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Executive summary

In February 2020, CESAER published a position paper (CESAER, 2020) expressing its support for further strengthening of Open Science and Open Access in Horizon Europe. The importance of Open Access publishing of conference materials was explicitly mentioned due to its importance to universities of science & technology (S&T).

As a follow-up to this position, this paper explores the current workflows around making conference papers in the Engineering disciplines openly available at a number of CESAER Member institutions. Recent initiatives aimed to make Open Access the default scholarly communications standard (e.g. the Plan S initiative) have mostly put emphasis on journal research articles, but conference papers and proceedings are also a key research output at the universities of S&T united in CESAER. This papers explores how large the fraction of conference papers is against the total number of research outputs, how often they are being published Open Access and what actions may be envisioned to increase their accessibility and mid- and long-term visibility.

An analysis of the institutional research outputs for CESAER Member institutions involved in this study shows that roughly 40% of the publications at universities of S&T are conference papers, while the remaining 60% are research articles in journals and periodicals (based on the Web of Science Core Collection). The paper argues that the relevance of these conference papers for specific fields in the engineering disciplines like Computer Science and Electronic and Electrical Engineering cannot be overstated underlining the importance of addressing this area.

By comparing the amount of publications stored in institutional systems against those indexed in international literature databases, the analysis highlights the very real prospect of these conference papers becoming 'lost in space'', i.e., not being indexed or made openly available anywhere. Even if an expanded, more comprehensive version of many of these conference papers may eventually be published as journal articles, this absence of references even at a metadata level for the original conference papers means a real risk of wasted research, a loss in citations and several missed opportunities for collaborations with non-academic partners including industry.

This paper further explores whether a more effectively applied policy for making these research outputs openly available at institutional repositories might be a good strategy to ensure the findability and discoverability, even after conference websites expire or are taken down. Several recommendations are suggested for institutions hosting conferences of their own, and for authors of the conference papers, towards establishing a shared understanding of what the rights of authors are in terms of openly sharing at least the full-text of accepted manuscripts.

The paper calls on research funding and performing organisations, notably including the members of cOAlition S, to make a dedicated effort to ensure that conference outputs follow the same high-standard publishing workflows that apply to journal articles, including the issuing of persistent identifiers and clear policies by conference organisers regarding the authors' rights to disseminate them via their institutional systems. This notably includes applying the rights retention strategy for conference outputs. Concretely, researchers who wish to deposit their author-accepted manuscript in a repository with an open license (e.g. CC BY), and without any embargo, must always be able to do so, including for peer-reviewed conference papers and proceedings.

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Introduction

Many research results shared in writing through conferences are ‘lost’, meaning the full-text publications are not findable online, and those that are regularly go offline often after relatively short periods of time after the conference (e.g. they are shared via the conference webpage which expires or is not renewed). Sometimes not even the metadata associated with a given conference paper is available online. Despite this volatility, presenting results at conferences is an important way for sharing the latest scientific findings for researchers at universities of S&T, especially in the engineering disciplines (Kademani, Sagar, & Kumar, 2009; Nemeckova & Adlerova, 2017) [s. Appendix 2, fig. 2, Comparative analysis of bibliographic data from technical universities].

The often-early results are shared in various ways at conferences, ranging from presentations and posters to papers and proceedings. To be accepted to present at a conference, an abstract usually needs to be submitted for review and selection. Some contributions are peer-reviewed, some end up in collections (e.g. conference proceedings) and some are reworked into journal articles (IEREK – International Experts for Research Enrichment and Knowledge Exchange, 2018; Kampourakis, 2017). All other material is made available in different ways with an uneven visibility, accessibility, and reusability: besides printed copies delivered at the venue, the conference material can be provided on storage devices, on commercial or non-commercial conference platforms, temporary presentations on the conference website or are not available online at all. Thus, a substantial share of conference material is ‘lost in space’ in the sense that it is neither findable nor accessible. Figure 1 below shows an analysis of a common publishing workflow for conference materials. On the left side there are items that are at least findable and citable. The right side shows material that often end up being ‘lost in space’.

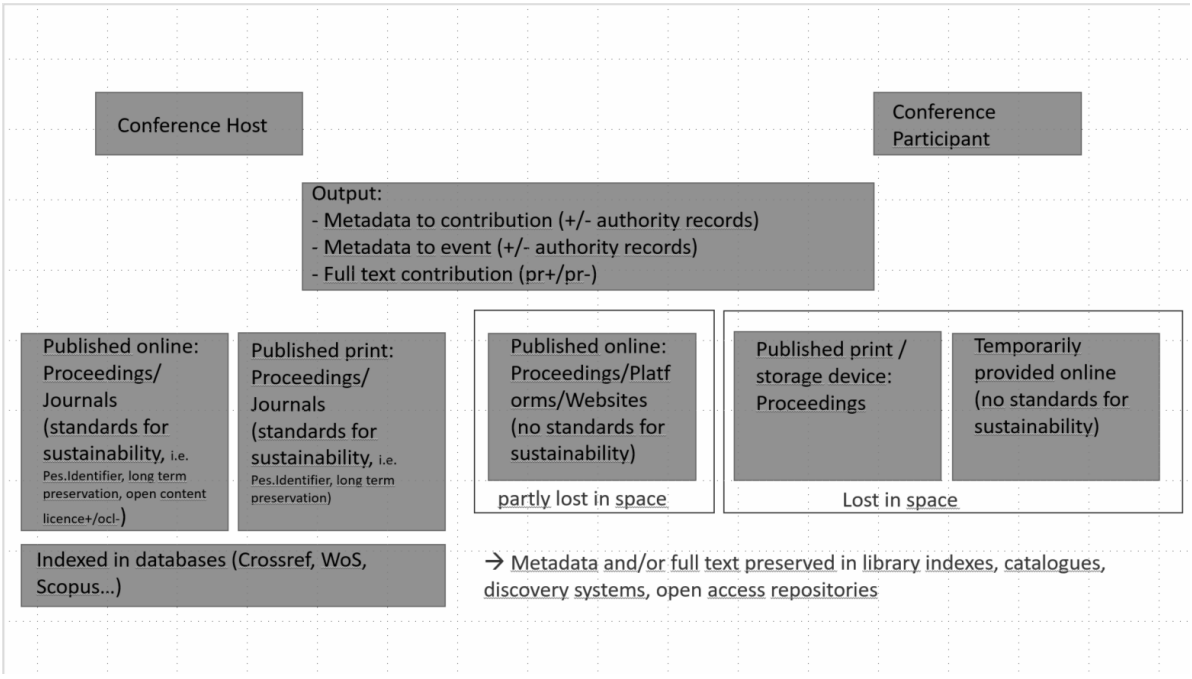

Fig.1: Publishing workflows for conference materials - Paths into invisibility

It is worth asking to what extent institutions (and their libraries) know which conferences are taking place or have taken place, or which materials from these events are published, and which papers are likely to remain invisible. Little research has been published on this issue (Kändler & Schmeja, 2018; Nemeckova & Adlerova, 2017). In this paper, the publication data for conference papers produced at CESAER Member institutions involved in the Open Access Working Group (OAWG) which operated under the Task Force Open Science 2020-2021 is examined in detail to get insight into the amount of conference papers that get indexed in databases and are thus visible via their metadata and on what rate of them are not visible.

In our experience, libraries will do their best effort to try and rescue 'lost' conference publications, for instance by adding printed works to the library collection. The difficulty lies in handling the residual material, for example memory sticks and download links. Basically, it requires two things for the library. The first is that the library must have access to the material, which is often not the case. The second is that the library must be able to preserve the material. Depending on the library, this may not be a possibility (e.g. neither procedure nor required infrastructure exist). Consequently, the invisibility problem affects the researcher/user who is looking for a publication that is no longer available. Nevertheless, there are ongoing efforts by libraries to gather information on conferences and conference materials. This involves the preservation of structured metadata with persistent identifiers in library indexes, catalogues, and retrieval systems to make the information at least findable and citable. However, this does not necessarily allow access to the corresponding publications. In this paper, we present some new initiatives around conference indexing and publishing that provide solutions to some of the problems around ambiguity in the field of conference materials publishing.

Given that CESAER is fully committed to Open Access and has previously expressed its support to strengthen Open Science, the idea is to explore whether Open Access could be a way to 'rescue' lost publications. The requirements of external research funders, such as the European Commission and those in cOAlition S regarding Open Access publishing and concerning all types of publications including conference papers are presented.

Finally, a set of recommendations is provided in this paper to conference organisers and libraries for providing Open Access to the conference materials and long-term preservation of those materials, both retrospectively and for contributions presented at currently ongoing conferences, in order to follow the best practices outlined.

Background and current context

By “conference” this document means a formalised research event, such as conferences, congresses, seminars, symposia, and workshops, where scholars gather to discuss research and developments in a certain field (Commission of the European Communities (CEC), 1992). Some participants present their newest research while others attend to learn from colleagues. During the event, research results and ideas are presented orally with visualisation in speeches, presentations, posters, discussions, etc., that are documented in conference materials (Nemeckova & Adlerova, 2017).

Conferences in engineering

For engineers, conferences are one of the key ways to stay up to date with ideas, concepts, devices, and innovations and to network with colleagues (Montesi & Owen, 2008a; Rowley-Jolivet, 1999). Conferences are frequently the origin for cross-pollinating ideas that can be transferred from one project to another, and from one field to another. In engineering this is also often the way to find new solutions and to bring together academic and industry knowledge and funds for new projects and innovations. Industry interest in conference proceedings is higher than in journal articles, because the information in journals is, in our experience, often made available with 6-18 months delay compared to the immediacy of what is presented at a conference, which can include results ‘fresh out of the lab’.

Conferences are also important for career advancement; therefore, conference materials:

- Provide a way to engage with cutting-edge research prior to official journal publication and which may already include findings, innovations, best practices, or new methodology.
- Allow researchers to explain their research in a less formal setting than peer-reviewed journal articles and periodicals.
- Allow researchers to present new concepts and techniques in a field which is not fully developed. This allows other researchers to be involved and influence the direction of research at the early stages.
- Offer opportunities to network with the researchers, research teams or institutions doing research on the same topics.
- Enable conversations between the academy and the industry (Marijan & Gotlieb, 2021).

Importance of conferences in the fields of computer sciences and electrical engineering

A series of studies about the Computer Science discipline has quantified the significant value of conference publications in this research field (Caires, 2015; Eckmann, Rocha, & Wainer, 2012; Franceschet, 2010; Garousi & Fernandes, 2017; Kochetkov, Birukou, & Ermolayeva, 2020; Montesi & Owen, 2008b). In this discipline, the vast majority of the peer-reviewed publications are in the form of conference proceedings, which have become the primary channel of research communication, including due to the relatively short timeframe of the

review process for conference papers (Shamir, 2010). The significance of conference papers often stems from the fact that, in fast-moving research areas, the time required to publish papers at conferences is substantially less than that of publishing in journals. The citation rates of papers from leading conferences in computer science, electrical engineering and some other fast-moving research areas approximate the citation rates of journal articles (Zhang, 2016). Especially in Informatics the conference is as important as the journal, and researchers will be rated by which conference accepted their paper. To a certain extent it is considered equivalent to publishing in a highly renowned journal.

A similar higher-than-average relevance of conference contributions is found in other fields among the engineering disciplines such as Electrical and Electronic Engineering (EEE), where learned societies like the Institute of Electrical and Electronics Engineers (IEEE) and the Institution of Engineering and Technology (IET) publish a great deal of conference contributions.

Conference indexing and research assessment

Conference publications are different from journal articles: they get published faster (IEREK – International Experts for Research Enrichment and Knowledge Exchange, 2018; Kampourakis, 2017) but they are less frequently peer-reviewed and indexed. Scientific evaluation also often involve conference papers and citations of conference papers (Kochetkov et al., 2020), so these need to be tracked too. Traditionally, two main resources for checking conference publications and their associated citations are the Web of Science and Scopus databases. When analysing conference citation data for research assessment and internal promotion purposes, it is important to consider the differences between the various material types as well as the way the data collection has taken place.

According to Web of Science (“Web of Science Core Collection Help,” n.d.), proceedings papers are published literature of conferences, symposia, seminars, colloquia, workshops, and conventions in a wide range of disciplines. Conference papers are generally published in a book of conference proceedings. Records are kept in the two Web of Science indexes for conference proceedings: Conference Proceedings Citation Index Science (CPCI-S) and Conference Proceedings Citation Index Science Social Sciences and Humanities (CPCI-SSH). Items in these indexes are identified as Proceedings Papers. However, the same records covered in the three main Web of Science indexes – Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI) – are identified as articles when published in a journal.

According to Scopus (“Scopus Content Coverage Guide,” n.d.), a conference paper is an original article, reporting data that was presented at a conference or symposium. Conference material enters Scopus in two different ways: (1) as a special issue of a regular journal, or (2) as a dedicated conference proceeding. Proceedings can be published as serial or non-serial and may contain either the full-text versions of the papers presented or only the abstracts. The source title usually includes words like proceeding(s), meeting(s), conference(s), symposium/symposia, seminar(s) or workshop(s), although some journals also include proceeding(s) in the title. Scopus covers conferences that publish full-text papers whereas conferences that publish only abstracts (meeting abstracts) are not considered for coverage.

Conference papers are counted as publications within researcher evaluation processes for promotion purposes in many countries. According to the Norwegian model, which is also implemented in other European countries, a conference paper published in an anthology with an ISBN is equal to a book chapter for assessment purposes. Refereed conference papers published in a series with an ISSN are evaluated equally to refereed journal articles (source: “A Bibliometric Model for Performance-based Budgeting of Research Institutions Recommendation from the committee appointed by the Norwegian Association of Higher Education Institutions on assignment from the Ministry of Education and Research”).

When examining submissions for research assessment exercises at specific institutions, conference papers are scarcely mentioned as opposed to journal articles. However, when looking at the research outputs stemming from a funded research project, it is frequent to find, at least in the engineering disciplines, far more references to conference papers than articles (Caires, 2015; Franceschet, 2010; Purnell, 2020).

Conference publishing in Open Access

Open Access as a possible solution

If we consider the various types of publication and publishing options for conference materials, it becomes clear that the retrieval of contributions and their accessibility are of the utmost importance. And thinking one step further, this of course also means the interoperability and – in the best-case scenario – the reusability of the contributions. These are precisely the FAIR principles according to which research outputs and their bibliographic metadata should be disseminated. FAIR stands for Findable, Accessible, Interoperable, Re-usable. These FAIR principles address both research data management itself and infrastructures and services.

For this reason, Open Access publishing of conference proceedings increases conferences and researchers' visibility and accessibility and fits best as a default publishing model. This dissemination model is important not only for research evaluation purposes, but also for new industry projects, collaborations, and innovations.

Conference papers in Open Access: a research funder requirement

While the European Commission's framework programme for research & innovation (previously Horizon 2020 and now Horizon Europe) promote Open Access for all types of publications, Open Access publishing has primarily focused on journal articles. The results of this policy show that most Open Access publications resulting from Horizon 2020-funded projects have been journal articles given that peer-reviewed articles are still dominant as a publishing format for Open Access outputs in many fields of science ("Continuous reports - H2020 Online Manual," n.d.).

From 2021, Horizon Europe goes a step further than Horizon 2020 and applies stronger to all scholarly outputs, following Plan S principles promoted by cOAlition S representing an important number of European national research agencies and funders.

As per the Plan S requirements, many European funders are strongly promoting immediate Open Access to all publication types ("About | Plan S," n.d.). Unfortunately, a clear mandate on conference papers as part of Plan S is still largely missing. In thematic areas such as engineering, where conferences play an important role, it will be necessary to find a way to ensure that these publications are also openly accessible and able to comply with the requirements of the funding bodies.

Plan S follows a set of core principles where immediate Open Access under an open license lies at the core. It also provides more concrete guidelines such as no payment for Open Access publishing fees for articles published in hybrid journals not covered by transformative agreements with publishers, and the fact that authors should retain copyright. These conditions along with other advances in the field of publication of conference results as explained later will need to be considered to improve the accessibility and preservation of conference papers within CESAER Member institutions.

Publisher platforms or Publisher and societies platforms

Learned societies such as the ASTM, the AIP and the IEEE have their own publicly available platforms and databases for conferences they organise. The advantage of these platforms is that they are professionally managed: there is not only a clear publishing policy, but also appropriate cataloguing of metadata, paper identification by DOI number, long term preservation policy, and indexing on the key international databases for research literature such as Scopus, Web of Science and others, that make the conference materials findable and make citations possible for these outputs.

Within these platforms publishers are developing 'Read & Publish' models that cover conference papers besides peer-reviewed articles. These Read & Publish agreements allow researchers to access the subscription literature and to get the Open Access publishing fees covered under a single deal. Research funders grouped under cOAlition S recognise such models as a way to achieve Open Access compliance during a transition period. Models such as the ACM's Transformative Model for Open Access Publication and the AIP's model for Read and Publish covering both articles and conference papers in a single system could become the default approach for fellow learned societies and publishers in engineering.

A dominant publisher like the IEEE does not yet have a full Open Access programme for conference papers. As the largest professional association in Electronic and Electrical Engineering, this publisher plays an important role. Conferences published by IEEE are currently not Plan S-compliant, but they do allow to deposit papers in the institutional repository as part of the Green Open Access route. A next step would be the publishing of the papers with an open license such as the Creative Commons BY license.

Some other conferences such as conferences in Security (Usenix), Artificial Intelligence (AAAI, NIPS) or Computer Science (OOPSLA/POPL/ICFP) sponsored by the ACM Special Interest Group on Programming Languages (SIGPLAN) are all Gold Open Access using article-processing charges. For conference organisers aware of the relevance of providing Open Access to their outputs, there are also options for OA publishing of conference proceedings in platforms like the EPJ Web of Conferences, the IOP Conference Series, publishing proceeding papers in Springer Lecture Notes in Computer Science or other possibilities listed in the Scientific Information Service at CERN.

Conference indexing and publishing initiatives

Even when the conference outputs have not been made openly available, libraries attempt to obtain these publications from researchers to subsequently ensure their visibility and usability.

The following best practice approaches and initiatives related to conference papers can be considered in the context of OA conference indexing and publishing at universities of S&T:

- TIB Open Publishing ("TIB Open Publishing - Technische Informationsbibliothek (TIB)," n.d.), a recently launched Open Access platform for conference proceedings and research journals for the TIB research community

- ConfIDent (“Home - ConfIDent,” n.d.) – the project of the German National Library of Science and Technology and the Department of Information Systems & Databases at RWTH Aachen University that aims to make the bibliographic metadata for conferences and other research events permanently accessible in a high quality through automated processes and scientific data curation. ConfIDent as a sustainable service addresses researchers who search for and publish information on scientific events, as well as universities, information infrastructure institutions, specialised societies, publishers and funding agencies.

Other notable international initiatives in conference publishing are the following ones:

- PIDs for Conferences & Projects (“PIDs for Conferences & Projects Initiative (Crossref),” n.d.) This Crossref-led project aims to establish a persistent identifier (PID) system and registry for scholarly conferences. PIDs enable the creation of a persistent metadata record for a conference and, when applied to published proceedings, allows a more efficient decision-making for researchers, libraries, publishers, funding agencies and evaluation bodies. Longer term, it may also help identify fraudulent and/or low-quality conferences. This CrossRef initiative initially intended to explore PIDs for both conferences and funded projects, but has limited its scope to conferences during its first phase.
- OA conference platforms such as the Joint Accelerator Conferences Website (JACoW), an international collaboration that publishes the proceedings of particle accelerator conferences held around the world. All conferences agree to the policies and requirements for publication. Originally created for the publication of the proceedings of the Asian, European, and North American particle accelerator conferences, which in 2010 became the International Particle Accelerator Conference series (IPAC), today the site hosts the proceedings of JACoW collaboration conferences.
- OpenProceedings is a service to the research community that originated from the will of two major Computer Science conferences (EDBT—International Conference on Extending Database Technology, and ICDT—International Conference on Database Theory) to make their papers available to the general public for free, following an Open Access strategy. ICDT and EDBT started this Open Access publication platform and made it available to other high-profile, peer-reviewed Conference Proceedings. The service is hosted at the University of Konstanz and its University Library, who have a renowned track record of encouraging and supporting Open Access publications.

Repositories

Libraries do not always have access to conference outputs and often cannot make such materials permanently available. As a possible solution, we propose publishing conference outputs Open Access via institutional or subject-based repositories. Some of the most popular repositories for the deposit of conference papers are Zenodo, Arxiv (“Submission of indexes for conference proceedings | arXiv e-print repository,” n.d.) or RePEc in the area of Economics and Business. Some of these will allow to mint a DOI for a deposited conference paper if the author chooses to do so, which may allow easier citation and tracking of its research impact if none was minted by the conference organisers themselves.

The organiser and/or publisher of a conference is responsible for the public release of the resulting conference materials. As stated above, the conference organiser and/or publisher sometimes has a platform available to publish conference materials within a volume of conference proceedings. Even if such a platform is available, it is a good practice for researchers to deposit the conference papers into their institutional repository following the 'Green' Open Access route. The use of repositories is advisable for three main reasons:

- It is a way to publish conference materials for free;
- It allows a DOI to be minted if that persistent identifier is not provided, and;
- The institutional repository guarantees long-term preservation and sustainability.

Professional knowledge is needed for the evaluation of conference publishing platforms, so some support from the library may be welcome when researchers are exploring their options for making their conference outputs openly available. In most cases the decision on how the conference publishing will take place does not depend on the researcher, so the institutional repository and subject repositories (Green Open Access) are the easiest way to make sure that a conference paper does get deposited Open Access and preserved for a long time. In fact, both research funders and institutions often have mandatory deposit policies for the full-text accepted manuscripts for conference papers into the institutional repository network. This collective, cross-institutional effort has already resulted in the availability of close to 10 million records for conference outputs in the OpenAIRE repository network at https://explore.openaire.eu/

Method

This study is based on the experience of library staff at CESAER Member universities. Library staff in publishing services are aware of the places where conference materials can be published, but also learn where the materials are finally published or made available. The long-term sustainability of these publication locations is difficult to estimate; how many of these conference papers will be available in the mid- and long-term can only be vaguely imagined.

In the course of their daily work, librarians witness multiple ways through which information may be lost. For instance: departments and institutes publish the results of the conferences they organise on the institute's website only. Or, when there is a change at the head of the institute, the website may disappear with all its contents. Conference websites, which are set up especially for these events, are not necessarily built to last, they may not be maintained and operated in the long term, they may be relocated or disappear, maybe even with the next technical system change. In our experiences, whenever there is a change at the head of a department, the staff or managers also often come across collections of 20-year-old CDs and DVDs; these are either thrown away unnoticed or handed over to the library for further use. In most of these described cases, the information about the events and their results disappears unnoticed and completely for awareness and digital availability purposes.

To concretise these empirical perceptions, the next step was to investigate the literature on this topic. Here, an attempt was made to verify these impressions and experiences on the basis of published studies and to obtain concrete data and facts. The achieved result proved to be insufficient: this specific aspect of the publication analysis, the examination of lost and disappearing contributions has been little or not at all conducted so far.

To illuminate this still open field of research more closely, the next step was to conduct a data analysis using the international and multidisciplinary citation database Web of Science (Clarivate Analytics) as well as the institutional repositories or research information systems at CESAER Member universities. The observations were verified based on publication data. To get an idea of how many conference-related articles are published, the overall output of a CESAER Member's publication data was analysed. The data gathered presents an analysis of quantitative data collected from Web of Science and from some CESAER Member's institutional publication databases or repositories. The first step of the analysis shows the publication output of member universities represented in the OAWG of Task Force Open Science 2020-2021, covered by Web of Science, core collection. Data covers items published in 2018 – this means the year of print publication as defined by WoS [s. APPENDIX 2, Tab. 1-2]. Only a small percentage of the publication output is indexed in the database Web of Science, although "Conference Proceedings Citation Index- Science" is included.

A further step in the analysis involved comparing the data indexed by WoS to the overall output of a university of S&T. This relied on the data from an institutional publications database that covers all types of documents and is not limited to a set of journals or alike. The information held in these institutional publications database is then analysed next to WoS data.

Discussion

Findings

Such is the importance of conference publications in the engineering disciplines, as stated above, that it is worth taking a closer look at it for specific institutions. For this reason, the publishing pattern of CESAER Members based on the overall output of that Members' publication data is analysed [APPENDIX 2, Tab.1-2]. Most of the scholarly output, nearly 22% of publication, covers engineering subjects. A refined search into this research area "engineering" based on document types, shows that most of the documents are journal articles (60%) followed by proceedings papers (38%) and other document types.

Looking at the publication output of individual Members indexed in Web of Science – differentiated by document type and research area engineering – the result shows a quite similar spread as in the above-mentioned analysis of all member universities [APPENDIX 2, Tab. 3-7]. The rates of journal articles to conference papers are roughly similar at all institutions, 60% to 40%. The publication output of RWTH Aachen University shows a slight shift in the spread of document types compared to the average data for member universities, with a 53% percentage for journal articles followed by 46% of proceedings papers and a couple of minor document types.

Only a fraction of a given institutional publication output is listed on Clarivate's "master journal list" or is indexed in the Web of Science database. To compare the data indexed by Web of Science to the overall output of a university of science and technology, additional data needs to be taken from an institutional publications database or from an institutional current research information system (CRIS) system, both of which cover all types of documents and are not limited to a set of journals or alike. An analysis is provided below for selected Member institutions involved in this study:

Publication data for *Universitat Politècnica de Catalunya* (UPC) is retrieved from its institutional portal Futur [Reference: http://futur.upc.edu Query: year: 2018, refined by document type: presentation of work at congresses (last view 23.09.2020), s. APPENDIX 3.1]. To compare both data sources – Web of Science and university bibliography – one of the key challenges is to adequately identify the engineering science publications. The category "Research Area", comparable to the category in Web of Science, does not exist for the institutional portal of UPC. This means that right now it is not possible to select only conference papers in the engineering fields. To still be able to compare the data, it is estimated that 80% percent of institutional publications are from the engineering research area, given that the UPC is a technical university whose research basically happens in the fields of engineering, architecture, science and technology. A 33.6% of the overall institutional output of UPC in 2018 is provided by conference papers. Nearly 10% of these bear a DOI – either a publisher DOI or one issued by an external institution such as the university or a learned society – and 11% of the overall output is openly available in the UPCommons institutional repository [Reference: http://upcommons.upc.edu (last view 23.09.2020)].

A complementary insight is taken into the publication data for RWTH Aachen University [Reference: Institutional bibliography and repository RWTH Publications

https://publications.rwth-aachen.de Query: year:2018 NOT year:->2017, refined by engineering faculties and refined by document type contribution to a conference proceedings or proceedings (date: 05.05.2020), s. APPENDIX 3.2]. Same as for the UPC portal, the RWTH Aachen University bibliography does not offer the possibility of classifying publication data according to research areas. For this reason, the structure of the university with its division into faculties is used as a starting point for the identification of engineering science publications, while bearing in mind that engineering science research is also conducted – and publications are produced – in the natural science disciplines. The engineering science faculties of RWTH Aachen University are subdivided as follows: Architecture, Civil Engineering, Mechanical Engineering, Georesources and Materials Engineering, Electrical Engineering and Information Technology. Medical Engineering is located at the medical faculty. Where there is no co-authoring engineering institute, the conference publication is not considered for the purpose of this data analysis. Another relevant challenge is to compare the same time range. The Web of Science database defines “year published” (PY) the year the article is published in print form. As opposed to this, the RWTH Aachen university bibliography defines “year published” as the first date in which an article is published, either online or print.

To get all records somehow related to conferences or scientific events, the data is refined by proceedings as well as contribution to a conference proceeding, including abstracts and posters. Of course, some proceedings are published in a journal. These are also included. Nearly 27% of all conference papers published by members of the engineering faculties of RWTH Aachen University in 2018 are indexed in Web of Science. This means that as much as a 73% of the publication output of RWTH Aachen University could get ‘lost in space’ as described above, especially if they don’t have a persistent identifier. 35% (i.e., over one-third) of the articles not indexed in Web of Science have a DOI, either a publisher or an institutional repository DOI or both.

The results in [APPENDIX 2, 3.2] show that the researchers in the engineering sciences used many different publication pathways to make their papers available, even if an assignment to one or the other category cannot always be clearly decided. Some conference papers exist in a printed version only or are published on a conference website, or on a personal researcher webpage, or are provided by non-shareable media such as a USB storage device. In these cases, the papers are not indexed by the Web of Science or any other index other than the RWTH Aachen Universities library catalogue and discovery system. 18% of the papers are published with a learned society publisher or are provided on a society website. 13% of the papers are published with a publishing house. Of course, most of these items - apart from those published as print-only publications - have a DOI as a persistent identifier. 9% are published with a university or a subdivision like a department as a publisher. Further on, 7% of these contributions are published by a so-called “Thesis-Publisher”, an academic publisher, as well as a print service provider. 3% are published via a research institute as publisher in print only format or as USB storage device handed to the participants and another 1% of the articles are published on general scientific publishing platforms or conference proceedings platforms that cannot be assigned to any professional scientific society or association.

At Delft University of Technology [APPENDIX 2, 3.3], another example of a technical university, publication data based on the institutional Pure CRIS System at TU Delft is analysed.

Altogether 1,573 conference publications are documented for publication year 2018, all of these records show a digital object identifier. 46% are provided Open Access.

A Scopus search for conference papers published in 2018 with at least one University of Strathclyde-affiliated co-author yields 517 results. The portal offers a subject classification feature too, showing 333 outputs in Engineering, 198 in Computer Science, 126 in Physics and Astronomy, 102 in Materials Science and 98 in Energy (the list of subjects is somewhat longer). These figures show that the same conference paper may often be simultaneously assigned to different subject fields. On top of this, the Scopus subject classification does not exactly match the approach generally taken in this analysis where Computer Science would for instance be part of Engineering. However, this is just an approximate estimation where the most relevant aspect is to ascertain, same as other CESAER Member institutions have done above, the percentage of conference papers recorded in the institutional CRIS system that are not indexed in the international literature databases.

A query on the institutional Pure CRIS at the University of Strathclyde for conference contributions (document types of conference contribution, conference article, paper, poster, abstract and proceeding) published in 2018 by Strathclyde-affiliated authors yields 677 results. While significantly higher than the 517 items that result from a Scopus query, the rate of institutional conference outputs indexed in international literature databases seem nevertheless to be high. These need to be further filtered by discipline. The fact that both the Scopus literature database and the institutional Pure CRIS are both run by the same company provides in principle some useful level of alignment in this regard. The research classification for publications stored in the institutional CRIS is not as systematic and effective as it could be since it's based on keyword analysis, so a different approach is taken based on the departmental affiliation of the Strathclyde co-authors of the publications. [APPENDIX 2, 3.4] shows detailed data and analysis of the domain distribution, with a total of 441 conference contributions.

An attempt to translate these different views from universities of S&T into a general publication and communication pattern for the research community in the engineering sciences shows that 65% of these outputs do not have a persistent identifier and 23% are only published in print or data medium or are provided at a conference website only. These conference papers are bound to become invisible for science communication and the information will 'get lost in space' if the metadata is not indexed in library catalogues or discovery systems, and if the files are not published or archived on a repository following publishing standards.

Recommendations

Some recommendations in the area of conference organisation have recently been released: “Digital Presentations & Conferences Best Practices” by the US Library of Congress and “Good Practice for Conference Abstracts and Presentations: GPCAP” by the GPCAP Working Group (Foster et al., 2019; the Library of Congress IT Design & Development Directorate, 2020). The first one is addressed to conference organisers. The second includes detailed recommendations on how to proceed with abstracts and presentations from the conferences in the field of pharmaceutical and medical device science and biotechnology.

Our own recommendations are mainly addressed to conference organisers within universities and to libraries as guarantees of the discoverability and accessibility of the institutional research production. On top of that, a further set of recommendations are issued for institutional authors of these publications to be aware of what their rights are regarding openly sharing them via their institutional systems.

A first set of recommendations addresses conference:

- Include in conference planning the appropriate actions so that the different contributions presented at the conference (papers, communications, posters, interactive formats as videos and recordings) are published Open Access in the institutional repository in compliance with Plan S.
- Consider the institutional repository or any other institutional publishing venue as a possible option, such as a university publishing platform that can guarantee permanent and transparent Open Access to conference outputs. The library is the natural partner to help you with this. Having all the conference contributions published in the institutional repository will increase visibility and impact of contributors, the conference itself and the university.
- Use the rights retention strategy-approach and specifically state in your communication with conference participants that conference contributors retain the rights to their contributions (e.g. if they wish to upload their presentation, paper or similar in their institutional repository with a CC BY license then they are welcome to do so.

Second set of recommendations addresses academic libraries:

- Continue research of the subject and to gather more data from expert interviews with researchers.
- Regarding repositories, they will need to be Plan S compliant. Repository managers thus will need to be aware of its requirements and if necessary, adopt new practices and functionalities. As per the Plan S Implementation Guidelines for Repositories Results of COAR repository platforms survey (2020) (“Plan S Implementation Guidelines for Repositories Results of COAR Repository Platforms Survey Executive Summary,” 2020), the technical criteria mandated by Plan S for repository platforms are the following:
    - Use of PIDs for the deposited versions of the publications such as DOI or handle.
    - High-quality article-level metadata in standard interoperable non-proprietary format, under a CC0 public domain licence.

    - Machine-readable information on the Open Access status and the licence embedded in the article, in standard non-proprietary format. In terms of the support that the institution must give to the repository, continuous availability and a helpdesk need to be guaranteed. Other seven additional criteria are strongly recommended by COAR.
- Consider Intellectual Property issues: arrangements for the university to have the rights for reproduction and public communication will be necessary. This is important in case of conferences from international associations, etc.
- Identify so called predatory conferences by poorly written content, missing details on the organisation, broken links etc. Useful tools are already available for the purpose such as this "Think. Check. Attend" or, at an institutional level, this "Choose the Conference to attend" ("Choose the Conference to Attend - Technion Library," n.d.) by the Technion Library.
- Extend the institutional Open Access policy to specifically cover conference proceedings as a mandated additional document type. Most of the current Open Access policies focus only on peer-reviewed articles.
- In their communication with researchers, librarians should emphasise that publishing conference papers Open Access and depositing them in the repository offers many advantages. The papers are better indexed, are archived in a sustainable way and are cited more often.
- Annually measure and reward the Open Access availability of the conference materials. Same as with articles, it is a good strategy to work on a growth expectation per academic institution. With these measurements the institution can reflect on the efficiency of its own Open Access policy and take the appropriate measures to increase the number of contributions in the institutional repository. There are methods available – such as the Delft method (Chawla, 2017; TU Delft, 2020) – for librarians to make the measurements for their institutions.
- Next to the conference papers, host other academic output related to events held at university in the Institutional Repository such as slides, abstracts and scientific posters, preferably Open Access.
- Identify conferences to be held at the university and contact the organisers to offer them facilities related to the management and preservation of conference papers:
    - Help organisers think about all the publishing aspects of the conference, creating a checklist
    - Offer and use submission management software such as Open Conference Systems (OCS). Alternatively, even if it is not a specific solution for conferences, Open Journal Systems (OJS) can also be offered to support conference organisers in setting up the conference platform, based on the PKP guidelines
    - Ask conference organisers to specifically allow research papers submitted from the university to be published and archived in the institutional repository. A proactive attitude towards asking permission for depositing conference papers in the repository is highly recommended when the information is not clear/offered in the conference webpage.

    - Integrate OJS/ OCS with the institutional repository, developing an automatic gateway between both systems.

Third set of recommendations addresses authors of conference materials:

- Make sure you understand your rights as an author to openly share at least the full-text accepted manuscript via your institutional systems. If the conference organisers do not specify on their website what their policy is in this regard - as it's often the case - check directly with them on the matter.
- Make sure you understand the workflows the conference organisers have in mind for publishing the conference outputs and what publishing standards will be applied for the purpose. If there are no plans to mint persistent identifiers for these publications, the library may be able to mint one for your conference object, but there should not be a duplicated effort around this.
- Contact your library for advice on what to do if the papers are made openly available from a conference website which may be at risk of disappearing over time (i.e., if not set-up as a long-term achriving solution as a repository or a professional publisher offer).

Conclusions

Conference papers should be better valued, especially in the fields of engineering, and subsequently better positioned in research evaluation processes. This value should be at least partially conveyed by better forms of exposure, indexing, identification, sustainable archiving and by making these academic outputs Open Access as a default.

A large fraction of the published conference papers is currently not findable, accessible nor permanently stored. As a result, a lot of valuable scientific work is hard to find, lost, or not traceable and therefore cannot be reused.

How can we as CESAER Member institutions tackle these problems and what solutions can be proposed?

We can specifically include conference papers in our institutional policies and workflows by:

- Promoting broad mandates for Open Access publications at universities. These mandates should include conference proceedings next to peer-reviewed articles. By doing so, the policies are or will be compliant with the Plan S strategy and with other funders' policies.
- Monitoring the annual uptake of conference proceedings to evaluate these policies
- Professionally storing conference papers in our own institutional library infrastructure especially when this work is not done by conference hosts or publishers in a sustainable way. The institutional repository is the designated place to deposit the publications and provide identifiers as DOI, URN or a handle.
- Supporting, as libraries, our institutional conference organisers with guidelines and recommendations on how to best publish and disseminate their papers. The availability of open platforms such as OJS and OCS could be a very valuable asset for this purpose.
- Exchange information across institutions on practical solutions and improvements to exploit best practices in the domain.

Since further research is needed on this developing topic, the authors welcome feedback and comments from any reader.

Appendix 1: Conference materials

Conference papers refer to articles that are written with the goal of being accepted to and to be presented at a conference. There are different types of conference papers: these may be oral presentations, tabled discussions, or poster presentations among others.

Proceedings can be defined as the published record of a conference, congress, symposium, or other meeting sponsored by a learned society or association, usually but not necessarily including abstracts or reports of papers presented by the participants. Conference proceedings are collections of papers presented in a conference that may be published in a book or a website form. When the entire text of the papers presented is included, the result is called transactions (Kampourakis, 2017).

Regarding the differences between conference papers and journal articles, a conference paper usually presents an earlier-term research work or an innovative idea that has emerged during the research. A journal article that is generally published on an issue or topic within the scope of a journal and tends to have page limits. Journal articles typically include more comprehensive and in-depth research than conference papers, sometimes elaborating on a topic previously presented at a conference. Journal articles are published in a journal that focuses on a certain discipline and contains peer-reviewed papers that are generally considered credible and are very good sources to cite.

The main difference between journal and conference paper lies in the acceptance process: peer-review is more rigorous in the case of journal articles. Conference papers are usually submitted within a deadline, its review time is shorter and the review less thorough than a journal submission. The paper is reviewed by the programme committee for the conference, and the committee then notifies the author(s) the acceptance or rejection of the paper. If accepted, the conference paper is usually published in the conference proceedings by a publisher, either a professional organisation like a society publisher or a commercial publisher. Proceedings may be provided via a learned society's website, an online publisher or via a data medium such as a USB storage device. When the papers are submitted before the conference, the proceedings are accessible to participants; in other cases, the proceedings are published after the conference and after the authors have received feedback during the sessions. As opposed to this, the journal peer-review process does not have a fixed deadline. Same as for conference papers, the journal's decision is on the acceptance or rejection of the paper. Conversely, a journal's review decision could also follow a different route: the reviewers could ask for minor or major revisions in the paper. Thereafter, the paper undergoes several review phases, often limited to three before the paper is either rejected or accepted. In most fields, a research paper published in a prestigious journal is widely accepted by the research community, and it arguably has a better academic standing than a paper presented at a conference.

It is a common practice for many journals to publish issues that include articles that stem from related conferences. Especially when a journal has a special affiliation with a group, one would expect the members of the group participating in a conference to submit their conference papers to their journal to pursue publication. In this case the peer-review process is still needed, as shown for instance on this example of MDPI policy.

Appendix 2: Conference publications of CESAER Member institutions indexed in Web of Science and IR

Overall publication output at CESAER Member universities – A Web of Science-based analysis

Table 1 below shows the institutional research output of seventeen member universities of the CESAER Task Force for Open Science, Subgroup Open Access, as portrayed on the Web of Science Core Collection (Clarivate Analytics). The publications are classified by research areas following the definition provided by the database. Data covers items published in 2018, meaning the year of print publication as defined by WoS.

Research areas	records	% Of total
Engineering	14,001	20.19
Computer Science	6,557	9.46
Physics	6,426	9.27
Chemistry	5,524	7.97
Materials Science	5,085	7.33
Science & Technology – Other Topics	4,503	6.49
Environmental Sciences. Ecology	2,958	4.27
Mathematics	2,535	3.66
Energy. Fuels	1,880	2.71
Optics	1,876	2.71
Neurosciences. Neurology	1,668	2.41
Business. Economics	1,611	2.32
Biochemistry. Molecular Biology	1,592	2.30
Telecommunications	1,450	2.09
Automation. Control Systems	1,362	1.96
Geology	1,340	1.93
Mechanics	1,158	1.67
Psychology	1,101	1.59
Astronomy. Astrophysics	1,097	1.58
Oncology	1,088	1.57

Instruments. Instrumentation	955	1.38
Radiology. Nuclear Medicine. Medical Imaging	934	1.35
Construction. Building Technology	931	1.34
Water Resources	865	1.25
Pharmacology. Pharmacy	841	1.21
TOTAL	**69**,**338**	100.00

Table 2 shows the institutional research output for member universities of the CESAER Task Force for Open Science, Subgroup Open Access as displayed on the Web of Science Core Collection (Clarivate Analytics). Data covers items published in 2018 refined by research area "Engineering" and classified by document type.

Document Type	**No of records**	**% Of total**
Article	7,930	56.64
Proceeding's paper	5,882	42.01
Review	249	1.78
Editorial material	209	1.49
Correction	35	0.25
Letter	7	0.05
Book chapter	4	0.03
Biographical item	3	0.02
Reprint	3	0.02
Book review	2	0.01
Retraction	2	0.01
Bibliography	1	0.01
News item	1	0.01

When the search is refined by Open Access options in the Web of Science, 4,723 articles out of 14,001 – i.e., nearly 34% of the total – are at least available free to read.

Publication output of CESAER Member universities - A Web of Science-based analysis

a) The Technion – Israel Institute of Technology

Reference: https://www.cesaer.org/members/member/?id=128 (last view 19.05.2021). 13,703 students, about 570 academic staff (2020).

Table 3 shows the institutional publication output at the Technion–Israel Institute of Technology covered by Web of Science. Data covers items published in 2018 refined by research area Engineering showing document types.

Document Type	No of records	% of total
Article	351	60.62
Proceeding's paper	237	40.93
Editorial material	8	1.38
Review	5	0.86

When the Web of Science search is refined by Open Access options, 74 articles out of 579 (13%) are at least available free to read.

b) *Universitat Politècnica de Catalunya*

Reference: https://www.cesaer.org/members/member/?id=144 (last view 19.05.2021).
Students: 28,208, Professors 3,317, academic staff 2,052

Table 4 shows the institutional research output of Universitat Politècnica de Catalunya covered by Web of Science. Data covers items published in 2018 refined by research area "Engineering" showing document types.

Document Types	No of records	% Of total
Article	622	58.24
Proceeding's paper	428	40.08
Editorial material	22	2.06
Review	16	1.50
Correction	3	0.28
Bibliography	1	0.09

Letter	1	0.09

When refined by Open Access options in the Web of Science, 411 articles out of 1,068 (38%) are at least available free to read.

c) RWTH Aachen University

Reference: https://www.cesaer.org/members/member/?id=116 (last view 19.05.2021). 47,173 students, 550 professors and 5,828 other academic staff (2020).

Table 5 shows the publication output of RWTH Aachen University covered by Web of Science. Data covers items published in 2018 refined by research area "Engineering" showing document types.

Document Types	No of records	% Of total
Article	608	53.33
Proceeding's paper	524	45.97
Review	18	1.58
Editorial material	13	1.14
Correction	2	0.18
Letter	1	0.09

When the Web of Science search is refined by Open Access options, 244 articles out of 1,140 (21%) are at least available free to read.

d) University of Strathclyde

Reference: https://www.cesaer.org/members/member/?id=152 (last view 19.05.2021) 23,000 students, 3,500 academic staff.

Table 6 shows the institutional research output of University of Strathclyde covered by Web of Science. Data covers items published in 2018 refined by research area "Engineering" showing document types.

Document Types	No of records	% Of total
Article	392	60.31
Proceeding's paper	248	38.15
Review	13	2.00

Editorial material	9	1.39
Correction	2	0.31
Book chapter	1	0.15

When refined by Open Access options, the Web of Science query shows that 408 articles out of 650 (63%) are at least available free to read.

e) Delft University of Technology

Reference: https://www.cesaer.org/members/member/?id=133 (last view 19.05.2021). Students: 26,476, PhD Population 2,918, academic staff 3,680

Table 7 shows the publication output of Delft University of Technology covered by Web of Science. Data covers items published in 2018 refined by research area "Engineering" showing document types.

Document Types	**No of records**	**% Of total**
Article	1,065	63.51
Proceeding's paper	571	34.05
Review	48	2.86
Editorial material	23	1.37
Correction	5	0.30
Book review	2	0.12
Biographical item	1	0.06
Letter	1	0.06
News item	1	0.06

When refined by Open Access options, the Web of Science query shows that 730 articles out of 1,677 (44%) are at least available free to read.

f) KU Leuven

Reference: https://www.cesaer.org/members/member/?id=31 (last view 15.09.2021). 60,057 students, about 4,049 academic staff (2020).

Table 8 shows the institutional publication output at the KU Leuven covered by Web of Science. Data covers items published in 2018 refined by research area "Engineering" showing document types.

Document Type	No of records	% Of total
Article	670	56.45
Proceeding's paper	506	42.63
Review	26	2.19
Editorial material	9	0.76
Correction	1	0.08
Letter	1	0.08

When the Web of Science search is refined by Open Access options, 581 articles out of 1,187 (49%) are at least available free to read.

Publication output of CESAER Member universities – An analysis based on data kept in institutional CRIS Systems or repositories (IRs)

a) *Universitat Politècnica de Catalunya* data (IR)

Out of 5,931 documents published by UPC researchers in 2018:

- 1,996 are conference papers
- 640 published in OA in the institutional repository
- 578 with DOI issued either by a publisher or by an external institution such as a University or a learned society.

b) RWTH Aachen University data (IR)

Conference publications.
Year published 2018 refined by subject “engineering” (selected faculties). Date: 2020-05-05

Category	No of records	% Of total
Indexed Web of Science	516	27%
Print-only / data medium / conference website	442	23%
Society publisher/ scientific society website	349	18%
Publishing house	247	13%
University (university press / institute / department)	175	9%
“Thesis-Publisher” / print service provider.	138	7%
Research institute	50	3%
General scientific or conference publishing platforms	17	1%
Ministry	2	0,10%

c) Delft University of Technology data (CRIS)

Source: TUD OA 2018 analysis

Date report: 14-4-2019

Based on TU Delft Pure CRIS publications PY=2018 on 1-4-2019

Conference publications TUD OA 2018 - Pure		
Open Access	**%**	**No publications**
Yes	46.98%	739
No	53.02%	834
Total	**100.00%**	**1,573**

Out of 1,573 conference publications 1,050 have a DOI.

Note: The TU Delft OA analysis was based on the April 2017 VSNU Framework monitoring of OA. In order to determine the OA-status of publications several sources (e.g., DOAJ and Unpaywall) and identifiers (DOIs and ISSNs) were used.

d) University of Strathclyde data (CRIS)

Data based on University of Strathclyde Pure CRIS publications, published in 2018.

Department	No conference papers	With a DOI	Open Access
Electronic and Electric Engineering	148	28	136
Design, Manufacturing and Engineering Management	58	16	49
Mechanical and Aerospace Engineering	54	13	52
Naval Architecture, Ocean and Marine Engineering	52	12	44
Biomedical Engineering	33	2	25
Physics/Institute of Photonics	33	6	25
Computer and Information Sciences	25	6	24
Civil and Environmental Engineering	23	1	20
Chemical and Process Engineering	15	6	12

These figures show that the rates of conference papers published at Strathclyde that get indexed in Scopus is higher than the average found at other CESAER member institutions -- the default English-language publication pattern may play a role here even if English is the mainstream language for science communication in the sciences and the engineering disciplines.

Two additional findings are worth highlighting from the figures on the table above:

1. The number of openly available conference contributions at Strathclyde is very high for all disciplines. This is due to the mandatory Open Access policy that applies to journal articles and conference papers published at all institutions in the UK: the full-text accepted author manuscript *must be deposited in an institutional CRIS or repository within three months of manuscript acceptance* if a paper is to remain eligible for the national-level research assessment exercise. This very strong policy drives up institutional compliance and strongly limits the risk mentioned in other institutional case studies above of conference papers becoming “lost in space”.
2. The number of publications with a DOI among the 677 Strathclyde conference contributions in 2018 is a significantly low one, with just 100 items having one. Publisher DOIs are predominant among these, especially those issued by specific (generally Open Access) series of conference proceedings like the EDP Sciences MATEC Web of Conferences, the Elsevier Procedia series or the IOP Journal of Physics: Conference

Series. Institutional DOIs are in turn mostly provided by records deposited in the Zenodo repository. DOI minting for conferences is clearly an area where there's room for progress, even if things may undoubtedly have improved in this sense since 2018. This said, because the mandatory Open Access policy in the UK requires deposit upon manuscript acceptance, the number of DOIs is likely to be an underestimation since records in the institutional CRIS are created upon manuscript acceptance and may not be revisited by researchers upon online release to add the DOI.

The rate of Open Access conference outputs held at the Strathclyde Pure for 2018 is 87.8%, while the percentage of such outputs that feature a DOI is only 20.4% (this is mainly because no DOI is minted by default upon deposit of an item in the Strathprints institutional repository).

e) KU Leuven (IR)

As per the information kept in the institutional repository at KU Leuven, following data is recorded for the year 2018, published conference proceedings with a KU Leuven affiliation:

- At KU Leuven level
  - % Conference proceedings in the repository: 7.3%
    - (Articles take up 42.9%; followed by abstracts and book chapters)
  - % Of conference proceedings for which a DOI is mentioned (partly depends on whether or not the researcher adds this): 56.9%
  - % Of conference proceedings with a file uploaded: 47.7%
    - Of which % is Open Access now (so excl. temporary embargoes): 78.2%
- At level of Science, Technology & Engineering group
  - % Conference proceedings in the repository: 17.2%
    - (Articles take up 48.9%; followed by abstracts)
  - % Of conference proceedings for which a DOI is mentioned (partly depends on whether or not the researcher adds this): 63 %
  - % Of conference proceedings with a file uploaded: 48%
    - Of which % is Open Access now (so excl. temporary embargoes): 81.9%

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