Sains dan Teknologi	2089-6131	2016	Non-APC	14	2	0.1	0.4	1
95	EAI Endorsed Transactions on Collaborative Computing	2312-8623	2016	Non-APC	3	1	0.3	0.5	1
96	Journal Keteknikan Pertanian	2407-0475	2016	100,000 IDR (\$7.6)	3	12	4	12	1
97	Mechanics of Advanced Materials and Modern Processes	2198-7874	2015	€300 (\$333)	7	3	0.9	0.4	1
98	RCT Revista de Ciencia e Tecnologia	2447-7028	2016	Non-APC	7	0	0	0	0
99	Acta Tecnologia	2453-675X	2016	Non-APC	3	0	0	0	0

[illegible]

Appendix 2

APC Engineering and Technology Journals and Their Publishers

	Journals	Publisher
1	Mathematical Problems in Engineering	Hindawi
2	Materials	MDPI
3	Applied Sciences	MDPI
4	Engineering Applications of Computational Fluid Mechanics	Taylor & Francis
5	Journal of Environmental Health and Engineering	BioMed Central
6	International Journal of Rotating Machinery	Hindawi
7	Theoretical and Applied Mechanics Letters	Elsevier
8	Case Study in Thermal Engineering	Elsevier
9	Engineering, Technology & Applied Science Research	ETASR
10	Advances in Civil Engineering	Hindawi
11	Journal of Modern Transportation	Springer
12	Journal of Control Science and Engineering	Hindawi
13	Journal of Engineering	Hindawi
14	Advances in OptoElectronics	Hindawi
15	Case Studies in Engineering Failure Analysis	Elsevier
16	Journal of Industrial Engineering	Hindawi
17	Advances in Radio Science ARS	URSI
18	Mehran University Research Journal of Engineering and Technology	Mehran University
19	Chinese Journal of Engineering	Hindawi
20	Atmospheric Measurement Techniques Discussion	European Geoscience Union
21	Sensing and Bio-Sensing Research	Elsevier
22	The Journal of Engineering	Institute of Engineering Tech
23	Journal of Quality and Reliability Engineering	Hindawi
24	Journal of Engineering and Technological Sciences	Institut Teknologi Bandung
25	Journal of Solid State Lighting	Springer

26	Journal of Agricultural Machinery	Ferdowsi University of Mashhad
27	Cogent Engineering	Taylor & Francis
28	Frontiers in Built Environment	Swiss Federal Institute of Technology
29	International Journal of Manufacturing Engineering	Hindawi
30	Al-Qadisiyah Journal for Engineering Science	Al-Qadisiyah University
31	Civil and Environmental Engineering	De Gruyter
32	Microsystems & Nanoengineering	IECAS
33	Case Studies in Fire Safety	Elsevier
34	Journal of Applied Engineering Sciences	University of Oradea
35	Jurnal Spektran	Universitas Udayana
36	Journal Keteknikan Pertanian	Institut Pertanian Bogor
37	Mechanics of Advanced Materials and Modern Processes	Springer

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