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The Cost of Open-Access Publishing in an Engineering Academic Community: A Study of Zagreb Faculty of Electrical Engineering and Computing

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Abstract - Since the early 1990s, open access (OA) scholarly publishing has become widespread in the international scientific community. Although there are numerous benefits of OA publishing, researchers experience a number of disadvantages related to the transition to the OA model. Article processing charges (APCs) paid by authors/institutions have become a key mechanism for funding full OA (the gold OA model). This paper addresses the issue of OA publication costs and attempts to find out what financial resources have been used by researchers at the University of Zagreb, Faculty of Electrical Engineering and Computing for publishing in gold OA journals over the last five years. The published OA articles indexed in the Web of Science Core Collection for the period from 2016 to 2020 were analysed. A quantitative analysis of Journal Citation Reports metrics for 163 journals was conducted to identify a relationship between APCs and journal rankings. In addition, a detailed study of gold OA articles was carried out by examining the websites of 31 publishers and identifying APCs for 64 journals. Funding and collaboration models were extracted for 174 gold OA articles as they provide insight into the extent of national funding in relation to financing based on international collaboration. Finally, a calculation of invested funds over the last five years is presented.

Keywords - Open Access; gold open access model; scholarly publishing; article processing charge (APC); University of Zagreb, Faculty of Electrical Engineering and Computing (FER)

I. INTRODUCTION

Open Access (OA) is an Internet model for publishing scholarly, peer-reviewed journals that has evolved since the early 1990s [1]. As defined by Creative Commons, open access papers are “digital, online, free of charge, and free of most copyright and licensing restrictions [2]. Their widespread distribution improves research and discovery and may increase the impact of the published research results. The main types of open access are gold and green. Gold open access means that an author publishes an article in an open access journal and its publisher is responsible for making the content freely available immediately. In contrast, green open access means that an author publishes

an article in any journal and then self-archives a copy in an open-access institutional or specialist online repository or other website. Hybrid open access journals have a mixed profile, publishing articles in both open and subscription models. They allow authors to pay an article publication charge and publish specific work as Gold open access papers.

There are many benefits of OA, particularly in terms of the wide and rapid dissemination of scholarly ideas and discoveries in new research, teaching, and practice, as well as boosting the knowledge economy. Therefore, OA has been supported from the beginning by research funders, universities, and national governments, which introduced OA mandates and policies that require researchers to make their findings publicly available [3].

The most serious threat to academic OA publishing are predatory journals that publish articles for a fee without performing a quality peer review process and editorial work such as checks for plagiarism. According to an analysis, predatory publishers collect millions of dollars in publication fees that are ultimately paid out by research funders [4]. As a warning to the academic community, an international panel of scholars and publishers has agreed in 2019 a definition on predatory publishing which says that “Predatory journals and publishers are entities that prioritize self-interest at the expense of scholarship and are characterized by false or misleading information, deviation from best editorial and publication practices, a lack of transparency, and/or the use of aggressive and indiscriminate solicitation practices.” [5]

Among other disadvantages of OA, article processing charges (APCs) are most often highlighted. OA journals provide articles to readers for free and there are no longer charge subscription fees to readers or libraries. Therefore, academic/research institutions and authors themselves must cover the costs of publishing and distribution. The financial “author-pays” model is used by many OA journals that publish under the gold and hybrid models. Publication prices are influenced by many factors, such as

the reputation and impact of the journal, the disciplinary publication market, available funding in a particular research area, etc. [6]. A 2011 report showed that open access publication fees were only paid with personal funding in 12% of cases, with funders paying in 59% of cases, and universities in 24% of cases [7].

Medical and health-related research fields are leading the adoption of OA, followed by physics, mathematics, and earth and space sciences. Chemistry and engineering have the lowest adoption of OA, with the latter ranging from 17.4% to 29%. One factor limiting the acceptance of OA in these fields is that they are industry-oriented, which is incompatible with the wide and open dissemination of knowledge. However, authors in these two fields publish most OA publications through the gold OA route [3].

In the fields of electronics and computer science, there are two distinct publication patterns. Due to their roots in basic science disciplines such as physics and mathematics and their various application-oriented, research-intensive subfields, researchers in these fields are more likely to publish in internationally visible and highly ranked journals. Authors have also embraced OA publishing, and the number of OA journals is growing steadily, both in the portfolios of major publishers and in the journals of professional organizations. On the other hand, many of the engineering publications are practice-oriented rather than research-oriented and are published in local journals.

According to the analysis of Björk and Korkeamäki, the share of OA journals in all Scopus indexed engineering journals was 13.4%, while the share of OA in all indexed articles was 10.4% [8].

In many engineering disciplines and computer science, publishing in conference proceedings is almost as important as publishing in journals [9][10]. Since the mid-1990s, conferences and symposiums have become an important publication venue for the dissemination of research results and now occupy a relevant position. This is also reflected in the publication programs of professional societies such as IEEE [11].

Research in article processing charge (APC)-based business models and their impact on open science is mainly concerned with the impact of high prices on OA publishing [12][13][14], the characteristics of APC journals [6][15][14], and their quality [16]. The question of what factors influence the level of APCs and their increase [17] is also a frequent research topic, as is the calculation of APCs in different disciplines and time periods [18][19].

This paper addresses the issue of gold OA publication costs and financial resources used by scholars at the University of Zagreb, Faculty of Electrical Engineering and Computing over the last five years (2016 – 2020).

II. FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING (FER)

The Faculty of Electrical Engineering and Computing (FER) at the University of Zagreb is the leading national research and higher education institution. It offers high-quality Bachelor's, Master's, and postgraduate programs and attracts the best students in Croatia. In addition to educating generations of highly qualified and versatile engineers, FER makes a valuable contribution to the development of the Croatian industry through numerous projects. According to the European Commission data, FER is at the top in Croatia when it comes to attracting EU projects [20].

The Faculty has developed valuable international collaborations with many research institutions around the world and currently participates in about 250 projects, both at the EU and national levels, funded by various grant schemes. The number of international projects in the last five years makes it one of the most internationally active institutions in Croatia.

In terms of scientific output, scholars at FER are highly productive, regularly publishing scientific papers in prestigious journals and international conference proceedings.

In a recent study [21] on scientific citation ranking with about 160,000 of the world's most cited scientists in all scientific disciplines, 2% of the most influential scientists in the world for 2019 include 47 Croatian scientists, where three of them come from FER.

III. METHODOLOGY

The study was based on data available in the Web of Science Core Collection databases (WoSCC) and DOAJ database, which provides extensive information on OA journals, including APC costs for publishing in each journal. WoS groups OA papers in the following categories: DOAJ Gold, Other Gold, Bronze, Green, or Gold in combination with one of the above categories. In this respect, WoS Gold OA papers in this study refer only to papers that were classified in WoSCC as DOAJ Gold or Other Gold. All remaining categories are considered as Other OA. The specific objectives were:

- Whether and to what extent do national funders participate in funding OA publications?
- What is the average gold OA publishing cost per article?
- Is there a correlation between Journal Citation Reports (JCR) quartile category and APCs?

Using the address field to search WoSCC, a total of 1,611 papers affiliated with FER were found for the period 2016-2020. These papers were filtered to include only papers that were classified as articles or reviews. Papers that had more than one classification (e.g., article; proceedings paper) were not included in the study. WoSCC data were exported in Excel form. The

quantitative analysis was done using Excel's statistical functions. This produced our first dataset, which consisted of 804 papers published in a total of 163 journals, including open, closed and hybrid. A comparative analysis of those journals was performed to determine the JCR journal ranking category for each journal for the year 2019, the most recent year for which data were available. For journals that had multiple categories with different quartiles, the best quartile was taken. After that, we filtered only the gold OA papers for further analysis, which resulted in a new dataset, consisting of 174 articles published in a total of 64 journals (31 publishers). We identified the APC cost for each journal from the DOAJ database to detect a possible relationship between APCs and journal rankings. Funding and collaboration models were extracted for every gold OA article for which WoSCC records provided data on funding resources. Finally, we calculated the total funds invested over the last five years, with a detailed analysis of the average price per article published by the most represented publishers and scientific fields.

IV. FINDINGS

There was a total of 804 papers of the article and review types. 407 were published as open access (51%) and 397 in closed access (49%). Out of 407 OA papers, 236 were authored exclusively by Croatian authors and 171 were authored by Croatian authors in co-authorship with foreign scientists.

Further analysis of the OA papers revealed that 174 of them (just over 40%) were published in gold OA, accounting for about a fifth of all published papers (Figure 1.). Croatian authors published 136 papers (78%) of those papers and 38 papers (22%) were published in co-authorship with foreign collaborators.

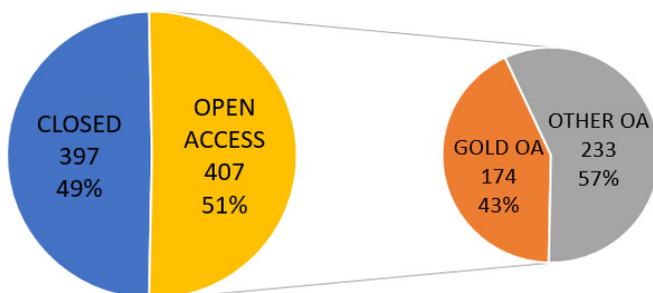


Figure 1 WOSCC indexed papers in the 2016-2020 period

Croatian journals published 26 of the gold OA papers (15%) and 148 of them were published by the international journals (85%). For this analysis, journals classified as "Croatian journal" refer to journals whose publishers are located in Croatia and journals classified as "international journals" refer to journals whose publishers are located in other countries, regardless of the characteristics of their authors or editorial boards.

As expected, FER's authors published mainly in the journals in Engineering, Electrical & Electronic; Computer Science, Information Systems; and Telecommunications categories. Distribution was generally similar for gold OA papers, though the journals in the Engineering, Electrical and Electronic category published twice the number of papers available in other OA routes.

The main focus of the study was to analyse the funding of OA publishing and how it relates to the quality of scientific journals. The results showed that the total amount of funds invested in gold OA publishing was EUR 205,940. The analysis showed that, out of 174 papers published by the gold OA route, 54 had no stated source of funding, while 120 were funded by grants, foundations, institutions, or a combination of these. The amount of funds invested for publishing papers with no stated funding source was EUR 51,623, while for papers funded by grants and foundations it was EUR 154,317.

The average APC cost for all gold OA published papers was EUR 1,197 (Croatian journals EUR 335 and for international journals EUR 1,351). The total amount paid for papers written by Croatian authors was EUR 159,068 and for papers written in co-authorship with foreign authors EUR 46,872. Regarding the source of funding, a total of EUR 65,323 was paid from Croatian sources, EUR 46,093 from international sources, and EUR 42,901 from combined Croatian and foreign sources (bilateral agreements, cooperation projects, etc.).

To determine the relationship between the APC and journal quality, all gold OA papers were categorised by quartiles according to JCR data for the journals where they were published. The results are presented in Table 1.

TABLE 1. GOLD OA PAPERS BY JCR QUARTILES

Quartile	Number of gold OA papers
Q1	48
Q2	37
Q3	37
Q4	38
ESCI	14

That was followed by the calculation of the average APC cost for each quartile, which can be seen in Table 2.

TABLE 2. AVERAGE APC FOR GOLD OA PAPERS

Quartile	Average APC cost (EUR)	Total Cost (EUR)
Q1	1,408	67,598
Q2	1,312	47,224
Q3	1,746	64,637
Q4	441	16,304
ESCI	727	10,177
TOTAL		205,940

According to our analysis, the Q3 papers had the highest average APC cost and Q4 the lowest.

To answer the question of whether there is a relationship between gold OA papers and journal quality,

we compared closed, other open, and gold OA papers by looking at the ratio of Q1, Q2, Q3, and Q4 papers, i.e., how many papers were published in each category (papers in ESCI journals were filtered out for this analysis). In general, authors at FER published the majority of their papers in journals categorised by JCR as Q1. This is true whether we consider the total number of all papers published (49% were in Q1), closed papers (47% were in Q1), or all types of open access papers (51% were in Q1). In each of these cases, the ratio is roughly similar: Q1 papers are the most numerous, accounting for around 50% of published papers, followed by Q2 papers, then Q3, and finally Q4. However, if we look more closely at the percentage of gold Q1 papers, we find that the ratio is significantly different: only 30% of gold OA papers were published in Q1 journals. The number of Q2, Q3, and Q4 papers was almost the same, with Q4 papers being the second most common, even if by just one paper.

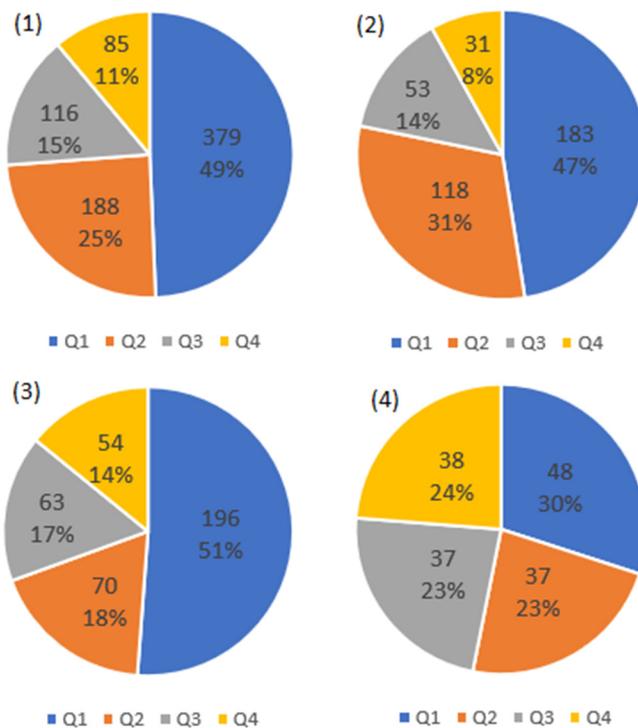


Figure 2. Distribution of journal quartiles for (1) All papers, (2) Closed papers, (3) All OA, and (4) gold OA.

V. CONCLUSION

OA publishing has many advantages, such as faster dissemination of new knowledge and its greater impact. It is nowadays strongly recommended and even mandated by many institutions and funding bodies. For example, the European Commission [22] mandates Open Access for all scientific publications funded by EU programs.

On the other side, in a Taylor & Francis researcher survey conducted in 2019, 40% of researchers said that they would not submit their work to a fully open access journal that charged for publication and published no subscription content. The respondents said that they wouldn't submit to such a journal primarily because they

don't have access to funds or don't like paying to publish on principle [23]. The results of a Springer Nature survey on funding OA papers showed that lack of funding is the greatest obstacle for OA publishing. The results confirmed that authors are using a wide range of funding sources, with APCs covered by research funders, institutions, publisher agreements, and other sources (e.g. personal funds) [24].

The results of our analysis show that gold OA papers accounted for about a fifth of all published papers of FER scholars. This is similar to the results of previous studies [3][16]. Publishing by gold route suggests that high APC prices are not the reason that discourages FER authors from publishing in such outlets. Besides, gold OA publishing has been funded mainly from national resources. As the principal national funding agency (Croatian Science Foundation) limits the costs allocated for OA to EUR 2,000 per year (per project) [18], it can be assumed that OA is funded through cooperation with industry.

Nevertheless, the calculated average price per gold OA article of EUR 1,197 may be seen as a financial problem for those FER scholars who do not participate in any grant-supported research project.

It is worth noting that only 15% of the gold OA papers were published in Croatian journals. Therefore, the question arises whether this is due to a lack of Croatian scientific journals in the field of electrical engineering and computing, or whether Croatian journals in the field are underrepresented in the WoS database. It should also be further investigated how much do scholars at other departments of the University of Zagreb and in other scientific fields rely on national or foreign funding sources for OA publication and whether there is a correlation between the number of institutional research projects and the number of OA publications.

An analysis of the distribution of closed, open and gold OA papers in Q1 ranked journals shows that there is no difference between OA and paywall journals (Figure 2). However, an analysis of the JCR quartile ranking of journals publishing gold OA papers shows a poorer representation of the highest-ranked journals. As the quality of gold OA journals is often debated in academia, these data certainly suggest the need for further research on this topic.

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