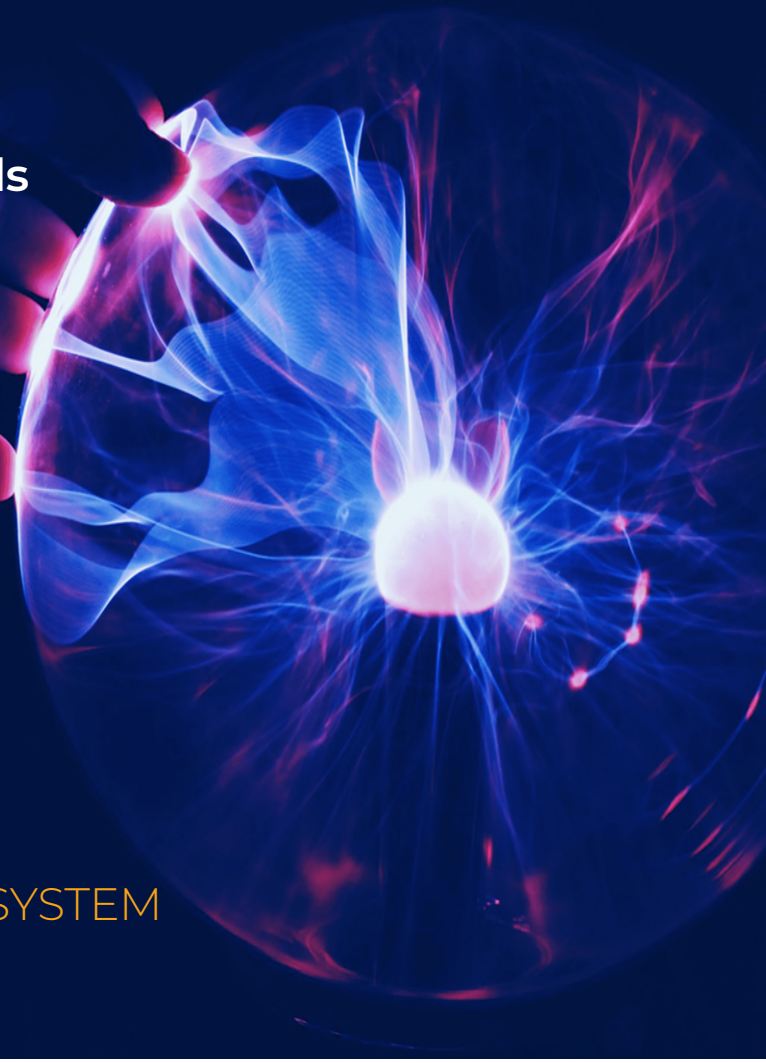
Open and Universal Science Project (OPUS)

OPUS helps reform the assessment of research towards a system that incentivise researchers to practice #OpenScience



WP1

STATE OF THE ART ON AN ECOSYSTEM FOR OPEN SCIENCE

Deliverable 1.2:

Initial State of the Art on Open Science Literature

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Authors	Jessica Huntingford (Resolvo Srl) Gareth O'Neill and Fleur Lebhardt (TGB) Dragana Mitrovic (ICoRSA) Katarina Haluskova (ABIS) Raminta Pučėtaitė and Aurelija Novelskaitė (Vilnius University) Emma Day (VITAE) Juliana Chaves Chaparro (UNESCO) John Crowley (Trust Inside)
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1. Introduction

OPUS Work Package (WP) 1 - State-of-the-Art on an Ecosystem for Open Science conducted an analysis of initiatives and literature to reform research(er) assessment and incentivise and reward Open Science.

This WP kicked off the OPUS project, with a view not only to landscaping content, but also to providing direct input to:

- Identification of incentives for Open Science (Rewards and Incentives for Researchers) – project WP2;
- Identification of metrics and indicators for Open Science (Rewards and Incentives for Researchers) – project WP3;
- Pilots to Implement and Monitor Open Science – project WP4.

Within WP1, Task 1.2 ran a State-of-the-Art on Open Science Literature. This state-of-the-art on existing literature and recommendations to reform research(er) assessment and incentivise and reward Open Science was designed to support the development of interventions in WP2, of indicators and metrics in WP3 and of pilot action plans in WP4.

Within this overall review, specific focus was placed on a review of

- Research(er) assessment and Open Science and incentives and rewards and Open Science
- Precarity of research careers and Open Science
- Gender equality and Open Science
- Industry practices and Open Science
- Trust and Open Science[1].

Deliverable 1.2 - *Initial State of the Art on Open Science Literature* has the overall objective to present the results of this landscaping, in order to provide an initial structured input to the project's overall objective to "*develop coordination and support measures to reform the assessment of research and researchers at Research Performing Organisations (RPOs) and Research Funding Organisations (RFOs) towards a system that incentivises and rewards researchers to practise Open Science*". This Deliverable, going beyond its original scope, not only reviews the literature but also takes a first step towards defining a framework to incentive and reward the transition to Open Science. This initial work will further evolve in subsequent work packages, through consultation and testing.

The subsequent chapters of this deliverable are structured as follows:

Chapter 2. Overall Methodology for Literature Review, looking at vocabulary and scope and at the approach towards the bibliographical analysis;

Chapter 3. Incentives and Rewards for Open Science

Chapter 4. Precarity and Open Science

Chapter 5. Gender Equality and Open Science

Chapter 6. Industry Practices and Open Science

Chapter 7: Trust and Open Science

Chapter 8: Conclusions and Input to WP2 (interventions) and WP3 (indicators and metrics)

Chapter 9. Annexes and Bibliography

[1] N.B. In the original OPUS work plan, the topic of trust was located within Task 1.1 – landscaping of initiatives. However, it emerged that a literature review was more appropriate for this topic. As such, the decision was made to shift content to Task/Deliverable 1.2. This does not represent any change to the scope of the analysis.

2. Overall Methodology for Literature Review

2.1. Vocabulary and Scope

Open Science (OS) is defined by UNESCO[2] as an inclusive construct that combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community. It comprises all scientific disciplines and aspects of scholarly practices, including basic and applied sciences, natural and social sciences and the humanities, and it builds on the following key pillars: open scientific knowledge, open scientific infrastructures, science communication, open engagement of societal actors and open dialogue with other knowledge systems.

The vision of openness in the design, collection, publishing and dissemination of research results was initially formalised by the European Commission in its 2013 document Digital Science in Horizon 2020[3] and then further developed in a series of following publications[4]. The vocabulary around OS is not completely uniform, with terms such as “open research” being preferred in some countries and institutions to highlight the inclusions of the arts and humanities, and terms such as “open innovation” being applied in relation to industrial participation in OS. One of the main goals of OS is to increase the verification and reproducibility of research results and by extension to create a greater trust in science by researchers and the public.

Within the OPUS project, we use the term “Open Science” to cover all academic disciplines and all stakeholders (academic, industrial, policy makers and funders), as well as a wide range of practices to open up activities and outputs of the research life cycle. These practices include open access to publications, data that is made Findable Accessible Interoperable Reusable (FAIR) and open, open source software, open methodologies, open peer review, and citizen science. This also includes open infrastructures and open digital tools to facilitate researchers in practising OS.

Moreover, the scope of the OPUS project is such that we work specifically to promote a transition to OS by reforming the research(er) assessment system to incentivise and reward researchers to take up OS practices. As such, the literature review carried out within OPUS provides a landscaping of key literature on incentives and rewards for OS, as well as the related topics of precarity of researcher careers and OS, gender equality and OS, industry practices and OS, and trust in OS.

2.2. Background to OPUS Bibliographical Analysis

OPUS partners undertook a systematic bibliographic analysis to access the main literature available in relation to the concept of 'open science' and the various areas of interest for the OPUS project.

In order to define the approach, initial research was carried out to ascertain how the academic bibliographic production recognised the concept of 'open science'. For this purpose, a cluster analysis under a specialised bibliographic analysis software, VOSviewer[5] was chosen. The data included in the analysis were 1201 articles indexed in the SCOPUS database, where on 4 September 2022 a 'Keywords' search was performed limited to "Open science" as the exact key expression. All scientific fields were considered, selecting only papers in open access, in methodological coherence with the concept being searched. The analysis ran with the VOSviewer software, using the keyword clustering criteria (default in version 1.6.18 of the programme). The minimum co-occurrence was set at 5. This means that a pair of keywords must appear together in 5 papers for the software to generate a link between the two keywords.

[2] UNESCO Recommendation on Open Science. 2021. SC-PCB-SPP/2021/OS/UROS. https://unesdoc.unesco.org/ark:/48223/pf0000379949
[3] European Comission (2013). Digital science in Horizon 2020. https://ec.europa.eu/digital-single-market/en/news/digital-science-horizon-2020
[4] See for example: European Commission (2016). Open innovation, open science, open to the world: A vision for Europe. Brussels: Directorate-General for Research and Innovation. ISBN: 978 92 79573460 https://doi.org/10.2777/061652 / European Commission (2018). “Commission recommendation (EU) 2018/790 of 25 April 2018 on access to and preservation of scientific information”. Official journal of the European Union, n. L 134/12 of 31/05/2018. http://data.europa.eu/eli/reco/2018/790/oj / European Commission (2019). “Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information (Recast)”. Official journal of the European Union, n. L 172/56 of 26/06/2019. http://data.europa.eu/eli/dir/2019/1024/oj
[5] Van Eck, N. J., & Waltman, L. (2018). VOSviewer Manual (Edition 1.6.8.). Available at: https://www.vosviewer.com/documentation/Manual_VOSviewer_1.6.8.pdf

The keyword search is summarised below (Figure 1.1).

KEY (research AND evaluation AND criteria) AND (LIMIT-TO (EXACTKEYWORD , "Evaluation Criteria")) AND (LIMIT-TO (EXACTKEYWORD , "Research") OR LIMIT-TO (EXACTKEYWORD , "Research Efforts") OR LIMIT-TO (EXACTKEYWORD , "Evaluation Framework") OR LIMIT-TO (EXACTKEYWORD , "Research Evaluation") OR LIMIT-TO (EXACTKEYWORD , "Academic Research")

Figure 1.1: Overview of key word search

The search produced 8 clusters, the most important of them with 202 keywords. This overall result suggests a high overall thematic coherence, i.e. that 'open science' involves relatively little internal thematic variability. 46% percent of the keywords are found in a single cluster, and 5 of the 8 clusters contain 93.4% of the keywords.

Following discussions of this initial analysis, OPUS partners decided to assess the suitability of the Scopus database to be used as the main tool for the bibliographical search. Scopus, along with the Web of Science, is one of the two most widely used databases for bibliometric analyses, despite the emergence of others in recent years. The Scopus database is recognised for the quality of studies indexed and the international scope. Studies on journal coverage show that Web of Science is more selective than SCOPUS. They show that all journals indexed in Web of Science are also covered by Scopus and that Scopus indexes 66.07% more unique journals as compared to Web of Science[6] and that its ASJC classification has many merits[7]. Furthermore, Scopus' interface is highly usable and user-friendly, offering intuitive navigation and easy access to a vast range of academic resources.

In order to check the exhaustiveness of the SCOPUS database for the purpose of the OPUS project, a test search was run on OpenAIRE|Explore[8] for the topic of Research Assessment. OpenAIRE|Explore is an open discovery portal covering a comprehensive and open dataset of research information. Open means, in this case, it is free at the point of use. It contains a repository for research products, projects, organisations, and data sources. For this study, the search targeted publications in the repository of research products. SCOPUS includes publications such as journals, book series and conference series with an ISSN (International Standard Serial Number) or non-serial publications such as monographs or one-off conferences with ISBN (International Standard Book Number). The OpenAIRE|Explore database of publications, on the other hand, includes non-peer reviewed publications and grey literature.

Separate searches were conducted for search terms in "title" and "abstract", as the OpenAIRE|Explore interface does not have the search option "key words". These were compiled into one list (excluding duplicates). A comparison of search results is provided in Table 1.1.

Search words	AND	SCOPUS (Title-ABS-key) total number of hits [open access]	OpenAIRE (Title-ABS) total number of hits [open access]
"research* assess*" OR "academ* assess*" OR "scien* assess*" OR "research* eval*" OR "academ* eval*" OR "scien* eval*"	"open science"	72 [open access: 37] *(3 duplicates)*	85 [open access: 79] *(7 duplicates)* *33 (excluding 'other literature types')*

Table 1.1: Comparison of search results from SCOPUS and OpenAIRE on "Research assessment"

To align and compare the search results between the two tools, specific non-peer reviewed documents such as preprints, (Doctoral) theses, presentations, and project deliverables were excluded from the OpenAIRE list. This resulted in a total number of hits of 85. Both lists contained duplicates of publications (3 for Scopus, 7 for OpenAIRE). Comparing the lists of articles revealed only limited overlap of 4 publications between the two search tools. From the articles that were selected for in-depth review, only 1 appeared in both lists. This search shows that the two tools cover quite different areas of publications. A closer look at the types of publications that came up in the OpenAIRE list revealed that this discrepancy is based on the fact that a considerable number of publications labelled as 'other literature type' were actually presentations, posters, blog posts, etc.

[6] Singh, V.K., Singh, P., Karmakar, M. et al. The journal coverage of Web of Science, Scopus and Dimensions: A comparative analysis. Scientometrics 126, 5113–5142 (2021). https://doi.org/10.1007/s11192-021-03948-5
[7] Gusenbauer, M. Search where you will find most: Comparing the disciplinary coverage of 56 bibliographic databases. Scientometrics 127, 2683–2745 (2022). https://doi.org/10.1007/s11192-022-04289-7
[8] https://explore.openaire.eu

Excluding these types of publications cut the OpenAIRE list down to 33 hits and around 21% of these remaining publications were not in English (compared to 0% in SCOPUS).

In conclusion, Scopus is an excellent tool to conduct searches for literature reviews and its database turned out to be more comprehensive than the OpenAIRE database. Scopus was, therefore, chosen by the OPUS partners. However, since it is a paid service and not accessible to everyone in the consortium, partners relied on each other to perform the individual searches. Consequently, and in line with the concept of open science as well as the vision of OPUS, it is suggested to complement future literature searches with an open search data base, such as OpenAIRE|Explore.

Finally, for this deliverable the Scopus search was complemented by a number of key documents that were identified as non-academic publications, hence unlikely to emerge from this bibliographical database. In addition to publications already known to the OPUS consortium, some partners ran searches on the Google Scholar database to complement results for their subtopic. This was particularly used in cases where the list of hits was limited. It should be noted here that this Google Scholar approach was not conducted in a systematic manner, recognising Google Scholar as a useful supplement for specific searches while at the same time considering some of its limitations[9], including missed relevant information and its usability.

2.3. OPUS Bibliographical Analysis

The methodological approach for the Bibliographical analysis was then undertaken for each of the sub-topics: Research Assessment / Incentives and Rewards for Open Science; Precarity and Open Science; Gender Equality and Open Science; Industry Practices and Open Science; Trust and Open Science.

The approach is summarised below (Figure 1.1). In order to ensure rigour, consistency and objectivity, each sub-task leader followed the above described methodology and then shared initial results with the WP1 Leader and the Scientific Coordinator. Further details for each sub-topic (specific search criteria) are included in individual chapters.

1) Define purposeful search terms and relevant variations of it;
2) Chose the cut-off date for publication year 2000 (could be adjusted to later for specific searches with justification);
3) Combine search terms in different combinations, starting with broader search and then narrow down and keep track of the results in an overview table, and downloading the extract of the search results. Note the difference between word combinations vs. terms;
4) Decide on the most reasonable combination of search terms based on the overall search outcome and extract search results into excel;
5) Combine the SCOPUS extracts for the selected search word combinations in one single excel sheet and sort for titles to identify duplicates. Keep note of how often the article appears and delete the affected rows to cut down the list;
6) Categorise the article according to relevance based on title (yes/maybe/no) – and further check relevance of article by scanning the abstracts. Check on open access;
7) Compile a final list of articles to be reviewed.

Figure 1.2: Overview of bibliographical analysis approach

In order to keep within scope and available resources, partner then filtered down from initial lists, getting closer and closer to the specific area of interest of the OPUS project. Specific information on the filtering process for each sub-topic can be found in subsequent chapters.

Selected articles were then allocated to partners from WP1, based on their areas of expertise and their allocated Person Months. Reviewers were provided with a common template in which they were asked to document the following extracted data:

- Title / Author / Year / DOI / Publisher / Publication
- Open Access (Yes/No) and Link
- Reviewer
- Article Abstract

[9] Haddaway, N.R., Collins, A.M, Coughlin, D., Kirk, S. The Role of Google Scholar in Evidence Reviews and Its Applicability to Grey Literature Searching PlosOne 0(9): e0138237 (2015). https://doi.org/10.1371/journal.pone.0138237

- Main Findings related to the sub-topic
- Assessment Framework and Framework Categories (only for sub-topics on Research Assessment / Incentives / Rewards)
- Description of any Interventions (relevant to WP2), if/when they have been tested and with what results
- Description of any Indicators/Metrics (relevant to WP3), if/when they have been tested / with what results
- Any other key Questions / Input for WP2/3/4?
- Any specific references to Trust and Open Science?
- Relevance for WP5 (Policy Input)?

Example reviews were provided, to support partners in extracting the more relevant information, and completed reviewers were uploaded onto the shared repository. In addition, partners were asked to provide a summary of findings on the on-line bibliography, in order to ease the work of the sub-chapter authors. Upon completion of the reviews, an on-line meeting was held with the core partners involved in the review to discuss findings.

Chapter 9. Annexes provides the full bibliography of articles reviewed for each sub-chapter. Moreover, an OPUS zotero library has been set up for swift access to all articles and for citation generation[10].

The decisions made during the search and selection process of the documents may have generated certain limitations in our study. In this sense, the filters selected, the inclusion/exclusion criteria defined or the databases used may have led to the non- consideration of relevant documents for our purpose of study. However, as described above and demonstrated in the sub-chapters below, significant effort was made to cross-check search criteria.

Moreover, the selection of the database (SCOPUS) was verified against others, particularly with a view to ascertaining the quality of open access tools, such as OpenAire. As described above, the results show that SCOPUS does have a greater coverage. However, on principle, project partners would like to support the evolution of open access tools. Therefore, they suggest continued use of OpenAire in the project (e.g. for the updating of the state of the art at project conclusion) and in other projects (see for example OPUS sister project SECURE (Sustainable Careers for Researcher Empowerment)[11], which learns from OPUS state of the art and starts the literature review from OpenAire). OpenAire does not yet have the same reach as the SCOPUS / World of Science options, so must run in parallel with other options. It is noted that a publicly owned, alternative to SCOPUS and World of Science, which is free at the point of user for users, would be beneficial in the future.

[10] https://www.zotero.org/groups/4932671/opus_project_library?token=0z91v34ti5tqagmfhnnqxyve5ct7rv98a4ukensk
[11] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/999999999/project/101094902/program/43108390/details

3. Incentives and Rewards for Open Science

This section presents the results of the literature review on incentives and rewards for researchers to do Open Science as well as for research(er) assessment including Open Science (OS). The literature searches and results for these topics have been combined due to the thematic overlap: incentives and rewards are essentially realised through research(er) assessment.

The methodology used for the searches and the results of the searches are first presented. An overview is then given of initial observations and key input from the literature review for both interventions and indicators/metrics for Open Science. The results of this literature review provide input into Work Packages 2 (WP2) and 3 (WP3).

The full list of articles reviewed is available in Annexe 1 –Articles reviewed for Incentives and Rewards.

3.1. Methodology and Overview of Search Results

Search Methodology

A bibliographical search was conducted to identify key literature on the topics of incentives and rewards for Open Science and research(er) assessment including OS. The methodology for searching and selecting key publications consisted of 4 consecutive steps (in line with the approach described in Chapter 2. Overall Methodology for Literature Review):

1. **Identify relevant key terms for literature search**

A number of key terms for the search were identified, whereby the bases of some terms were chosen to include relevant variations of the term. For example, the search term 'research*' produces results that include 'researcher' and 'researchers'. The following search terms were selected based on initial iterative scoping searches:

- academ* assess*
- academ* career*
- academ* eval*
- career*
- incentiv*
- indicator*
- metric*
- open research
- open science
- research* assess*
- research* career*
- research* eval*
- reward*
- scien* assess*
- scien* career*
- scien* eval*

2. **Search publications database using key terms**

A search was then done using combinations of these key terms in Scopus. This is an abstract and citation database for research publications that contains over 1.8 billion cited references. The search was restricted to relatively recent articles published after 2000 and consisted of the following combinations of the above search terms:

- [research* career* OR academ* career* OR scien* career*] AND [open science OR open research]
- [incentiv* OR reward*] AND [research* career OR academ* career OR scien* career* OR Open Science OR Open Research]

- [research* assess* OR academ* assess* OR scien* assess* OR research* eval* OR academ* eval* OR scien* eval*] AND [open science OR open research OR career*]
- [indicator* OR metric*] AND [open science OR open research]

3. **Remove duplicate results and assess relevance**

The searches resulted in a list of potentially relevant articles for the literature review. Some articles were repeated across the four combinations of searches and these duplicates were removed. The remaining individual articles were then assessed for their relevance on the topics of incentives and rewards for OS and research(er) assessment including OS. This initial relevance assessment was based on the titles of the articles and content summaries in the article abstracts.

4. **Review relevant articles and select key articles**

The list of relevant articles was further complemented by additional relevant articles that were identified in other literature review searches in Scopus. This extended list of relevant articles was then reviewed in detail according to a review template (as described in Chapter 2.3. OPUS Bibliographical Analysis). This resulted in a list of key articles to provide input to develop the interventions and indicators/metrics for OS.

5. **Collect additional key articles from consortium**

The list of key articles from the Scopus search was then extended with additional articles that were identified by the consortium as being critical for the topics of incentives and rewards for OS and research(er) assessment including OS. These articles were predominantly not peer-reviewed academic publications but rather 'grey literature' and included policy papers from the European Commission, policy papers from stakeholder organisations, and reports from expert groups at the European Commission (EC). These articles were reviewed in detail and added to the list of key articles to create a final list of key articles for WP2 and WP3.

Search Results

The search in Step 2 involved searching Scopus using combinations of key terms and resulted in a total of 1711 potentially relevant articles as in Table 3.1.

Search words	- AND	Total number of hits
"Research* career*" OR "Academ* career*" OR "Scien* career*"	"Open Science" OR "Open Research"	21
Incentiv* OR Reward*	"Research* career" OR "Academ* career" OR "Scien* career*" OR "Open Science" OR "Open Research"	613
"Research* assess*" OR "Academ* assess*" OR "Scien* assess*" OR "Research* eval*" OR "Academ* eval*" OR "Scien* eval*"	"Open Science" OR "Open Research" OR Career*	434
Indicator* OR Metric*	"Open Science" OR "Open Research"	643
	Total	1711

Table 3.1: Results of Scopus Term Combinations in Scopus

The list of 1711 potentially relevant articles was reduced in Step 3 after deduplication to 1625 articles, then after a check on the titles to 751 articles, and finally after a check on the abstracts to 52 articles. This list was in Step 4 then complemented with 11 articles that were identified as possibly relevant in other literature review searches bringing the list up to 63 articles, which were then screened in detail to identify the key articles from the searches resulting in 33 articles (see Annexe 1). This list was finally complemented in Step 5 with 25 articles (see Annexe 1) that were identified by the consortium as being critical for WP2 and WP3 resulting in a final list of 58 key articles as in Table 3.2.

Scopus Search Results	Duplicate Articles Removed	Article Titles Checked	Article Abstracts Checked	Extra Articles Added	Search Articles Screened	Critical Articles Added
1711	1625	751	52	63	33	58

Table 3.2. Number of Key Articles Remaining after Screening

It should be noted that the project recognises that this list of key articles on the topics of incentives and rewards for OS and research(er) assessment including Open Science may not be fully complete. OPUS will ensure complementarity and community feedback through further engagement with the literature, interactions with project partners, interactions with members of the project advisory board, and a public consultation on draft proposals for the interventions and indicators/metrics for Open Science with the community.

3.2. Overview on Incentives and Rewards

Observations for Research(er) Assessment

As described above, the literature search on incentives and rewards for OS yielded 33 articles selected from the SCOPUS search and 25 key articles identified by the consortium. These articles will feed into the development in WP2 of a framework of interventions to support the implementation of a revised research(er) assessment system (including OS) at research-performing and research-funding organisations. These articles will also feed into the development in WP3 of a framework of indicators/metrics for research(er) assessment (including incentivising and rewarding researchers to practise OS). Some initial overarching observations from the review of the 58 key articles are presented below for WP2 and WP3.

It should be noted that a 'research' assessment system is not necessarily the same as a 'researcher' assessment system. A research assessment system should focus specifically on research-related activities and outputs, while a researcher assessment system should focus on researchers and thus also include non-research-related activities and outputs. It should also be noted that there are many differences in the research and education systems, cultures, and regulations across countries in Europe. This means that a more flexible system, rather than a one-size-fits-all approach, will be needed. The OPUS project will develop a proposal for a comprehensive researcher assessment framework that allows institutions to select relevant interventions and indicators/metrics according to their own needs and preferences. WP2 will specifically propose support measures to implement such a framework at institutions, while WP3 will propose a new Open Science Career Assessment Matrix (OSCAM) for researchers.

An overarching message from the literature is that the current researcher assessment system is too focused on peer-reviewed publications and citations in top journals, and that a more comprehensive approach is needed that goes beyond such publications and citations. A revised researcher assessment framework should thus include both a research and non-research dimension. The research component should take the full research lifecycle into account from theory formation, methodological design, data collection, data analysis, and result reporting. The non-research component should also be encompassing and include a wide range of activities that are typically done by researchers, such as teaching courses, supervising students, managing projects and researchers, and science communication.

Another key message from the literature is that the assessment of researchers should take into account current national, European, and global policies and practices to transition towards OS, whereby the outputs of researcher activities are made accessible. A revised researcher assessment system should thus include both an open and non-open dimension. The open component should capture those outputs from the research and non-research dimension that are made openly available, such as publications in open access, FAIR and/or open data, open peer reviews, and open educational material. The non-open component should capture those outputs from the research and non-research dimension that may not or indeed should never be made open, such as grant proposals, sensitive data, peer reviews, student supervision results, and internal project and researcher management results.

A further key message from the literature, and which builds on the previous messages, is that the assessment of researchers is too focused on quantitative bibliometrics and should instead be broadened to include a wide range of alternative metrics or 'altmetrics'. A revised researcher assessment system should thus include both a quantitative and qualitative dimension that consists of indicators/metrics for research/non-research as well as open/non-open activities and outputs. Such a framework should provide research-performing and research-funding organisations with a suite of options to assess and reward researchers in their recruitment, career progression, and grant applications as well as to incentivise and reward OS. The organisations should hereby have the freedom to select and prioritise specific indicators/metrics in their own researcher assessment systems. It should be noted that there is always the possibility of the misuse and gaming of indicators/metrics and that eventual misuse and gaming will need to be tackled as it arises in implementation.

Key Policy Developments and Frameworks

A major policy development for improving the working conditions of researchers was the **European Charter for Researchers and Code of Conduct for the Recruitment of Researchers**[12]. The Charter and Code

[12] European Commission. European Charter for Researchers and Code of Conduct for the Recruitment of Researchers (2005). https://euraxess.ec.europa.eu/sites/default/files/am509774cee_en_e4.pdf

provides a wide range of principles and requirements specifying the roles, responsibilities, and entitlements of researchers as well as employers and funders of researchers, with a focus on the recruitment, career development, and career progression of researchers. The implementation of the Charter and Code is recognised by the European Commission via the granting of the Human Resources Strategy for Researchers (HRS4R)[13] award to participating research-performing and research-funding organisations. Currently, 1412 organisations have endorsed the Charter and Code, while 701 organisations have received the HRS4R award. A revision of the Charter and Code is now underway, whereby the principles and requirements are being updated and include specific reference to the assessment of researchers and Open Science[14].

The community-driven **San Francisco Declaration on Research Assessment (DORA)**[15] formed an early milestone in reforming the assessment of researchers[16]. DORA aims to stop the use of the journal impact factor (JIF) to measure the quality of individual research articles and in hiring, promotion, or funding decisions. DORA proposes a set of 18 recommendations to support the adoption of better practices in research assessment. Currently, 19987 individuals and 2712 organisations worldwide have signed DORA. Building on the impetus of DORA, the **Leiden Manifesto for Research Metrics** aimed to combat the misuse of bibliometrics when evaluating research literature[17]. The Leiden Manifesto offers best practices in metrics-based research assessment via 10 principles to guide institutions in measuring research performance and research evaluation. The **Hong Kong Principles** also complement DORA and acknowledge that current metrics act as perverse incentives in the assessment of researchers[18]. The five principles aim to recognise and reward researchers for behaviours that strengthen research integrity and responsible research practices in appointments, promotions, and grants.

Another major policy development for researchers and researcher assessment was the drive by the European Commission towards Open Science[19] and the creation of the **Open Science Policy Platform (OSSP)**[20]. The OSPP was a high-level advisory group to the European Commission which consisted of expert representatives from research-performing and research-funding organisations, academies and learned societies, citizen science organisations, publishers, Open Science platforms and intermediaries, and libraries. The OSPP focused on 8 challenges to make Open Science a reality: incentives and rewards; next generation metrics; European Open Science Cloud (EOSC); scholarly publishing; research integrity; citizen science; skills and training; FAIR data. The first mandate of the OSPP ran from 2016-2018 and provided initial recommendations for the implementation of Open Science[21]. The second mandate of the OSPP ran from 2018-2020 and provided practical commitments for the implementation of Open Science[22].

The drive towards improving the working conditions of researchers and adopting Open Science was further prioritised and championed by UNESCO. A **Recommendation on Science and Scientific Researchers**[23] set out to provide global common ground on principles and values for conducting research as well as on the rights and responsibilities of researchers. The recommendation includes specific reference to and guidelines for the performance appraisal of researchers. A separate **Recommendation on Open Science**[24] aimed to provide an international framework for shared principles and values as well as concrete actions to implement Open Science. This recommendation includes specific reference to and guidelines for incentives and rewards for Open Science. UNESCO hereby monitors the implementation of the recommendations.

The most recent stakeholder-driven development for researcher assessment is the creation of a Coalition for Advancing Research Assessment (COARA)[25]. COARA consists of a global coalition of research-performing

[13] https://euraxess.ec.europa.eu/jobs/hrs4r
[14] European Commission. Technical Document on a European Framework for Research Careers. Unpublished document for ERAC Plenary Meeting in February 2023 (2023)
[15] https://sfdora.org
[16] San Francisco Declaration on Research Assessment (2012). https://sfdora.org/read
[17] Hicks, D., Wouters, P., Waltman, l., de Rijcke, S., and Rafols. I. Bibliometrics: The Leiden Manifesto for Research Metrics. Nature 520, 429–431 (2015). https://www.nature.com/articles/520429a
[18] Moher, D., Bouter, L., Kleinert, S., Glasziou, P., Sham, M., Barbour, V., Coriat, A., Foeger, N., and Dirnagl, U. Hong Kong Principles for Assessing Researchers. Fostering Research Integrity. Plos Biology 18(7), e3000737. (2020). https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3000737
[19] European Commission. Open Innovation, Open Science, Open to the World. A Vision for Europe (2016). https://op.europa.eu/en/publication-detail/-/publication/3213b335-1cbc-11e6-ba9a-01aa75ed71a1
[20] https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science_en
[21] European Commission. OSPP-REC. Open Science Policy Platform Recommendations (2018). https://op.europa.eu/en/publication-detail/-/publication/5b05b687-907e-11e8-8bc1-01aa75ed71a1
[22] Mendez, E., Lawrence, R., MacCallum, C., and Moar, E. Progress on Open Science. Towards a Shared Research Knowledge System. Final Report of the Open Science Policy Platform (2020). https://op.europa.eu/en/publication-detail/-/publication/d36f8071-99bd-11ea-aac4-01aa75ed71a1a
[23] UNESCO. Recommendation on Science and Scientific Researchers. Annex II of the Records of the 39th Session of the UNESCO General Conference (2017). https://unesdoc.unesco.org/ark:/48223/pf0000260889
[24] UNESCO. Recommendation on Open Science (2021). https://unesdoc.unesco.org/ark:/48223/pf0000379949
[25] https://coara.eu

and research-funding organisations, national and regional assessment authorities and agencies, researcher organisations, associations of these organisations, and learned societies. The coalition has set up a governance structure and has drafted the COARA **Agreement on Reforming Research Assessment**[26], building on a scoping report for such a coalition by the European Commission)[27], whereby organisations signing the agreement become members of the coalition. There are now 455 signatories who agree to work together to enable systemic reform on the basis of common principles within an agreed timeframe and to facilitate exchanges of information and mutual learning between all stakeholders. The agreement specifically consists of 4 principles for overarching conditions, 6 principles for assessment criteria and processes, two core commitments to enable better recognition of diverse practices and activities that maximise research quality, two core commitments to enable a move away from inappropriate uses of metrics, three supporting commitments to enable a move towards new research assessment criteria, tools, and processes, and finally 3 supporting commitments to facilitate mutual learning, communicate progress, and ensure that new approaches are evidence-informed.

There have lastly been several high-level policy developments providing further support for reforming researcher assessment in Europe. The European Research Area and Innovation Committee (ERAC) has produced a guideline paper on **Research Evaluation in a Context of Open Science and Gender Equality**[28]. The report provides stakeholders involved in research evaluation reforms with 6 general principles aimed at fostering both Open Science and gender equality in research evaluation procedures. The European Council next adopted **Conclusions on Research Assessment and Implementation of Open Science**[29]. The conclusions set out a position for future activities on the three specific policy priority areas of the reform of research assessment systems in Europe (which should include incentive and rewards schemes), a European approach and capacities for academic publishing and scholarly communication, and development of multilingualism for European scholarly publications. The European Commission is furthermore now developing a proposal for a **European Framework for Research Careers**[30]. This framework will consist of 8 key components, whereby one will focus on recruitment and working conditions of researchers, and another will focus on career development and progression. The proposal highlights criteria for a new system for the assessment and reward of researchers which includes valuing a diversity of activities and outputs and Open Science.

Key Input for Interventions and Indicators/Metrics

Zooming in on frameworks supporting the implementation of researcher assessment at institutions, Vitae's **Researcher Development Framework (RDF)**[31] offered a new approach to researcher development and proposed a professional framework for planning, promoting, and supporting the personal, professional, and career development of researchers. The RDF was created from empirical data collected by interviewing researchers and consists of a set of descriptors structured in four domains and twelve subdomains, which encompass the knowledge, intellectual abilities, techniques, and professional standards to do research as well as the personal qualities, knowledge, and skills to work with others and ensure the wider impact of research. Each of the 63 descriptors is divided into distinct stages of development or levels of performance. The RDF is designed for researchers to evaluate and plan their professional development, for research managers and supervisors to support the development of researchers, and for trainers, developers, human resources specialists, and careers advisors in the planning and provision of support for researchers' development. It should be noted that the RDF is not intended to be linked to performance management or replace locally agreed progression criteria for researchers.

The expert group on incentives and rewards for Open Science under the OSPP produced an innovative proposal on the **Evaluation of Research Careers Fully Acknowledging Open Science Practices**[32]. The

[26] COARA. Agreement on Reforming Research Assessment (2022). https://coara.eu/agreement/the-agreement-full-text
[27] European Commission. Towards a Reform of the Research Assessment System. Scoping Report (2021)
[28] European Research Area and Innovation Committee. Research Evaluation in a Context of Open Science and Gender Equality. Triangle Task Force Guideline Paper (2021). https://data.consilium.europa.eu/doc/document/ST-1201-2021-INIT/en/pdf
[29] European Council. Council Conclusions on Research Assessment and Implementation of Open Science. Conclusions adopted by the European Council at European Council Meeting 3877 in June 2022. https://www.consilium.europa.eu/media/56958/st10126-en22.pdf
[30] European Commission. Technical Document on a European Framework for Research Careers. Unpublished document for ERAC Plenary Meeting in February 2023 (2023)
[31] Vitae. Researcher Development Framework (2011). https://www.vitae.ac.uk/vitae-publications/rdf-related/researcher-development-framework-rdf-vitae.pdf/view
[32] O'Carroll, C., Rentier, B., Cabello Valdes, C., Esposito, F., Kaunismaa, E., Maas, K., Metcalfe, J., McAllister, D., and Vandevelde, K. Evaluation of Research Careers Fully Acknowledging Open Science Practices. Rewards, Incentives, and/or Recognition for Researchers Practicing Open Science (2017). https://op.europa.eu/en/publication-detail/-/publication/47a3a330-c9cb-11e7-8e69-01aa75ed71a1

group developed a multi-dimensional assessment framework with recommendations for research-performing and research-funding organisations to evaluate researchers across all career stages, disciplines, and sectors using a wide range of evaluation criteria, as well as to incentivise and reward them to do Open Science in their recruitment, career progression, and grant assessment. This OSCAM consists of 6 high-level categories on research output, research process, service and leadership, research Impact, teaching and supervision, and professional experience. These categories consist, in turn, of 23 subcategories which are linked to specific activities that could be taken into account in an evaluation. The framework is essentially a blueprint which allows organisations to select and adjust assessment criteria and define the weighting and quantitative versus qualitative nature of criteria for their own institutional needs and priorities.

Building on the OSCAM, the expert group on indicators for researchers' engagement with Open Science under the OSPP developed a detailed proposal for **Indicator Frameworks for Fostering Open Knowledge Practices in Science and Scholarship**[33]. The group further built on the work by the earlier expert group on altmetrics under the OSPP on **Next-generation Metrics**[34], on the **Recommendations of the OSPP on Next-Generation Metrics**[35], on the **Mutual Learning Exercise on Open Science on Altmetrics and Rewards**[36], and on the **Open Science Monitor**[37]. The group aimed to provide frameworks for understanding and applying science and technology indicators which are defined broadly and enable the transition from the current scientific and scholarly system towards a more open and inclusive configuration of knowledge practices and infrastructures. The report proposes four indicator frameworks for open knowledge infrastructures, open knowledge capabilities, open knowledge practices, and career assessment as well as recommendations for the practical implementation of indicators for open knowledge practices. The indicator framework for career assessment consists of 23 indicator categories and 79 indicators and is intended as a suite of qualitative and quantitative indicators to be adapted by organisations.

The literature discussed so far may be considered key background literature on the policy developments framing the discussion on the reform of researcher assessment, on proposals for principles and guidelines for reforming researcher assessment, and on proposals for concrete frameworks to develop interventions and indicators/metrics to implement a reformed researcher assessment.

The OPUS project will build on this key literature to develop a comprehensive framework of indicators/metrics to assess researchers, which includes incentivising and rewarding Open Science, and a framework of interventions to support the implementation of a researcher assessment framework at research-performing and research-funding organisations.

The remaining literature identified in the review will serve as input to frame or develop specific aspects of these two frameworks. This includes examples of implementation at the national level (Netherlands 2019[38] and Norway 2021[39]) and association level (LERU 2022[40]), evaluation criteria in specific disciplines (Li et al

[33] Wouters, P., Ràfols, I., Oancea, A., Kamerlin, S., Holbrook, J., and Jacob, M. Indicator Frameworks for Fostering Open Knowledge Practices in Science and Scholarship. Report of the Expert Group on Indicators for Researchers' Engagement with Open Science (2019). https://op.europa.eu/en/publication-detail/-/publication/b69944d4-01f3-11ea-8c1f-01aa75ed71a1
[34] Wilsdon, J., Bar-Ilan, J., Frodeman, R., Lex, E., Peters, I., and Wouters, P. Next-generation Metrics. Responsible Metrics and Evaluation for Open Science. Report of the European Commission Expert Group on Altmetrics (Wilsdon et al 2017)
[35] Hormia-Poutanen, K., Kristiansen, E., Lawrence, R., Leonelli, S., Manola, N., Méndez, E., Rossel, C., Vignoli, M., and Agostinho. M. Recommendations of the OSPP on Next-Generation Metrics. Presentation by Almetrics Workng Group of the Open Science Policy Platform in Zurich in November 2017 (2017). https://ec.europa.eu/research-and-innovation/sites/default/files/rio/events/Next-Generation%2520Metrics__C.%2520Rossel%2520and%2520R.%2520Lawrence.pdf
[36] Miedema, F., Mayer, K., Holmberg, K., and Leonelli, S. Mutual Learning Exercise. Open Science. Altmetrics and Rewards (2018). https://op.europa.eu/en/publication-detail/-/publication/449cc187-693f-11e8-ab9c-01aa75ed71a1
[37] https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science/open-science-monitor/about-open-science-monitor_en
[38] Universities of the Netherlands, NFU, KNAW, NWO and ZonMw. Room for Everyone's Talent. Towards a New Balance in the Recognition and Rewards for Aademics (2019) https://www.nwo.nl/en/position-paper-room-everyones-talent
[39] Universities of Norway. NOR-CAM. A Toolbox for Recognition and Rewards in Academic Careers (2021). https://www.uhr.no/en/resources/nor-cam/
[40] League of European Research Universities. A Pathway towards Multidimensional Academic Careers. A LERU Framework for the Assessment of Researchers (2022). https://www.leru.org/publications/a-pathway-towards-multidimensional-academic-careers-a-leru-framework-for-the-assessment-of-researchers

2009[41] and Ochsner 2017[42]), issues for early-career researchers (de Herde 2021[43], Stürmer et al 2017[44], and Vanholsbeeck 2021[45]), and challenges with Open Science (Abdala 2021[46], Allen & Mehler 2019[47], and González-Teruel 2022[48]).

3.3. Looking forward to WP2/WP3 (incentives and rewards)

The literature review on incentives and rewards has provided three main types of input which should be incorporated into the development of the interventions in WP2 and the indicators/metrics in WP3:

- OPUS should develop a researcher assessment framework for research-performing and research-funding organisations to assess researchers based on research/non-research, open/non-open, and quantitative/qualitative aspects of their activities and outputs;
- The researcher assessment framework should build on the guiding principles of key policy developments and frameworks and on key categories and indicators/metrics from the review, whereby the framework should offer a suite of assessment criteria that can be selected and tailored according to the needs of research-performing and research-funding organisations;
- The implementation of the researcher assessment framework should be supported by appropriate interventions at research-performing and research-funding organisations, which are linked to the categories and indicators/metrics in the framework and ensure that the organisations and researchers are adequately prepared for the selected assessment criteria.

The literature review provides extensive input to develop a first draft of a researcher assessment framework consisting of indicators/metrics with accompanying interventions for implementation. The draft framework will then be further developed based on feedback from the pilots of selected aspects of the framework and a public consultation with key stakeholders and the wider research community.

[41] Li, J., Land, L., and Ray, P. Evaluation Criteria for Frameworks in eHealth Domain. AMCIS 2009 Proceedings (2009). https://aisel.aisnet.org/amcis2009/160
[42] Ochsner, M., Hug, S., and Daniel, H. Assessment Criteria for Early-career Researcher's Proposals in the Humanities. Conference Proceedings of the 16th International Conference on Scientometrics and Informetrics (2017). https://www.issi-society.org/publications/issi-conference-proceedings/proceedings-of-issi-2017
[43] De Herde V., Björnmalm M., and Susi T. Game Over. Empower Early-career Researchers to Improve Research Quality (2021) https://insights.uksg.org/articles/10.1629/uksg.548
[44] Stürmer S., Oeberst A., Trötschel R., ND Decker O. Early-Career Researchers' Perceptions of the Prevalence of Questionable Research Practices, Potential Causes, and Open Science (2017). https://econtent.hogrefe.com/doi/10.1027/1864-9335/a000324
[45] Vanholsbeeck M. Between the Traditional, the Neo-liberal and the Open University. Early-career Investigators Caught in the Briple bind of Academic Career Requirements. Handbook on Research Assessment in the Social Sciences (2021). https://www.e-elgar.com/shop/gbp/handbook-on-research-assessment-in-the-social-sciences-9781800372542.html
[46] Abadal E. Open Science. A Model with Some Pieces Still to Fit In [Ciencia Abierta. Un Modelo con Piezas por Encajar] (2021). https://arbor.revistas.csic.es/index.php/arbor/article/view/2403
[47] Allen C. and Mehler D. Open Science Challenges, Benefits, and Tips in Early-career and Beyond (2019). PLOS Biology 17(12): e3000587. https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3000246
[48] González-Teruel, A., López-Borrull, A., Santos-Hermosa, G., Abad-García, F., Ollé, C., and Serrano-Vicente, R. Drivers and Barriers in the Transition to Open Science. The Perspective of Stakeholders in the Spanish Scientific Community. Profesional de la información. Volume 31. Number 3 (2022). https://www.scipedia.com/public/Gonzalez-Teruel_et_al_2022a

4. Precarity of Research Careers and Open Science

This section presents the results of the literature review conducted in order to establish the state of the art in the possible relationship between precarity of research careers and Open Science.

While precarity of research careers is not the primary focus of the OPUS project and Open Science in general, an informed understanding of one of the most serious issues for researchers is important to ensure a comprehensive state of the art as defined in Objective 1 of the OPUS project. After having presented the methodology applied and the results from the literature review, this section goes on to present identified gaps and areas where further analysis would be required.

The full list of articles reviewed can be found in Annexe 2 – Articles reviewed for Precarity.

4.1. Methodology and Overview of Search Results

The literature review on the sub-topic "precarity of research careers and Open Science" was conducted as a desk-based research of relevant literature. It aims to analyse key literature in order to understand the impact of precarity to OS and vice versa. In particular, the review sought to answer the following overall research question:

> *"Does the literature show if the transition to Open Science has an impact on precarity (positive or negative) AND if precarity has an impact (positive or negative) on the uptake of Open Science?"*

A first general online and Scopus search on literature covering both terms "precarity" AND "Open Science" did not generate any relevant results for this literature review. The question was opened to consultation with OPUS partners and OPUS Advisory Board. It became obvious that there is extensive literature on either the topic of "Open Science" OR "precarity of research careers", but none which address explicitly the connection between the two, as per the overall question of this literature review.

Therefore, in order to ensure a basic understanding of the impact that precarity has on the research system and researchers, a desk-based literature review was conducted based on the overall methodology for the OPUS literature review as described in Section 2.

For this sub-topic, the search approach described in Chapter 2.3. OPUS Bibliographical Analysis was used. The search terms and relevant variations (Step 1) were:

1. precarity/precarious/precariousness
2. research/researcher/academic/scientific
3. research careers/researcher careers/academic careers/scientific careers
4. open science

The full overview of the search combinations for the sub-topic "precarity and Open Science" are shown in table 4.1.

Search words	- AND	Total number of hits
Precarity	Research	860
	researcher(s)	121
	Academic	245
	Scientific	29
Precarious	Research	3289
	researcher(s)	417
	Academic	608
	Scientific	335
Precariousness	Research	751
	researcher(s)	67
	Academic	118
	Scientific	83

Precarity	research careers	71
	researcher(s) careers	25
	academic career(s)	53
	scientific career(s)	3
	“academic career”	13
	“research career”	2
	“researcher career”	1
	“scientific career”	0
Precarious	research careers	180
	researcher(s) careers	56
	academic career(s)	96
	scientific career(s)	16
	“academic career”	29
	“research career”	4
	“researcher career”	1
	“scientific career”	1
Precariousness	research careers	43
	researcher(s) careers	14
	academic career(s)	23
	scientific career(s)	5
	“academic career”	9
	“research career”	1
	“researcher career”	0
	“scientific career”	2

Table 4.1: Overview of search combinations for “precarity and Open Science”

These different search combinations used during the Scopus search resulted in a total number of 4.282 articles, including duplicates. After identifying and omitting all duplicates as well as articles published before the year 2000, the total number of articles was reduced to 2.842. This list included articles which, according to their title, could immediately considered as not relevant e.g. articles related to “precarious housing”, “COVID-19”, “medical/clinical research”. In reference to the COVID pandemic, this is not to say that it did not have an impact. Literature does show how COVID worsened already precarious situations. However, the specifics of the COVID pandemic are out of scope in relation to the specific research question. Using the filter option in Excel with key words identifying non-relevant articles for this literature review, the list was further shortened to 271 articles. The abstracts of these identified articles were reviewed and categorised according to their relevance (yes/maybe/no), resulting in a final number of possibly relevant articles of 76.

In addition, other relevant publications were included to this list. These were identified based on a basic Google Scholar search and recommendations from OPUS partners and include reports and position statements of relevant stakeholders within the research community. In total, 12 publications were reviewed in detail using the OPUS review template, while 73 more articles were subject to a general review as they are focusing on other relations to precarity such as gender, race, psychological and psychosocial effects, national-based contexts or individual and autobiographic examples.

4.2. Overview on Precarity of Research Careers

The main findings from the literature review of relevant articles identified in the SCOPUS search, as well as relevant reports and position statements, are presented in this brief overview.[49]

Standing, G. describes in "The Precariat"[50] several characteristics that contribute to a general definition of precarity. Precarity is related to unsecure occupational identity combined with unstable labour conditions, no or less non-wage and rights-based benefits, poor payment conditions and career perspectives, and loss of other rights.

This can apply to research careers where insecure employment conditions (e.g. short-term or fixed-term contracts, poor to no career advancement and career stability) are impacting researchers, especially postdocs[51] and early career researchers or young academics who represent a highly vulnerable group[52].

The report by the **Organisation for Economic Cooperation and Development (OECD)**[53] can be seen as the most comprehensive publication which analyses the challenges of precarity of academic research careers in general across different research systems and how they are addressed in different OECD countries. The report analyses findings from dedicated 15 OECD country notes and ca. 100 policy interviews in 11 OECD countries. It focuses on the *"research precariat", defined as postdoctoral researchers holding fixed-term positions without permanent or continuous employment prospects.*

The report emphasises different causes and contexts for precarity, summarised below:

- Increasing importance of competitive research funding, including funding from third-party sources with short-term commitment;
- Increasing number of doctoral degrees awarded, while the traditional academic career cannot absorb this number of doctorate holders who wish to stay in academia;
- Increasing number of postdoctoral researchers on fixed-term contracts, together with an increasing share of fixed-term contracts, compared to contracts with an indefinite or permanent character;
- Postdoctoral researchers leaving academia due to loss of professional identity and demotivation;
- Global market for researchers, which additionally intensifies the competition;
- Informal and discrete recruitment procedures for postdoctoral researchers resulting in unequal opportunities;
- Persistence of research workforce and lifting of retirement age cause reduced opportunities for younger researchers;
- Low remuneration of postdoctoral researchers;
- Slow process of implementing policy initiatives and changes due to complex research and governance ecosystems.

The effects of precarity are divided into the following categories:

- Insecure careers and unfavourable working conditions affect the mental health and well-being of researchers.

[49] The above citied project SECURE, awarded under the call HORIZON-WIDERA-2022-ERA-01-50, will produce a Deliverable on "State-of-the-Art on Research Career Frameworks and Tenure Track-like Models" with a focus on precarity of research careers, as well as recommendations and initiatives on EU level related to research careers.
[50] Standing, G. (2014). The Precariat. Contexts, 13(4), 10–12. https://doi.org/10.1177/1536504214558209
[51] Herschberg, C., Benschop, Y., van den Brink, M. (2018). Precarious postdocs: A comparative study on recruitment and selection of early-career researchers. Scandinavian Journal of Management, 34(4), 303-310. https://doi.org/10.1016/j.scaman.2018.10.001.
[52] Mula-Falcón, J., Lucena Rodríguez, C., Domingo Segovia, J., Cruz-González, C. (2021). Early career researchers' identity: A qualitative review. Higher Education Quarterly. https://doi.org/10.1111/hequ.12348.
[53] OECD. (2021). Reducing the precarity of academic research careers. OECD Science, Technology and Industry Policy Papers, 113, OECD Publishing, Paris, https://doi.org/10.1787/0f8bd468-en.

- The pressure to ensure funding and to publish extensively at an early stage of the career have a negative impact on the attractiveness of the research career. This is further aggravated by a low number of available permanent positions.
- The quality of science is adversely affected due to the motto of quantity (metrics) over research quality.
- Differences by gender and other demographic factors (e.g. socio-economic background, ethnicity, disability) show that female and non-privileged researchers are disproportionately affected by precarity.

The report offers the following nine policy recommendations to reduce the precarity of research careers together with an associated policy toolkit to be applied in the respective national context of a country:

1) Improve the working conditions and offer more transparent, predictable and flexible career prospects for postdoctoral researchers.
2) Offer broad professional development during postdoctoral training.
3) Promote equal opportunities, diversity and inclusion in research careers by identifying and addressing existing biases and challenges.
4) Establish better links between research assessment and funding, and human resource management policy objectives.
5) Improve institutional practices regarding human resource management in research.
6) Promote the inter-sectoral mobility of researchers.
7) Support the international mobility of researchers.
8) Develop the evidence base on research careers.
9) Include all relevant stakeholders in the governance and coordination of research careers and ensure concerted, systemic action.

Recommendation number 4) is of particular interest to OPUS. It does not reference OS, but it refers to changes to research assessment to go beyond the routine dominant use of bibliometrics in the process of research assessment. The policy recommendation is to adopt and include criteria that value not only quantitative performance metrics based on publications and citations. Other evaluation criteria to be included should value qualitative performance related to career development and research environment, as well as societal impact of the research. The report suggests that including evaluation criteria that value institutional practices and strategies related to equity, diversity and inclusion can have a positive impact the research system.

The article **"Navigating Open Science as Early Career Feminist Researchers"**[54] is one of the only publications available that, among other things, briefly analyses the link between the uptake and practice of OS of early career researchers and their implied precarity status. It is composed from a point of view of feminist early career researchers (ECR), but the findings can be transferred to a wider group of researchers at similar career stages and in similar positions.

The authors argue that ECRs have had a significant impact on OS discussions and movements within academia by promoting a stronger OS community through self-organised or grass-root organisations of ECRs. However, "*there is inherent overlap between the opportunities and barriers that open science presents to academics of all research epistemologies and career stages*", and precarious positions especially for (feminist) ECRs raise the barriers to practice OS. The authors also argue that mistakes and errors during the process of shifting towards or practicing OS, still a relatively new movement, may cause adverse professional and reputational consequences especially for (feminist) ECRs, given that their careers and reputations are often already affected by precarious conditions.

The authors give a generic recommendation for ECRs on how to start the learning process and practicing Open Science: "*Starting out in open science can be daunting for many ECRs as there are multiple options and resources available, but it is important to start in a way that feels most comfortable and accessible, while accounting for the inherent precarity and lack of agency that ECRs assume in academia. Ideally, open science should not be static, but rather a flexible learning process that adapts to its users.*"

[54] Pownall, M., Talbot, C. V., Henschel, A., Lautarescu, A., Lloyd, K. E., Hartmann, H., Darda, K. M., Tang, K. T. Y., Carmichael-Murphy, P., & Siegel, J. A. (2021). Navigating Open Science as Early Career Feminist Researchers. Psychology of Women Quarterly, 45(4), 526–539. https://doi.org/10.1177/03616843211029255

A number of organisations representing different groups of researchers have published position statements related to precarity of research careers.

The task force on researchers' careers of the **Initiative for Science in Europe (ISE)** published its "Position on precarity of academic careers" in 2020.[55] This position paper is designed to express and demonstrate ISE's view "*that precarity of academic careers is one of the most pressing issues of the research system".* It highlights some main causes of precarity related to funding sources and research grant evaluation. For OPUS, the reference to research assessment is of relevance, as it criticises that the use of quantitative metrics (such as number of publications and citations). Although "*research outputs are numerous and varied, the heightened value of scholarly publishing sets a precedent for the dominance of publication metrics in most research evaluations".* In this case, the ISE proposal (promote qualitative judgement and consider also various research activities and societally relevant outputs) provides some generic input to the OPUS research question. They propose OS as one of the variables to be considered in reformed assessment procedures. Considering that they see reformed research assessment as a means to reduce precarity, this suggests a link to OS as one of the elements to reduce precarity through assessment reforms.

"We encourage evaluation practices that acknowledge other activities (e.g., practicing open science, collaboration with industry, citizen science, open education resources based on research, data and software, etc.), beyond the publication as a chief deliverable, including recommendations defined in DORA, the Leiden Manifesto, and the Hong Kong principles."

In relation to reformed research assessment, the position statement stresses the need not only to reform the criteria (moving away from purely publication metrics to combine with qualitative judgement), but also to improve the explicit description of such criteria and for improved robustness and transparency of evaluation procedures.

"A survey of European research institutions suggests that without clear definitions, considerable subjectivity arises from different sources, such as the external reviewers involved or the discipline of the research in question."

In relation to OS specifically, they do warn that they "*envision the reward of such practices as an addition to and not a substitute of commonly rewarded activities. Therefore, rewarding also other activities does not entail any disadvantage to those researchers who were not enabled to practice them (either for lack of resources or other limitations out of their control).*"

The position statement has another reference to OS when analysing the link between the short-term and project-based funding resulting in an increased number of short-term contracts for early-career researchers. This leads to "*negative competitive behaviours, some of them resulting in research misconduct"*, which is "*being addressed by the recent push towards Open Science and Responsible Research and Innovation"*, without providing any further evidence or details.

In addition to this position paper, ISE also published a Manifesto for Early Career Researchers (2022)[56] which addresses the need of *fostering diversified research careers at a European level*. Though the Manifesto does not explicitly mention precarity or precarious research careers, it recognises the negative impacts that the COVID-19 pandemic and current economic situation have, especially on early career researchers, and offers a suite of recommendations for improvement. One of these is addressed directly to Research Performing Organisations, Research and Technology Organisations and Higher Education Institutions as a means of improving and stimulating research careers with regards to recruitment, rewarding and assessment systems and can be seen as a relevant recommendation for OPUS:

"*Improve recruitment, reward and assessment systems giving more appreciation and value to research performance beyond scientometry in order to encourage openness, collaboration and sharing as a means to increase research quality and impact. A better balance between educational, research, managerial and entrepreneurial achievements is the goal leading to the establishment of true European practices for recruitment and career development.*"

Marie Curie Alumni Association (MCAA) and **European Council of Doctoral Candidates and Junior Researchers (Eurodoc)** published a joint "Declaration on Sustainable Research Careers" in 2019[57] in which

[55] Initiative for Science in Europe. (2020). Position on precarity of academic careers. https://initiative-se.eu/wp-content/uploads/2021/02/Research-Precarity-ISE-position.pdf
[56] Initiative for Science in Europe. (2022). A Manifesto. https://initiative-se.eu/wp-content/uploads/2022/09/MANIFESTO-def.pdf
[57] Kismihók, G. et al. (2019) Declaration on Sustainable Researcher Careers. Brussels: Marie Curie Alumni Association and European Council of Doctoral Candidates and Junior Researchers. DOI: 10.5281/zenodo.3082245

they call on research institutions, funding bodies and governments to ensure sustainable researcher careers. This declaration recognises that researchers are confronted with increasingly precarious conditions and analyses the following challenges, identified as key factors influencing sustainable research careers during the MCAA symposium held in February 2019:

- Career prospects and research funding.
- Career management support.
- Transferable skills training and recognition.
- Networking.

The only reference to OS is related to a recommendation to put more emphasis on transferable skills training and recognition: "*Organisations should enrich their researcher training with transferable skills training, reflecting on the growing need of internationalisation, interdisciplinarity, open science, cross-cultural, or gender equality aspects of 21st century work".*

VITAE published its impact and evaluation research article "Do researchers' early careers have to be precarious?" in 2019[58]. The article presents an overview of data on precarity (researchers on fixed-term contracts) in the UK. It shows that precarity is an ongoing issue and that it is particularly true for early career researchers (with differences between disciplines), in stark contrast to other occupational groups. Implications of fixed-term contracts are summarised in terms that they offer flexibility, but this must be offset against costs and potential loss of talent. There is no direct reference to OS in this article. The conclusion of this article is the following:

"From our analysis, HE research is the only occupational group in which most doctoral graduates are predominantly employed (i.e. as early career researchers) on a fixed-term basis. Concordat-related reviews and analysis of destinations data suggest the trend for insecure employment of early career researchers is persistent, particularly in the sciences, and impacting on the attractiveness of the early career stage in HE."

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The **ReMO Cost Action** published the "Researcher Mental Health and Well-being Manifesto" in 2021[59]. The ReMO COST Action is a network of stakeholders from all levels of the research community that is setting out to address mental health and well-being within academia.

Key recommendations of this manifesto are summarised below:

- At the macro level: ongoing dialogue between all relevant stakeholders; systematic and structured data collection for evidence-based policy making; dissemination of state-of-the-art evidence and tools addressing mental health; and revising the academic reward system.
- At the meso level: Recognising mental health and well-being issues; sharing best practices across institutions; development of fair and personalised research performance assessment; addressing well-being in doctoral and staff professionalisation; supporting change initiatives at the organisational level.
- At the micro level: Supporting grassroots initiatives; peer-to-peer support actions; a person-centred approach to training and career management; anecdotal evidence collection.

There is no direct reference to OS in this Manifesto. The conclusion is that working conditions, forced mobility and unavailability of permanent contracts and precarity all have a significant impact on mental health. Based on consultations among the ReMO Cost Action members, the manifesto calls for a reform of the research ecosystem in a policy-level context, which sets the external framework for research institutions and researchers in order to benefit mental health and well-being.

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[58] Vitae. (2019). Do researchers' early careers have to be precarious?. https://www.vitae.ac.uk/impact-and-evaluation/what-do-researchers-do/do-researchers-careers-have-to-be-precarious-research-article.pdf/view
[59] Kismihók, G. et al. (2021) Researcher Mental Health and Well-being Manifesto. ReMO COST Action. DOI: 10.5281/zenodo.5559805

The **International Consortium of Research Staff Associations (ICoRSA)** published its position statement on sustainability of research careers and precarity in 2022[60]. This position statement presents a historical overview of activities and initiatives on EU level in the context of research careers. It emphasises a threefold impact that short-term contracts and precarity have:

- Low engagement by researchers (on all levels) in research career policy creation and with policy makers.
- Low researcher productivity, due to researcher disillusionment.
- Low project productivity.

There is no direct reference to OS in this position statement. It proposes generic recommendations for changes in order to ensure a "*funded career path that will lead Early Stage Researchers ("ESRs") up to Senior Researchers, in all disciplines, providing sustainable career paths, with clear processes for recruitment, promotion, progression and involvement in decision making, and make their career opportunities on a par with Industry"*. The proposed changes relate to core governmental funding for research to support viable career paths to senior level and increased funding options for intersectoral mobility (between university and industry). *All aspects of these recommendations must be permeated by considerations pertaining to equality, diversity, and inclusion, as well as research integrity and ethical considerations.*

4.3. Looking forward to WP2/WP3 (Precarity)

Through our literature review, no literature was identified to provide an answer to the overall research question as to whether practising Open Science can have a positive or negative impact on precarity of research careers or whether precarity has a positive or negative impact on the uptake of Open Science. As such, there is not direct input to WP2 and WP3, in terms of specific interventions, indicators and metrics for Open Science, with a focus on potential to contribute to better rewards and incentives for researchers.

Open Science aims to improve research careers. Precarity is one the most serious issues of research careers. However, there is very limited data or information available that analyses the link between these two topics. This identified gap implies the need for more research studies, with different and longitudinal approaches, in order to provide a comprehensive international picture. One suggested approach is a tailored survey aimed at researchers at all disciplines and career stages which would gather data and information to fill the enormous gap in the knowledge of precarity of research careers and Open Science.

[60] International Consortium of Research Staff Associations. (2022). Position Statement on sustainability of research careers and precarity. https://icorsa.org/wp-content/uploads/2022/09/Position-Statement-on-sustainability-of-research-careers-and-precarity_ICoRSA.pdf

5. Gender Equality and Open Science

In this section, we consider the results of the literature review on the topic of Gender Equality and Open Science. Following a presentation of the scope and the methodology, the section presents an overview of findings from the literature. In concludes with some input to interventions (WP2) and indicators and metrics (WP3).

The full list of articles reviewed can be found in Annexe 3 – Articles reviewed for Gender. Throughout the chapter, other articles and documents consulted during the research are cited directly in the text.

5.1. Methodology and Overview of Search Results

Gender equality (or equality between women and men) (GE) refers to the equal rights, responsibilities and opportunities of women and men and girls and boys. Equality means that women's and men's rights, responsibilities and opportunities will not depend on whether they are born male or female. Moreover, GE implies that the interests, needs and priorities of both women and men are taken into consideration, recognising the diversity of different groups of women and men. Thus, in general, equality between women and men is seen both as a human rights issue and as a precondition for, and indicator of, sustainable people-centred development[61].

Within the framework of the new European Research Area (ERA), the concept of GE acquires new notable dimension – i.e. inclusiveness[62]. This inclusiveness dimension aims to better tackle intersectionality, i.e. intersections between gender and other diversity categories, as well as to take into account inclusiveness at the geographical and sectorial levels to ensure that all countries are on board and that the innovation and private sectors are also involved.

Both GE and Open Science (OS) have been promoted and fostered by the ERA, but both are still in need of further efforts to be fully implemented at European, national and institutional levels[63]. Moreover, in the context of Responsible Research and Innovation (RRI), some experts claim that there is no connection between Gender and Open Access as two RRI dimensions[64]. However, other experts assert that consideration of gender issues in the development of OS policies and reform of research evaluation should have a positive impact on the promotion of GE goals and the elimination of gender biases in research[65].

Therefore, the research question that was raised in this part of the study is as follows:

What is the relationship between Open Science and Gender Equality?

Methodological approach

The Scopus database was sought using the main concept "open science" in combination ('and') with several other keywords (Figure 5.1).

- gender / gendered / engendered - women (woman) / men (man) / male(s) / female (s) / masculine / feminine / masculinity (ies) / femininity (ies) - gender equality	- research / researcher (s) - academy / academic (s)/ academician (s) - science / scientists / scientific

Figure 5.1: keyword search for Gender Equality

The search was limited with the cut-off date for the publication year 2000.

The total result of the query was 1134 papers, but some of them overlapped (see Table 5.1). After critical evaluation of the abstract, 28 articles were selected for further in depth analysis.

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[61] The conception has been suggested by UN Women (https://www.un.org/womenwatch/osagi/conceptsandefinitions.htm). A similar conception is used by EIGE (https://eige.europa.eu/thesaurus/terms/1168).
[62] European Commission. (2021). European Research Area Policy Agenda. Overview of actions for the period 2022-2024. doi: 10.2777/52110. https://research-and-innovation.ec.europa.eu/system/files/2021-11/ec_rtd_era-policy-agenda-2021.pdf
[63] ERAC, European Research Area and Innovation Committee. (2021). 'Triangle Task Force' Guideline Paper on 'Research evaluation in a context of Open Science and gender equality'. https://data.consilium.europa.eu/doc/document/ST-1201-2021-INIT/en/pdf
[64] Wroblewski, A.; Bührer, S.; Leitner, A.; Fan, Ch. (2015). Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI). Analytical report on the gender equality dimension. https://morri.netlify.app/reports/2015-04-01-d2.3
[65] Op.cit ERAC, 2021

Search words	AND	Total number of hits
(Gender OR sex)	research or researcher (s)	79
	academy or academic (s) or academician (s)	18
	science or scientists or scientific	139
Gender equality	research or researcher (s)	3
	academy or academic (s) or academician (s)	0
	science or scientists or scientific *NOTE: the same results as with research.*	3
Gendered	research or researcher (s)	0
	academy or academic (s) or academician (s)	0
	science or scientists or scientific	0
Engendered	research or researcher (s)	1
	academy or academic (s) or academician (s)	0
	science or scientists or scientific *NOTE: the same results as with research.*	1
Women (woman) or men (man)	research or researcher (s)	65
	academy or academic (s) or academician (s)	6
	science or scientists or scientific	90
Male(s) or female (s)	research or researcher (s)	278
	academy or academic (s) or academician (s)	21
	science or scientists or scientific	483
Masculine or feminine	research or researcher (s)	0
	academy or academic (s) or academician (s)	0
	science or scientists or scientific	0
Masculinity (ies) or femininity (ies)	research or researcher (s)	1
	academy or academic (s) or academician (s)	0
	science or scientists or scientific	2

Table 5.1. Results of Scopus search for OS and gender (including GE)

5.2. Overview on Gender Equality

The overall findings suggest that open science and gender equality are interrelated, but the relationship is not always causal and not always unambiguous. Although generally argued as an instrument to give more power to women who experience inequality in academic contexts, feminist research takes a critical stance to open science as a tool to change the gendered discourse of women output and advancement in careers. On the other hand, a handful of prior studies demonstrate that gender is a controversial factor for predicting open science or, more often, open access publications as a constituent of the open science concept. These causal relationships are dependent on cultural and institutional settings which may be connected by a closed loop and act as mutually reinforcing factors. Below we extend the arguments for each perspective based on the literature review findings.

Open science as a predictor of gender equality.

Open science and, in particular, open access is regarded as a means to "facilitate greater diversity and inclusiveness"[66]. This is attributed to higher replicability of the open data, which increases integrity and fairness in and of science and, respectively, fair(er) evaluation of individual merits of academics. Feminist research also admits that feminist theory and open science are potential contributors to building social justice (including gender equality). Yet, this is not automatically achieved.

Open science has no effect on gender equality.

In particular, the feminist discourse focuses on open access as a constituent of open science which they consider "both a feminist and an ethical issue because the production, dissemination, and control of access to information and knowledge dissemination are all issues of power"[67]. They argue that although open access seems to be a positive initiative to reduce power imbalances between genders and geographical regions yet it may not produce any effect on gender equality. They claim that intersectionality between gender, race, early career stage, organisational structures and gender of the ones in power positions do not change social inequality. Hence, their perspective suggests that fragmentary efforts to change just one facet (e.g., open access, gender equality) of the responsible research and innovation movement will not work. A study in the USA by Olejniczak and Wilson[68] with a sample of over 180 thousand researchers yielded empirical findings in line with the feminist propositions. For example, it showed that the likelihood for a scholar to author an APC OA article increases with male gender, employment at a prestigious institution (AAU member universities), association with a STEM discipline, greater federal research funding, and more advanced career stage (i.e., higher professorial rank). Hence, the suggestion is that promoting values like transparency, validity, openness and accessibility of data, and engagement with communities in the overall research systems may be more helpful in realising open access and gender equality.

Traditional gender roles are a factor for negative interrelation between gender equality in academic contexts and open science.

Open science as a predictor of gender equality seems to be valid in the cultural and institutional contexts already characterised by equality. If discriminatory attitudes and/or practices exist due to cultural reasons, gender and open science are negatively interrelated. For example, in socio-cultural contexts where a traditional role is ascribed to women and their responsibility rests on the private life domain, women publish less in golden access journals as institutions do not invest in their career and, respectively, their publishing venues. Moreover, in such contexts gender intersects once again with other socio-demographic characteristics such as age, race, lower academic rank, positions in research teams, and Southern geographical location of residence, which negatively affects the growth rate of open access publications, mostly because of the limited access to funding of open access fees. In specific socio-cultural contexts, like Vietnam, and disciplinary domains, like social sciences and humanities, the people with whom female researchers co-author may be an important factor. Cooperation with male researchers, who are usually in a better economic situation and have a higher status in organisational hierarchies, may positively affect open science practices. This perspective, however, highlights an individual coping strategy which, according to the findings of the other reviewed studies, is not sufficient neither for open science nor gender equality.

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[66] Murphy, M.C.; Mejia, A.F.; Mejia, J.; Yan, X.; Cheryan, S.; Dasgupta, N.; Destin, M.; Fryberg, S.A.; Garcia, J.A.; Haines, E.L.; et al. (2020). Open Science, Communal Culture, and Women's Participation in the Movement to Improve Science. Proceedings of National Academy of Sciences of SA 2020, 117, 24154–24164

[67] Brabeck, M. M. (2021). Open Science and Feminist Ethics: Promises and Challenges of Open Access. Psychology of Women Quarterly, 45(4), 457–474. https://doi.org/10.1177/03616843211030926

[68] Anthony J. Olejniczak, Molly J. Wilson; Who's writing open access (OA) articles? Characteristics of OA authors at Ph.D.-granting institutions in the United States. *Quantitative Science Studies* 2020; 1 (4): 1429–1450. doi: https://doi.org/10.1162/qss_a_00091

Green open access[69] as a cheaper option to gain more recognition and power for being accessible to a wider public, hence, may look positive from the gender equality perspective in the institutional settings where bibliometrics dominate human resource management practices such as recruitment, performance assessment, remuneration and career planning[70]. Hence, the Plan S by cOAlition S[71] that advocates full and immediate open access publishing with retention of author's rights to the publication. This has potential to support gender equality through open access publishing by making everyone's research more transparent and challengeable and making author(s) more visible and impactful through other publishing initiatives, e.g. compendia or textbooks. However, as long as there continues to be a general distrust in the quality of open access journals and as long as publication records and reputations determine promotion and earnings, publishing in low quality or (not always correctly perceived as) predatory journals risks putting female scientists' reputations at risk[72].

Gender equality can be a predictor of open science.

In some sociocultural contexts like Brazil, Canada and Italy the studies found the rate of women publishing in gold open access journals higher or the same as men[73]. However, the papers do not provide explicit explanation but the Canadian data, which is attributed to equality as an overall policy and practice at national and institutional levels. Similarly, a survey of 1800 academics in the UK in 2013 found that men were more likely to share primary research data online compared with women suggests that the difference may be accounted for by disciplines and disciplinary cultures of sharing the data, implying that further research is needed in cultures (e.g. journal policies and practices, organisational incentives for opening the data) at institutional level to identify, e.g. the determinants and the role of interpersonal trust in certain academic fields to dismantle and overcome gendered barriers to open science.

5.3. Looking forward to WP2/WP3 (Gender Equality)

The above described literature review sought to identify interventions and metrics/indicators that could be of relevance to the OPUS framework to reward and incentivise OS, particularly in relation to gender. As per the findings above, it proves complex to separate gender and OS from other issues related to the role of women in scientific environment.

Indeed, looking first at possible categories of interventions, we find a series of suggestions that could relate to gender or be extended to a wider approach to support the transition to OS. Much of the literature focuses on Open Access and leads to categories such as:

- Policy: university procedures to promote OA policy and OA repositories to staff; procedures to disseminate and promote data-sharing policies and standards; incentive system and approach to the citing of data and databases.
- Infrastructural: availability of institutional repositories for depositing research articles.
- Standards: developing and adopting widely recognised, usable technological and descriptive standards on databases (lower technical/formatting barriers); developing data sharing standards for sub-disciplines (these should be disseminated by academic institutions, journals and funding agencies).

[69]The following types of open access (OA) are distinguished by Olejniczak and Wilson (2020): Bronze (the article is free to read on the publisher's website but no explicit license is presented); Green (the article is available in a repository, self-archived by the author); Gold (all articles in the journal are OA); and Hybrid (individual articles are OA if the authors have paid a publication fee, but other articles in the journal are closed).
[70] Atchison, A.L. Negating the Gender Citation Advantage in Political Science. PS Polit. Sci. Polit. 2017, 50, 448–455.
[71] cOAlition S is an international consortium of research funders, supported by Science Europe, hosted and administered by the European Science Foundation. It was launched on September 2018 to implement Plan S which came into effect in 2021. Plan S states that all scholarly publications on the results from research funded by public or private grants provided by national, regional, and international research councils and funding bodies, must be published in Open Access venues (journals or platforms) or made immediately available through Open Access Repositories without embargo. More at: https://www.esf.org/our-services/choose-your-service/scientific-platforms-administration/coalition-s/.
[72] Vuong, Q.-H. (2020). Reform retractions to make them more transparent. Nature, 582, 149. https://doi.org/10.1038/d41586-020-01694-x
[73] dos Santos Costa, E.H.; Weitzel, S.d.R.; Leta, J. Adherence of the Brazilian elite of researchers to open access journals and its relation to gender, region and area of knowledge. Em Questão 2020, 26, 15–42.
and
Ruggieri, R.; Pecoraro, F.; Luzi, D. An Intersectional Approach to Analyse Gender Productivity and Open Access: A Bibliometric Analysis of the Italian National Research Council. Scientometrics 2021, 126, 1647–1673.

- Capacity building: / training (advantages of open access publishing, data sharing / social media training to share research outputs and data), especially to those at the start of their career.[74]

On the other hand, the literature points to interventions related to Human Resource Management (HRM) that focus on diversity, gender and ethics, but actually go beyond a focus purely on OS.[75] In general, there are recommendations for systematically, coordinated approaches to promote OA publishing, with some proposing that institutions allocate resources (specific funding schemes to address gender equality through OS.[76]

Concerning indicators and metrics, the literature stresses (as per the objectives of OPUS, the need to change assessment procedures and to reform reward and incentives schemes. Again, gender becomes part of this framework and not a stand-alone factor. Variables emerge in some literature to further examine the effect of gender on the likelihood of choosing Open Access publishing.[77] However, while these may help to further assess the original research question posed in this chapter, they may not be directly relevant to the OPUS indicator/metric framework. On the other hand, the literature did review a set of 26 Open Knowledge Indicators, designed to understand the performance of universities and their progress towards openness.[78] These include collaboration, Open Access, diversity and also the focus on gender (Women above rank of senior lecturer; Women at rank of senior lecturer; Women at rank of lecturer; Women below rank of lecturer; Women in academic roles; Women in non-academic roles). As per the interventions, we see here gender indicators, and indicators that extend to other marginalised groups and inequalities, as part of a framework of "openness" rather than a stand-alone approach.

[74] See for example: Zhu, Y (2017), Who support open access publishing? Gender, discipline, seniority and other factors associated with academics' OA practice, Scientometrics, 111(2), 557–579 and Zhu, Y (2020), Open-access policy and data-sharing practice in UK academia, Journal of Information Science, 46(1), 41–52
[75] See for example, Brabeck, M. M. (2021) Open Science and Feminist Ethics: Promises and Challenges of Open Access. Psychology of Women Quarterly, 45(4) and Persson, S., & Pownall, M. (2021). Can Open Science be a Tool to Dismantle Claims of Hardwired Brain Sex Differences? Opportunities and Challenges for Feminist Researchers. Psychology of Women Quarterly, 45(4), 493–504.
[76] Nguyen, M.-H., Nguyen, H. T. T., Ho, M.-T., Le, T.-T., & Vuong, Q.-H. 2022. The Roles of Female Involvement and Risk Aversion in Open Access Publishing Patterns in Vietnamese Social Sciences and Humanities. Journal of Data and Information Science, 7(1), 76–96.
[77] Vuong et al (2021), Adopting open access in an emerging country: Is gender inequality a barrier in humanities and social sciences?, Learned Publishing 34: 487–498, Op.cit Nguyen et al 2022 and Olejniczak, A. J., & Wilson, M. J. 2020. Who's writing open access (OA) articles? characteristics of OA authors at PhD.-granting institutions in the United States. Quantitative Science Studies, 1(4), 1429–1450.
[78] Wilson et al (2022), Changing the Academic Gender Narrative through Open Access, Publications, 10(3)

6. Industry Practices and Open Science

This section presents the results of the literature review conducted in order to establish the state of the art in terms of Industry Practices and Open Science.

After having presented the methodology applied, this section described the overall results from the literature review. It then provides specific recommendations, emerging from the literature, for industry working on implementing OS practices. It concludes with some input to OPUS WP2/WP3, in terms of academic-industry collaboration.

The full list of articles reviewed can be found in Annexe 4 – Articles reviewed for Industry Practices.

6.1. Methodology and Overview of Search Results

Based on the common methodological approach (described in Chapter 2. Overall Methodology for Literature Review), the SCOPUS database was used to find relevant articles for review.

The focus of the reviews was to find any relevant information on the following research questions:

MRQ1 - What opportunities and benefits are unlocked for industry and business when engaging in OS?

MRQ2 - What challenges and barriers they face to fully implement OS practices?

MRQ3 - How is OS put into practice in industry and business?

Secondary research question:

SRQ1 - How business-academic-(policy) collaboration supports the uptake of OS?

For the first search, the search words included a combination of “open science” as key term, together with different umbrella terms and synonyms for the meaning of business, such as: industry, SMEs, enterprise, firm, corporation, organisation and commerce. The bases of the words from industry, corporation and organisation was included in order for the search result to include other possible parts of speech (such as adjectives, adverbs...). The searches only took into consideration publications after the year 2000 and final articles in English language.

Based on these individual searches, relevant keywords were chosen and combined into one final search with the following formula (Figure 6.1). This search resulted in of 734 articles.

TITLE-ABS-KEY ("open science" AND industr* OR business OR corporat* OR smes OR enterprise OR firm OR commerce OR organisation*) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2005) OR LIMIT-TO (PUBYEAR , 2004) OR LIMIT-TO (PUBYEAR , 2003) OR LIMIT-TO (PUBYEAR , 2002) OR LIMIT-TO (PUBYEAR , 2001) OR LIMIT-TO (PUBYEAR , 2000)) AND (LIMIT-TO (LANGUAGE , "English")).

Table 6.1 Open Science search formula

It was also decided to take into consideration another key term “open innovation” as it is widely spread among industry practice. The following formula (Figure 6.2) was used for the second search. The second search resulted in 1274 hits.

TITLE-ABS-KEY ("open innovation" AND industr* OR business OR smes) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2005) OR LIMIT-TO (PUBYEAR , 2004) OR LIMIT-TO (PUBYEAR , 2003) OR LIMIT-TO (PUBYEAR , 2002) OR LIMIT-TO (PUBYEAR , 2001) OR LIMIT-TO (PUBYEAR , 2000)) AND (LIMIT-TO (LANGUAGE , "English"))

Figure 6.2 Open Innovation search formula

The keywords used for the SCOPUS search and the total number of hits, as well as information on articles under Open Access can be found in the Table 6.1.

Search words	AND	Total number of hits
"Open Science"	Industry	151
	Industr*	208
	Business	92
	SMEs	2
	Enterprise	43
	Corporate	14
	Corporat*	20
	Firm	33
	Commerce	23
	Organisation	397
	Organisation*	460
	Organisation*	90
	"industry practices"	0
	"business practices"	2
	"business strategy"	1
	Industr* OR business OR corporat* OR SMEs OR enterprise OR firm OR commerce OR organisation*OR organisation*	734
Open innovation	Industr* OR business OR SMEs	1274*

Table 6.1 Search words and number of hits in SCOPUS (Open Science search)

Both searches were then combined and scanned to narrow down the number of articles between 20 and 50. First, the article titles were manually scanned to decide whether they are relevant for the objective of the literature review on industry practices. For more ambiguous papers, the abstract was read to understand better whether the article is relevant for further reviewing.

Since "Open Innovation" search had too many results to be able to detect the suitable papers to review one-by-one, we decided to look further for keywords such as "rewards", "incentives", "metrics", "indicators", "intervention", "policy" and "trust" from the titles, keywords and the papers´ abstracts. We were able to identify 68 papers, from which we selected 21 based on reading through the abstracts.

From "Open Science" search, we selected 18 papers from titles and abstract selection procedure. From these, we have further selected 15 papers as 3 were not accessible or were untraceable to download their full versions. Altogether, 36 papers were reviewed.

6.2. Overview on Industry Practices

General Findings

While some reviewed papers mainly from the "Open Science" term search take a very academic perspective, coming from a higher education institution´s point of view on industry practices, the papers selection included the perspective on Open Science (OS) and Open Innovation (OI) from large companies as well as SMEs and start-ups from various sectors within mainly European geographical coverage (including cases from Norway, Denmark, Portugal, Germany and Italy).

Altogether the reviewed papers provided with relevant and interesting insights on:

- the possible challenges, barriers, and risks to overcome for industry for adoption of open science practices;
- opportunities, benefits, best practices/cases and main trends of the companies that have already taken a more Open Science approach

- further steps and development action points needed and recommended for the transition to open science and/or open innovation

Among the most frequently cited challenges, the following 4 categories stood out[79]:

- Knowledge barriers, related to the loss of know-how or to imitation by competitors and the lack of willingness to share information;
- Collaboration barriers, linked to the partners' opportunistic behaviour or to the difficulty in finding the right partner, both in knowledge and cultural terms, and general mistrust between partners;
- Organisational barriers, related to the lack of managerial skills needed to establish an effective collaboration with external players and to the resistance to change of the organisation;
- Financial and strategic barriers, including both economic, legal and technical aspects, the perceived costs of OS and OI as well as lack of strategic vision of the firms with reference to their innovative knowledge.

Another set of barriers mentioned were asymmetry between knowledge transfer and information sharing of academia and industry, and lack of evidence and proof of benefits of open science in industry practices[80].

From a risk management perspective, both businesses and academia need to take into account industry sponsorship[81] and funding[82], as well as effects of commercial interest (commercialisation of knowledge)[83] in academia that might jeopardise public disclosure and, therefore, have a direct negative impact on the adoption of open science.

Many benefits and drivers of scientific openness were collected, particularly mentioning the factors of knowledge transfer, increasing propensity to introduce novel and breakthrough innovations, higher corporate innovation performance and OS tools that can overcome trade-offs and market failures.

One of the key opportunities seems to be access to unpublished results that can contribute to future for-profit endeavours. There is a great motivation for attraction and retention of high-quality scientists and researchers who are incentivised by permissive publication policy and, through this process, are pushed for more creative problem solving. Another set of opportunities unlocked thanks to adoption of OS and OI practices are acceleration of market introduction and product commercialisation, improved ability to meet customer demands, keeping up with competitors, reducing risk of market failure and access to resources (such as talent, technology, know-how, marketing and sales channels)[84].

It was determined that, in order to facilitate OS or OI, is in necessary to have developed:

- a tailored access and delivery of knowledge;
- proper data management practices;
- academic-industry collaboration;
- evidence and proof of best practices of OS in industry to convince scientists and institutions in its implementation;
- employee training, to moderate negative attitudes and create a more external oriented and collaborative mindset, developing more positive attitudes towards OI practices[85];
- localised trust in business and research collaborations, though the aspect of spatial proximity;
- mutual understanding mechanisms to build trust and enhance legitimacy;

[79] Bigliardi, B., & Galati, F. (2016). Which factors hinder the adoption of open innovation in SMEs? *Technology Analysis and Strategic Management, 28*(8), 869-885. doi:10.1080/09537325.2016.1180353
[80] Bergman, E.M. 2010, "Knowledge links between European universities and firms: A review", *Papers in Regional Science,* vol. 89, no. 2, pp. 311-333.
[81] Czarnitzki, D., Grimpe, C. & Toole, A.A. 2015, "Delay and secrecy: Does industry sponsorship jeopardize disclosure of academic research?", *Industrial and Corporate Change,* vol. 24, no. 1, pp. 251-279.
[82] Ibid.
[83] Bergman, E.M. 2010, "Knowledge links between European universities and firms: A review", *Papers in Regional Science,* vol. 89, no. 2, pp. 311-333
[84] Tobiassen, A.E. & Pettersen, I.B. 2018, "Exploring open innovation collaboration between SMEs and larger customers: The case of high-technology firms", *Baltic Journal of Management,* vol. 13, no. 1, pp. 65-83.
[85] Leonelli, S., Spichtinger, D. & Prainsack, B. 2015, "Sticks and carrots: encouraging open science at its source", *Geo: Geography and Environment,* vol. 2, no. 1, pp. 12-16.

- public policy strengthening OS norms;
- establishment of OI intermediaries;
- domestic knowledge bases and regional ecosystems as well as international linkages;
- social processes and creation of social impact (societal value).

Several papers describe the whole transition journey and organisational change processes of companies from closed to open innovation, describing different stages of development (such as: unfreezing, moving and institutionalising phases)[86].

Some of the best OS or OI practices of industry include:

- commitment from top management to trigger change;
- creation of independent organisational units (such as IP office) to manage innovation projects, which represents a strong signal that the status quo has been unfrozen, but without interfering with the firms' basic processes and routines;
- mobilising the firms' network of customers and suppliers as a key enabler of OS/OI adoption;
- the individual social network of the OI champion, which appears to act as an antecedent to firm-level relationships;[87]
- Outsourcing research (institutes becoming knowledge and technology centers for front-end innovation processes of firms)[88];
- Financing for research – from single source to multiple source funding (patent exploitation, IP commercialisation; universities from public to more private funding, corporates finance on own responsibility via third money or business unites);
- Research culture transitioning from closed disciplinary to open interdisciplinary thinking (internet-based collaborations, interdisciplinary journals, new scientific cross-links);
- Focus of research from broad universities to specific institutes;
- From stockpiling to patent donations (private companies donate patents to research institutions);[89]
- Interventions of large companies with start-ups for OI (through corporate accelerators, hackathons, trend spotting, entrepreneurial education or start-up procurement and investments).[90]

Finally, one key message highlights that OI benefits from incentives and performance measures that facilitate innovation practices at collective level, not only individual innovation behaviour.[91]

The papers cover very broad perspectives, which portrays that there is no "one size fits all" approach possible, but rather tailored and customised approaches for each institution. The literature review can stimulate a reflection for industries and academic institutions, in finding how to overcome obstacles and understanding the importance of applying Open Science and Open Innovation decisions. The papers also include a comprehensive navigation on how to effectively manage university-industry partnerships, which seems to be one of the key takeaways for the OS and OI full implementation.

Recommendations for industry implementing OS practices

One aspect arising from multiple reviewed papers is that OI and OS is triggered by change in the organisational structure of a firm and, in fact, serves as a starting point of the process of implementation of OI and OS practices.

[86] Chiaroni, D., Chiesa, V. & Frattini, F. 2011, "The Open Innovation Journey: How firms dynamically implement the emerging innovation management paradigm", *Technovation,* vol. 31, no. 1, pp. 34-43.
[87] Ibid
[88] Friesike, S., Widenmayer, B., Gassmann, O. & Schildhauer, T. 2015, "Opening science: towards an agenda of open science in academia and industry", *Journal of Technology Transfer,* vol. 40, no. 4, pp. 581-601
[89] Ibid
[90] Onetti, A. 2021, "Turning open innovation into practice: trends in European corporates", *Journal of Business Strategy,* vol. 42, no. 1, pp. 51-58.
[91] Breunig, K.J., Aas, T.H. & Hydle, K.M. 2014, "Incentives and performance measures for open innovation practices", *Measuring Business Excellence,* vol. 18, no. 1, pp. 45-54.

The creation of independent organisational units devoted to the management of innovation projects seems to be a strong signal that the status quo has been unfrozen, even though they do not necessarily interfere with established organisational processes and routines. Another key driver appears to be the role of individual social network of an OI champion, which can act as an antecedent and enabler of firm-lever inter-organisational relationships[92]. On the other hand, the firm´s network of customers and suppliers plays marginal role, at least in the initial phase of transition.

An organisation should also consider the importance of identifying a pilot project that serves as a field test for the OI/OS procedures and practices to be fine-tuned, become accepted and extended later on to the whole organisation. [93]

It also emerges that, in order to avoid a quick slip back to the traditional, Closed Innovation approach, it is useful to establish new organisational roles in charge of managing the evaluation and development processes of innovation opportunities generated in an OI environment.

This exemplifies the need to contemporarily intervene on both the 'organisational structures' and the 'evaluation processes' dimension to institutionalise the transition to OI/ OS practices.

Businesses can follow specifically 3 organisational phases for transitioning from Closed to Open Innovation, summarised in Figure 6.3[94].

1. Unfreezing

a) Top management are convinced of the benefits of OS/OI, as a key driver to trigger change and contribute to overcome the firms' organisational inertia.

b) The organisational structure is re-designed, representing the first managerial dimension for the implementation of OI, and leads to the establishment of an independent unit devoted to R&D activities and of an IP Office, aimed at managing the existing and new knowledge basis.

2. Moving

a) The firms' innovation network is created, mainly leveraging on the existing social network of the OI champion.

b) A firm-level inter-organisational network is established, by leveraging the personal social networks of R&D managers.

c) Preferred partnerships are set up with universities. Relationships with universities, indeed, are less risky in terms of potential spill-overs than others involving suppliers, customers or even competitors.

d) The IP Office defines mechanisms for facilitating knowledge transfer and for protecting companies from opportunistic behaviours. It is important to establish procedures to assess potential and opportunity to access external sources of technology.

3. Institutionalising (results are consolidated)

a) new organisational roles (instead of new structures) are introduced. In particular, this includes gatekeepers (Tushman, 1977), who are given the responsibility over innovation scouting activities, and innovation champions.

Figure 6.3 Organisational phases for transitioning from Closed to Open Innovation

Early cases of firms implementing OI outside high-tech industries show that they do not create new processes and metrics; instead they layer an OI perspective onto existing processes'. On the contrary, in other studies, there is evidence that the firms have undergone a profound change in terms of evaluation metrics used to inform management activities and resource allocation in R&D.[95] For example, the use of product development data as a measure of R&D performance offers also great potential for further examinations of antecedents of different types of innovation outcomes.[96]

Companies need new metrics of evaluation to focus more upon external sources and/or exploitation paths of innovation. In this respect, procedures are required to systematically scan and continuously monitor the range of technologies available, as well as new forms for involvement of external sources of innovation through the

[92] Chiaroni, D., Chiesa, V. & Frattini, F. 2010, "Unravelling the process from Closed to Open Innovation: Evidence from mature, asset-intensive industries", *R and D Management,* vol. 40, no. 3, pp. 222-245.
[93] Op. cit, Chiaroni, D., Chiesa, V. & Frattini, F. 2011.
[94] Ibid.
[95] Op. cit, Chiaroni, D., Chiesa, V. & Frattini, F. 2010
[96] Jong, S. & Slavova, K. 2014, "When publications lead to products: The open science conundrum in new product development", *Research Policy,* vol. 43, no. 4, pp. 645-654.

strategic use of corporate venturing. Particularly, external exploitation alternatives (like spin-outs and out-licensing) must be considered from the beginning of the evaluation process, as they might have a relevant impact on potential profits resulting from innovation. [97]

Industry also need to consider legal protection instruments. Whereas higher levels of spill-overs reduce willingness of firms to publish in a scientific format, legal protection instruments can reduce the "damage" of knowledge spill-overs and facilitate scientific openness. It can be concluded that firms do not show naïve openness, but are adapting to academic disclosure practices in exchange for valuable knowledge links, while trying to minimise negative side effects with respect to competitors.[98] On another hand, some large firms choose not to patent knowledge, but to publish large parts of their research in order to participate in the scientific community. In doing so, they mark findings as state-of-the-art and thus prevent others from patenting them.

Public incentives for R&D are of importance, thus assigning a role to RFOs to enhance effectiveness of publicly-funded OI projects and to minimise the risk to SMEs and other businesses. Recommendations include[99]:

- Funders should encourage projects to activate mechanisms, such as internships, to provide SMEs with human resources to dedicate to the project. Incentives could be allocated to encourage hiring of these resources within companies and ensure continuity.
- Funding bodies could seek to guarantee an engagement in a subsequent project oriented towards the R&D commercialisation phase for those consortia that prove to be productive and successful.
- Funders should encourage projects that consider creating a special body to support SMEs with coaching on project reporting (considering that SMEs often have basic accounting systems and that relying on external consultants could represent an excessively expensive cost)
- In the selection phase of collaborative innovation projects, funders should reward projects that consider:
  a) reducing numerosity and heterogeneity of consortia, in order to minimise opportunistic behaviour, the lack of clear ideas and the lack of prior mutual knowledge
  b) applying clear and rigorous criteria for the process of consortium creation e.g. ensuring that the project leader directly and personally selects the SMEs whose goals are supposed to be aligned with the scope of the project.

6.4. Looking forward to WP2/WP3 (Industry Practices)

The OPUS project does not include industry research performing organisations in the pilot organisations. Therefore, the main focus of the next steps of the project will be on how to support and reward academic/industry collaboration, as a key element of OS. To this end, the specific input to WP2 /3 has been analysed in this optic: seeking recommendations and best practices for academic-industry collaboration, which can be the basis for proposals for interventions and related indicators / metrics. These are summarised below (Table 6.2).

These proposals are based on the understanding that industry collaboration with academia (which can take different formats: collaborative projects / outsourcing) can lead to reduction of internal costs and can enhance performance. However, as noted above, this needs to be managed carefully. There is a need for serious consideration of commercial interest in academia (effect of commercialisation of knowledge), with barriers arising from faculty members and scientific researchers when trying to pursue commercialization of knowledge flows towards industry and business.

What initiative	Why is it relevant
Joint labs/ technology centers, joint operations or collaboration platforms	Creation of centres that provide a common collaboration platform for researchers of both institutions. As equal collaboration partners, both institutions have the right to publish and to commercialise the jointly created IP. This dual relationship increases the pressure on both partners to timely find applications for the scientific findings generated and to commercialise

[97] Op.cit, Chiaroni, D., Chiesa, V. & Frattini, F. 2011
[98] Simeth, M. & Raffo, J.D. 2013, "What makes companies pursue an Open Science strategy?", *Research Policy,* vol. 42, no. 9, pp. 1531-1543.
[99] Bertello, A., Ferraris, A., De Bernardi, P. & Bertoldi, B. 2022, "Challenges to open innovation in traditional SMEs: an analysis of pre-competitive projects in university-industry-government collaboration", *International Entrepreneurship and Management Journal,* vol. 18, no. 1, pp. 89-104.

between academia and industry	research results. The local consolidation of dedicated innovation teams has the potential to accelerate knowledge creation and open up faster commercialisation. Additionally, mutual career paths may emerge.
The role of entrepreneurial support systems within universities	The presence of technology transfer mechanisms within universities (e.g., technology licensing offices (TLOs), university-industry research centres, intramural regulations, patent support schemes, support to industry partner searches, venture business laboratories) can have an important role in URI and, as such, could be connected to the transition to OS. Adaptation: possible intervention: training of TLO staff in OS, OS trainings within technology transfer support services
Adequate training and support need to be provided to researchers	Targeted support and funding is suggested to help researchers manage information sharing so that they are aware, first, of what OS entails and what the potential benefits and concerns are, and second, they can support OS without having to deal with additional administrative burdens. This could take the form of dedicated information managers and could also involve research libraries.
Incentivising mutual understanding through informal knowledge exchange interactions	Projects must leverage mechanisms that increase trust between partners. When there are differences in terms of language, culture and organisational structure, it is important to stimulate informal knowledge exchange to encourage interactions that are not limited to the official steering committee or to the formal deliverables. Visits to the companies and informal sessions could leverage informal mechanisms of knowledge exchange and social control to increase mutual understanding within the project.
Assessment metrics (Altmetrics)	The importance of assessment metrics that reward data production (making data and material freely available) as a research outcome is stressed. If assessment metrics for scientific researchers took into consideration the contribution that they make to facilitate the free flow of information and ideas within the scientific community as well as within society as a whole, this would be a strong incentive for people who would like to support OS but cannot afford to (because they, for example, need to focus on activities that will get them tenure instead).

Table 6.2: recommendations and best practices for academic-industry collaboration

7. Trust and Open Science

This chapter first reviews a series of familiar general issues relating to trust in science and trustworthiness within scientific procedures and institutions. The review points to a number of issues that could be expected to connect trust to Open Science (OS), whether as an enabling condition or as a barrier. These are explored, providing the basis for a preliminary hypothesis on the way in which the trust nexus shapes possibilities for OS.

The chapter then considers the institutional implications of this hypothesis, mapping the structure of the Tree of Trust (the proposed analytical and operational framework for OPUS in these thematic areas), against specific institutional issues and response strategies that can be deployed by RFOs and RPOs.

The full list of articles reviewed can be found in Annexe 5 – Articles reviewed for Trust.

7.1. Methodology and Overview of Search Results

Based on the common methodological approach (described in Chapter 2. Overall Methodology for Literature Review), the SCOPUS database was used to find relevant articles for review.

The search with research or science and "trust" or "mistrust" resulted in a huge number of articles (as shown in table 7.1 below). These were filtered by generality, resulting in 20 of the most promising being reviewed (see searches 3 and 4 in the table). Meanwhile, the search with keywords "open science" or "open research" combined with "(mis)trust" provided only 16 references (search group 1 and 2). A non-systematic Google Scholar search was conducted to add references (e.g. grey literature) missing from SCOPUS.

	AND	Total number of hits	Group
"open research" OR "open science"	"trust in science" OR "mistrust in science"	16 (pub year >1999)	search 1
		16 (no-cut off date)	
"open research" OR "open science"	"conflict of interest"	35 (pub year >1999)	search 2
		35 (no-cut off date)	
research OR science	"trust in science" OR "mistrust in science"	499 (pub year >1999)	search 3
		509 (no-cut off date)	
research OR science	"conflict of interest"	10893 (pub year >1999)	search 4
		11731 (no cut-off date)	
		Among those only science (excluding research):	
		2312 (pub year >1999)	
		2490 (no cut-off date)	

Moreover, during the literature review in other sub-chapters, reviewers highlighted any articles where aspects of trust were mentioned and analysed. Within the research assessment chapter, literature mentioned a focus on robust and transparent research, trust as a driver or inhibitor for sharing research data openly, the question of trust in reflections of competition v collaboration and mistrust in relation to quality of OA journals.[100] The documents reviewed in precarity referred to the theme of trust in science and research misconduct.[101] Articles reviewed for the gender sub-chapter made reference to topics such as trust from a responsiveness and collaboration perspective, to trust in relation to willingness to share date and to the relationship between OA and public trust and OA and predatory journals.[102] The industry literature review raised a number of issues

[100] Holst et al (2022), Zuiderwijk et all (2020), Ignat and Avris (2021) and Bongiovani et al (2017)
[101] For example, the OECD report (2021) Reducing the precarity of academic research careers, makes reference to a discussion during a meeting of the OECD Global Science Forum in April 2018, on the theme of Trust in Science https://www.oecd.org/publications/reducing-the-precarity-of-academic-research-careers-0f8bd468-en.htm. The Initiative for Science in Europe paper on precarity of academic careers (2020) makes reference to trust in relation to research misconduct https://initiative-se.eu/precarity-paper-2021/
[102] Owen et al (2021), Stieglitz et al (2020), Vuong et al (2021), Wilson et al (2022)

related to trust between industry and academia in innovation ecosystems and for business-academic collaboration, particularly when dealing with commercial interests[103].

7.2. Overview on Trust

Trust in Science

The importance of trust in science, and its changing dynamics, are well-recognised and have been extensively addressed in recent literature. Science in an abstract sense remains one of the most trusted institutions in public life, across differences in national contexts, and scientists generally enjoy much higher public trust than other professionals. Nonetheless, there is a long-standing tendency among scientists themselves to express concern about erosion of trust in science as well as about the lack of scientific trustworthiness that may be causing it. Literature from the 1980s[104], as well as later literature studying the post-WWII period[105] point to this apparent paradox that trust in science is assessed to be in permanent crisis without ever really declining.

However, specific recent tensions are in evidence, and appear correlated with small but non-trivial reductions in trust in science as expressed in public surveys[106]. These tensions seem related to the intense politicisation of areas such as virology and climate science, fuelled both by policy-level polemics and the growing importance of social media in shaping the terms of public debate[107]. Apex scientific institutions have in a number of cases responded directly to these specific current issues by the organisation of high-level conferences and/or the publication of position statements on trust in science.[108] Researchers have also taken positions on desirable reforms, e.g. in science education, to re-establish public trust in science[109]. At the same time, critical perspectives from the humanities and social sciences emphasise the potentially elitist and exclusionary dynamics of the call from scientific institutions for science to be trusted[110].

Among these tensions, the following deserve particular mention:

- The existence of what has often been termed a "*replication crisis*" in certain areas of science[111] calls into question the robustness of scientific procedures, particularly as expressed through publication quality control. Supposed inability to derive reported results from reported data using reported protocols has been used both as a stick with which to beat science from the outside, notably in the context of the politicisation referred to earlier, and as a set of tensions within scientific communities, with significant disciplinary and generational differentiation. Criticism of traditional modes of peer review, the highly differentiated effects of open access, and the rise of so-called "predatory" publishing are all aspects of this crisis, which in a nutshell boils down to uncertainty as to what literature can be trusted. Coyne[112] (2016) has indeed argued that "*greater adherence to best publication practices, transparency in the design and publishing of research, strengthening of independent post-publication peer review and firmer enforcement of rules about data sharing and declarations of conflict of interest would make many replications unnecessary*".

  On the other hand, the idea of a "replication crisis" has been challenged in the literature. In relation to the definition, there is a lack of clarity as to the distinction between replication and reproduction, which tends in turn to conflate two issues. First, inability on the part of third parties to derive reported results from

[103] See for example, Bertello et al (2022), Costa and Matias (2020), Czarnitzki et al (2015)
[104] See for example Deutsch J, Francfort J, Hoffsaes C, Laborie F, Stewart J (1981), "Pour une régulation démocratique des sciences et des technologies". *Esprit*, 58/59: 44-47. https://www.jstor.org/stable/24469421
[105] See for example van der Leeuw S (2016), « La science, les politiques et le public: quelle réalité, quels écueils? ». Natures Sciences Sociétés, 24: 160-167. https://doi.org/10.1051/nss/2016014
[106] Algan Y, Cohen D (2021), « The French in the time of Covid-19: an economy and society facing the health risk". Notes du Conseil d'analyse économique, 66(2): 1-12, Bauer M.W., Hervois P, Dubois M (2021), Les Français et la science 2021 : représentations sociales de la science 1972-2020. Université de Lorraine, LES, Gemass. https://hal.science/hal-03949651, Bubela T, Caulfield T, Kimmelman J, Ravitsky V (2020). Faisons mieux les choses: représentation publique de la science sur la COVID-19. https://philpapers.org/rec/BUBFML
[107] Kempner J (2008), "The chilling effect: how do researchers react to controversy?". PLoS Medicine, 5(11): e222. https://doi.org/10.1371/journal.pmed.0050222
[108] See for example French Académie de médecine, plenary meeting on "Défiance et confiance dans la science" (Distrust and trust in science), 18 October 2021 (Académie de médecine 2022).
[109] Lesne J (2021), "Réviser le système de recherche pour ranimer la confiance sociale dans la science". Environnement, risques & santé, 20(1): 53-67 and Paulhiac-Pison M (2021), "Restaurer la confiance dans la science". Administration et éducation, 172: 101-106. https://doi.org/10.3917/admed.172.0101
[110] Bensaude-Vincent B (2018), « S'approprier ou partager la science? ». La pensée, 396: 21-31. https://doi.org/10.3917/lp.396.0021
[111] J.P. Ioannides (2005), "Why most published research findings are false". PloS Medicine, 2(8): e124. http://doi.org/10.1371/journal.pmed.0020124
[112] Coyne J.C., (2016), "Replication initiatives will not salvage the trustworthiness of psychology". BMC Psychol 4, 28. https://doi.org/10.1186/s40359-016-0134-3

reported data using reported protocols, which is better termed "reproducibility" or more precisely, following Goodman, Fanelli & Ioannidis[113], "results reproducibility". Absence of reproducibility may suggest a scientific integrity violation, but may also point to inadequate methodology or poor experimental design. Secondly, inability to produce identical or consistent results when applying reported protocols to different empirical phenomena (observed or experimentally designed) may indicate similar problems as in the case of non-replicability, but may also raise quite different questions about relevance.

Other arguments have been offered to support the view that the replication crisis is overblown or mischaracterised. It remains to be assessed whether these issues are as important in routine scientific practice as in polarised public debate. A study of attitudes and judgements among research evaluators in Argentina[114] suggests that they do not, in general, differentiate between publications based on their open access character. And with respect to the general public, Anvari & Lakens[115] (2018) report that being briefed about replication issues in the psychological sciences did not affect their sample's view as to whether future research in psychological science should be supported by public funding.

- Concerns about the role of funding in shaping science agendas, the performance of research and the dissemination of results are not new, but have taken on heightened significance with the combination of pressure on public funding and selective politicisation[116]. Again, these concerns have both an internal and external dimension. From the outside, criticism of supposed conflicts of interest is commonly used to discredit scientific results and/or their policy implications. Whether financial conflicts do in fact necessarily bias research is unclear, given the numerous confounding factors in any empirical assessment (for a sceptical view on the "funding effect"[117]; for attempts to establish criteria for funding "toxicity"[118]. The perception, on the other hand, is strongly entrenched in public debate (Sax 2012), and scientific institutions have established specific procedures to address the concerns[119]. However, meta-analyses suggest that, while there has been some progress in transparency about potential conflicts of interest – including in highly sensitive areas such as drug trials, the situation remains suboptimal[120].

- Within science communities, the same concerns may be expressed, but even when they are not, the connection between funding patterns and increasing dualisation of employment conditions and career paths (as discussed in Chapter 4. Precarity of Research Careers and Open Science) tends to encourage scepticism about inclusiveness and equity. This boils down to uncertainty as to who can be trusted.

- Questions about ideological and institutional biases in science and technology agendas are long-standing, notably with regard to military research. They have achieved new prominence in areas of social significance in which research agendas are largely driven by corporate strategies. Artificial intelligence and genetic engineering are perhaps the two areas of greatest public concern, and within science communities criticism of the effect on research of the intimate intertwining of hype and capital markets has become commonplace. More recently, emphasis has been put on the way in which many areas of

[113] Goodman, S.N., Fanelli, D, Ioannidis, J.P.A. (2016), "What does research reproducibility mean?" Science Translational Medicine. 8(341). https://doi.org/ 10.1126/scitranslmed.aaf5027.
[114] Bongiovani P, Miguel S, Hernández-Pérez T (2017). "Actitudes y percepciones de los evaluadores de la carrera científica en Argentina sobre la publicación en acceso abierto", Revista Española de Documentación Científica. 40(2), abril-junio 2017. http://dx.doi.org/10.3989/redc.2017.2.1404
[115] Anvari F, Lakens D (2018). "The replicability crisis and public trust in psychological science", Comprehensive Results in Social Psychology, 3:3, 266-286. 10.1080/23743603.2019.1684822
[116] Fabbri A, Lai A, Grundy Q, Bero L.A. (2018), "The influence of industry sponsorship on the research agenda: a scoping review". American Journal of Public Health, 108(11): e9-e16. https://doi.org/10.2105/AJPH.2018.304677, Gauchat G (2012). "Politicization of Science in the Public Sphere: A Study of Public Trust in the United States, 1974 to 2010". American Sociological Review, 77(2): 167–187. https://doi.org/10.1177/0003122412438225, Smith K (2010), "Research, policy and funding – academic treadmills and the squeeze on intellectual spaces". The British Journal of Sociology, 61(1): 176-195. https://doi.org/10.1111/j.1468-4446.2009.01307.x, Webster A (1994), "University-corporate ties and the construction of research agendas". Sociology, 28(1): 123-142. https://doi.org/10.1177/0038038594028001008
[117] See for example Krimsky S (2013), "Do financial conflicts of interest bias research? An inquiry into the "funding effect" hypothesis". Science, Technology & Human Values, 38(4): 566-587. https://doi.org/10.1177/0162243912456271
[118] Almassi B (2017), "Toxic funding? Conflicts of interest and their epistemological significance". Journal of Applied Philosophy, 34(2): 206-220. https://doi.org/10.1111/japp.12180 and Elliott K.C (2014), "Financial conflicts of interest and criteria for research credibility". Erkenntnis, 79(5): 917-937. https://doi.org/10.1007/s10670-013-9536-2
[119] See Sax J.K. (2012), "Financial conflicts of interest in science". Annals of Health Law, 21(2): 291. and with respect to journals Resnik D.B, Konecny B, Kissling G.E (2017), "Conflict of interest and funding disclosure policies of environmental, occupational and public health journals". Journal of Occupational and Environmental Medicine, 59(1): 28-33. https://doi.org/JOM.0000000000000910
[120] Benea C, Turner K.A, Roseman M, Bero L.A, Lexchin J, Turner E.H, Thombs B.D (2020), "Reporting of financial conflicts of interest in meta-analyses of drug trials published in high-impact medical journals: comparison of results from 2017 to 2018 and 2009". Systematic Reviews, 9: 77. https://doi.org/10.1186/s13643-020-01318-5

technological convergence appear ideologically driven, e.g. by what has been called "long-termism"[121]. This boils down to uncertainty as to whether science – at least in certain areas – can be detached from the techno-scientific framings that motivate, fund and publicise it.

- There are widespread concerns, within both science communities and the broader public, about the nexus between science and policy. The Covid-19 pandemic has, in particular, given rise to criticism of misuse of science by public authorities and/or politicisation of scientific expertise supposedly reflecting the ideology or affiliation of scientists rather than impartial consideration of research-based evidence[122]. While the visibility of the issue has been exceptional in this context, it is of course not new, and has long been a matter of concern in the STS community[123].

- The aspiration to greater and qualitatively more significant stakeholder engagement on science issues – from paradigmatic development to research design to application of results – is widely shared within and outside science communities. However, there are persistent concerns that adequate protocols for ensuring such engagement are not available, or not adequately disseminated, and that, as a result, trans-disciplinarity tends in practice to fall well below its ideals, often either including stakeholders in tokenistic ways that entrench hierarchies of power and recognition or diluting scientific method and protocols to make it acceptable to real or assumed social demand. These two failures are not mutually exclusive and may indeed support and reinforce one another when, e.g., tokenistic inclusion gives a biased reflection of what stakeholder communities actually want or have to offer.

These considerations point to the need to unpack the idea of trust in science into different dimensions of trust and mistrust, focusing on different aspects of science.

Open Science and the Trust Nexus

While issues relating to trust in science have been extensively studied, there is limited specific literature on the connection between trust and open science. From the perspective of the OPUS project, this raises an important policy-research question. There is a very clear policy agenda explicitly connecting increased trust and more open science at European level[124]. Similarly, at the international level, UNESCO's Recommendation on Open Science[125] is explicitly designed, among other objectives, to respond to "*failures of traditional closed science systems that have led to high levels of mistrust in science*"[126]. Yet the paucity of research on the topic suggests that these aspirational goals are not strongly anchored in evidence. This also means that practical mechanisms to achieve them are unlikely to be available.

This point should of course not be overstated. For example, structured procedures for public engagement on controversial technological issues (nanotechnologies, genetic engineering, nuclear waste…) have been extensively studied in the STS literature and are likely to offer good examples of the kind of information required to build institutionally relevant trust interventions and metrics on open science. Similarly, the critical literature on open access initiatives such the European Plan S offer useful pointers as to design of open science protocols that can foster trust. However, it remains the case that a comprehensive operational vision for the trust / open science nexus appears to be lacking at present. Of particular importance is the connection between the internal and external dimensions of trust in the context of open science. From the aspirational perspective noted above, there are two distinct issues.

On the one hand, public trust may be expected – albeit on limited evidence at present – to increase with scientific openness. Specific issues in this regard include, as noted above, availability of data for third-party analysis, transparency of publication procedures and full disclosure of potential or perceived conflicts of interest. There are limits to this expectation, notably in areas of high politicisation (such as climate change and pandemic response) in which more information about the scientific process may be expected to offer up inevitable vulnerabilities for polemical exploitation. But generally speaking, the idea that trustworthy scientists and science institutions are more likely to attract public trust appears reasonable, and certainly deserves to be assessed empirically.

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[121] Roco M.S., Bainbridge W.S. eds (2002), Converging Technologies for Improving Human Performance. NSF-DOC report.
[122] Koch N, Durodié B (2022), "Scientists advise, ministers decide? The role of scientific expertise in UK policymaking during the coronavirus pandemic". Journal of Risk Research, 25(10): 1213-1222. https://doi.org/10.1080/13669877.2022.2116083
[123] Weingart P (1999), "Scientific expertise and political accountability: paradoxes of science in politics". Science and Public Policy, 26(3): 151-161. https://doi.org/10.3512/147154399781782437
[124] European Commission 2016, Open Innovation, Open Science, Open to the World. A Vision for Europe. Luxembourg: Publications Office of the European Union
[125] Op.cit UNESCO 2021
[126] Persic A, F Beigel F, Hodson S, Oti-Boateng P (2021), "The time for open science is now". In World Science Report, UNESCO: 12-16

On the other hand, an important enabling condition for openness, as a concrete feature of scientific institutions at all levels, is trust among scientists. As noted below, there are indications from the limited literature on the subject that mutual professional distrust can be a barrier to participation in open science initiatives, which means, conversely, that building trust within institutions and professional communities can contribute positive to more open science. Again, this is a reasonable hypothesis that needs more detailed empirical assessment.

These considerations are not separate. If both hypotheses are reasonable, one would expect a connection between the trust scientists have in the institutions and procedures in which they participate and the trust the public has in science and scientists. This is precisely the core of open science as an aspirational policy goal.

From a research perspective, support for the aspiration is offered by Tijdink *et al.* (2021)[127], from a responsible research and innovation perspective and by Toom & Miller (2018)[128] from an ethics and integrity perspective. In terms of research aggregation, consolidation and meta-analysis, Mayo-Wilson, Grant & Supplee (2022)[129] propose "TOP Guidelines for Clearinghouses" which they argue should include "*reporting whether evaluations used open science practices, incorporating open science practices in their standards for receiving 'evidence-based' designations, and verifying that evaluations used open science practices*". It is their view that implementing such guidelines "*could increase the trustworthiness of evidence used for policy making and support improvements throughout the evidence ecosystem*". Similar arguments are made at a more general level by Bensaude-Vincent (2018)[130], who considers open science as a set of mechanisms by which science appropriation can be transformed into science sharing, and by Lesne (2020)[131], who emphasises open science as facilitating knowledge transfer at the science-policy nexus .

Both the importance of these issues and the difficulties in achieving such objectives, particularly in highly politicised contexts, are emphasised in the 2022 report *Confidence in Research: Researchers in the Spotlight*[132], which surveyed researchers' views regarding the effects of the pandemic on science. The survey offers four key takeaways and areas for action, all of which have implications for the practical achievement of openness in science: addressing misinformation, building public trust and understanding, preparing researchers for a public facing role, and tackling inequality.

With respect to trust, the report suggests that the enhanced public attention to science in the circumstances of the Covid-19 pandemic requires greater public understanding of research and the research process if toxic politicisation – which can only partly be alleviated by addressing misinformation – is not to undermine public trust in science, including in areas not directly related to the pandemic and policies to respond to it. The way in which e.g. dismissal of models is used interchangeably to discredit climate science and epidemiology is illustrative of how undermining can proceed. And the pathways proposed to build such understanding, and thus public trust in science, are essentially (aspects of) an open science agenda: investing in public campaigns and bodies, conducting research on research communication methods, promoting awareness of key research terminology, valuing interdisciplinary approaches, and spotlighting the societal impact of research. Lest this be interpreted as merely a "deficit" model of science communication, the report goes on to clarify that achieving such objectives requires "preparing researchers for a public-facing role", which implies rethinking what it is to be a scientist, in both public and private institutions, with wide-ranging implications for research management, career development, initial and further training, science communication, science advice, safety and security within academic employment, and an explicit focus on inequalities in science.

The survey thus suggests a broadly shared understanding of what the open science aspiration would entail in practice and of the key role of trust in realising it.[133]

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[127] Tijdink J.K, Horbach S.P.J.M, Nuijten M.B., O'Neill G (2021), "Towards a Research Agenda for Promoting Responsible Research Practices". Journal of Empirical Research on Human Research Ethics, 16(4): 450-460. https://doi.org/10.1177/15562646211018916
[128] Toom K, Miller P.F. (2018), "Ethics and Integrity". In J. Andersen, K. Toom, S. Poli, P.F. Miller, Research Management. Europe and Beyond, Elsevier: 263-287. https://doi.org/10.1016/B978-0-12-805059-0.00013-4
[129] Mayo-Wilson E, Grant S, Supplee L.H. (2022), "Clearinghouse Standards of Evidence on the Transparency, Openness, and Reproducibility of Intervention Evaluations". Prev Sci, 23: 774-786. https://doi.org/10.1007/s11121-021-01284-x
[130] Op. cit Bensaude-Vincent B (2018)
[131] Lesne J (2020), "Open Science: un potentiel inexploité pour le transfert de savoir à l'interface science-politique ». Environnement, risques & santé, 19(3): 209-212
[132] Economist Impact (2022), Confidence in Research: Researchers in the Spotlight. Elsevier. https://impact.economist.com/projects/confidence-in-research/pdfs/Confidence_in_Research-full_report.pdf
[133] However, there is a counter-argument, suggested e.g. by Gabrielsen (2020), referring explicitly to data-intensive science, to the effect that "… trust involves positive expectations about the actions of others that may or may not be accurate and involves quite a bit of risk that these expectations may be wrong. Openness aims to limit this risk, thereby making trust in other peoples' actions and intentions redundant. In the Open Science-scenario, there is no real need to trust anyone as everything will be available for checking and validation, and in this sense, Open Science is therefore

What follows is a set of hypotheses that are consistent with the limited available evidence, albeit not entailed by it[134]. Essentially, the best way of looking at the trust / open science nexus as a practical site of actionable and accountable interventions is by focusing on trustworthiness as a trust enabler. Science cannot open itself up in the normatively relevant way if the participants in science communities do not perceive it to be trustworthy, which in turn suggests that collaborative rather than competitive institutional environments tend to favour more open science. The main conclusion of this article is that if research organizations can support collaboration alongside competition as part of their research activity, benefits will follow. Open science is a means by which collaboration, sharing and openness can be embedded into research activities. A move to embrace open science requires a culture change at the institutional level and a series of actions to deliver that change[135].

Conversely, the interface between more open science and its publics will not function well if science is not perceived by the public(s) to be trustworthy. The importance of open access data sharing has been emphasised in these terms, to address the issues of politicisation and erosion of public trust in relation to Covid-19 pandemic responses, by Wells & Galvani (2022)[136]. Similarly, in discussing the importance of open data to enable transparent quality assessment and thus build public trust, Vazire (2017)[137] strikingly argues that researchers should but do not necessarily have higher standards than used-car salesmen. It appears reasonably clear that this has more to do with institutional environments than individual proclivities. For instance, Holst, Faust & Strech (2022)[138], highlight limited requirements and incentive structures for openness in German biomedical research at PhD and *Habilitation* level.

More generally, the systematic literature review by Zuiderwijk, Shinde & Jeng (2020)[139] identifies trust as a significant driver (or inhibitor, depending on the institutional context as well as individual perceptions of the scientific process) of open sharing of research data. While there is broad recognition of the benefits of open data sharing in terms of integrity, relevance and quality control, there are also widespread fears about the various kinds of "misuse" that can follow from open data sharing, whether through unethical exploitation, commercial exploitation or epistemically inappropriate applications. Strengthening the positive factors, by embedding them in concrete institutional practices, while creating credible safeguards against the negative factors, thus emerges as a crucial enabling environment to support open data. Berkowitz & Delacour (2022)[140] further argue that these issues give rise to particular challenges in the social sciences.

Trustworthiness thus includes, but also goes well beyond, integrity as a quality of individuals or even of procedures, as stressed by the focus on institutional issues such as conditions of scientific employment. It thus makes useful connections between intervention logics at the individual and institutional level.

By facilitating transparency and scrutiny of science procedures (e.g. funding, assessment, prioritisation, dissemination), openness should in principle facilitate detection of conflicts of interest and misconduct and institutional responses to them, from individual disciplinary action to institutional awareness-raising and training. Response to the replication crisis may thus lead to "*a culture of transparent, open science where the primary goal is to test and not support hypotheses about specific interventions.*"[141] A similar argument is made by Frias-Navarro *et al.* (2020)[142] with respect to education research. By contrast, Hickes (2023)[143] argues that,

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rather a 'trust-no-one-technology'." This is an outlier argument in the literature which, precisely for that reason, deserves to be noted.

[134] Rosman T, Bosnjak M, Silber H, Koßmann J, Heycke T (2022). "Open science and public trust in science: Results from two studies". Public Understanding of Science, 31(8), 1046-1062. https://doi.org/10.1177/09636625221100686

[135] Ignat T, Ayris P (2020), Built to last! Open science in European universities. Insights. 33:9, 1-19. https://doi.org/10.1629/uksg.501

[136] Wells C.R, Galvani A.P (2022), "Tackling the politicization of COVID-19 data reporting through open access data sharing". The Lancet Infectious Diseases, 22(12): 1660-1661. https://doi.org/10.1016/S1473-3099(22)00505-9

[137] Vazire S (2017), "Quality Uncertainty Erodes Trust in Science". Collabra: Psychology, 3(1): 1. https://doi.org/10.1525/collabra.74

[138] Holst M.R, Faust A, Strech D (2022). "Do German university medical centres promote robust and transparent research? A cross-sectional study of institutional policies", Health Research Policy and Systems. 20:39. https://doi.org/10.1186/s12961-022-00841-2

[139] Zuiderwijk A., Shinde R., Jeng W (2020), "What drives and inhibits researchers to share and use open research data? A systematic literature review to analyze factors influencing open research data adoption". PLoSONE 15(9). https://doi.org/10.1371/journal.pone.0239283

[140] Berkowitz H, Delacour H (2022), « Ouvrir les données de la recherche: quelles implications pour les sciences sociales? ». M@n@agement, 25(4) : 1-31.

[141] Hillary F.G, Medaglia J.D (2020), "What the replication crisis means for intervention science". International Journal of Psychophysiology, 154: 3-5. https://doi.org/10.1016/j.ijpsycho.2019.05.006

[142] Frias-Navarro D, Pascual-Llobell J, Pascual-Soler M, Perez-Gongalez J, Berrios-Riquelme J (2020), "Replication crisis or an opportunity to improve scientific production?". European Journal of Education, 55(4): 618-631. https://doi.org/10.1111/ejed.12417

[143] Hickes D.J. (2023), "Open science, the replication crisis and environmental public health". Accountability in Research, 30(1): 34-62. https://doi.org/10.1080/08989621.2021.1962713

in the field of environmental public health, "*open data initiatives can promote reproducibility and robustness but do little to promote replicability*". The emphasis on reproducibility rather than replication overlaps with the arguments of Coyne (2016)[144] and Prager *et al.* (2019)[145]. However, this shift towards reproducibility as an objective is entirely consistent with the broader vision of enhanced transparency, anchored in trustworthiness, contributing to trust-building.

Similarly, creating spaces in which lay publics can engage with agenda-setting and other paradigmatic processes within science, the perception that science is self-referential and therefore works only for the benefit of scientists can be attenuated. Open access to science results as published should broaden the conversation about what science means and how it should be used, including for policy purposes.

7.2. Looking forward to WP2/WP3 (Trust)

In terms of the OPUS project, this emphasis on trustworthiness as a trust enabler creates both a major opportunity and a significant challenge. The opportunity is to embed within the intervention protocols to be developed a trust perspective that can enable RFOs and RPOs to operationalize trust as a structural precondition of openness and a practical indicator of its effectiveness. The challenge is to develop trust metrics that are sufficiently credible to be widely adopted, sufficiently robust to deliver tangible benefits and sufficiently simple to be easily adopted and deployed.

In order to do this, it is proposed to use the Tree of Trust model to design a structured series of interventions that can benchmark trust within institutional environments, support design of trust-building strategies, and offer metrics to track achievement over time of strategic objectives.

The Tree of Trust model proposes a seven-dimensional structuring of trust in terms of the characteristic attitudes and behavioural patterns – the *"habitus"* – that express trust (or its absence) in an individual or social/institutional setting.[146] The Tree of Trust is operationalised through a barometer – a questionnaire typically comprising five questions for each habitus – which enables respondents to reveal their trust patterns and in particular their stance with respect to the various aspects of trustworthiness (their own and others') by answering questions that do not necessarily mention explicitly the word "trust" but nonetheless shed light on it. Based on the answers, the seven "leaves" of the Tree of Trust take on colours (from green to red, through yellow and orange), which express in a very intuitive and visual way the trust configuration arising from the barometer.

In order to contribute to open science interventions at institutional level, it is thus proposed to conduct a series of benchmarking workshops to allow each participant institution, with a group of relevant internal and if judged appropriate external stakeholders, to assess the colour of the open science Tree of Trust in its specific setting. Analysis of the underlying factors – the roots of the Tree – leading to identified trust issues will in turn enable participant institutions to devise response strategies and, over time, to assess success in implementing them.

As a starting point, for the design of specific trust barometers for open science, the following mapping of the Tree of Trust against open science issues and potential institutional interventions is proposed (Table 7.2).

It should be emphasised that many of the issues referred to are not trust-specific. Rather, as discussed above with respect both the aspirational policy objectives and the available evidence base, trust offers a helpful, and transversal, entry point into many aspects of open science. The Tree of Trust is thus best seen not as a stand-alone intervention, but rather as a structural component of the suite of OPUS interventions, recognising however that modularity may further facilitate uptake.

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[144] Op.cit Coyne (2016)
[145] Prager E.M, Chambers K.E, Plotkin J.L, McArthur D.L, Bandrowski A.E, Bansal N, Martone M.E, Bergstrom H.C, Bespalov A., Graf C (2019), "Improving transparency and scientific rigor in academic publishing". Journal of Neuroscience Research, 97(4): 377-390. https://doi.org/10.1002/jnr.24340
[146] By reference to the sociology of Pierre Bourdieu, these dimensions, because they intertwine attitudes and the behavioural patterns that express and reproduce them, are termed *"habitus"*. As helpfully summarized on Wikipedia, "In sociology, habitus consists of socially-ingrained habits, skills, and dispositions. It is the way that individuals perceive the social world around them and react to it. These dispositions are usually shared by people with similar backgrounds (such as social class, religion, nationality, ethnicity, education and profession) and opportunities. Thus, the habitus represents the way group culture and personal history shape the body and the mind; as a result, it shapes the present social actions of an individual." Bourdieu's understanding and use of the concept is specified in his *Outline of a Theory of Practice* (1972) as "the end product of structures which practices tend to reproduce in such a way that the individuals involved are bound to reproduce them, either by consciously reinventing or by subconsciously imitating already proven strategies as the accepted, most respectable, or even simplest course to follow. [They] ... come to be seen as inherent in the nature of things".

Habitus	Open science issues	Levers for institutional action
Co-responsibility, cooperation, emulation	Negative effects of individual and institutional competition, notably in publishing and funding. Transdisciplinarity as aspiration to co-responsibility across professional/lay boundary.	For RPOs, review policies and implicit policy framings with respect to competition vs cooperation, including internally between departments/disciplines. For RFOs, review incentive structures built into funding mechanisms.
Acceptance of uncertainty, risk and complexity	Public understanding of scientific method. Improved communication on uncertainties in scientific results. More sophisticated understandings of risks in public debate, including risks that have no history stemming from new technologies and discoveries. Misinformation.	Review communication procedures/strategies. Consider training and resources available to graduate students and researchers engaging with the public. Consider what role academic institutions should play in fact-checking public debate.
Empathy, kindness, recognition, tolerance	Appropriate working conditions for scientists, including entry conditions and career paths. Discrimination, gender equality. Mutual respect between scientists and laypersons in hybrid research and policy settings.	For RPOs, review employment policies/practices. For RFOs, review structural incentives embedded into funding mechanisms. Review and enhance equity/equality policies. Create training opportunities, encourage institutional learning and exchange of good/bad practices.
Independence of judgement when facing conflicts of interest or values	Transparency with respect to conflicts of interest, particularly as regards funding. Recognition of and sensitivity to ideological bias, notably paradigmatic blindspots.	Ensure existing guidelines are fully applied. Review as required to address blindspots. Develop a proactive training approach to foster take-up and buy-in as opposed to mere compliance. Especially for RFOs, ensure pluralistic engagement in programme design.
Acceptance of failure, trial and error, right to happiness	Making sure research assessment doesn't encourage hype, dissimulation, misconduct. Rethinking expertise to incorporate its necessarily fallible character, notably in forming policy.	Review assessment policies and procedures.
Consistency between words and actions, legibility, compliance with the rules of the game, honesty, authenticity, loyalty	Research integrity. Appropriate conduct in relating to lay stakeholders (including but not limited to human subject ethics, privacy…).	Ensure existing guidelines are fully applied. Review as required to address blindspots. Develop a proactive training approach to foster take-up and buy-in as opposed to mere compliance. Involve stakeholders in research protocol design/validation. Create training opportunities, encourage institutional learning and exchange of good/bad practices.
Timescale: reconciling short/long-term projects, connecting to the past, memory, forgetting, forgiveness	Improved understanding of the science/policy nexus, including the different relations to time between scientists, political leaders, the media / social media.	Awareness-raising and training, making sure knowledge and experience isn't confined to specialised science/policy communities.

8. Conclusions and input to WP2 and WP3

In this section, we summarise the findings that emerged from the literature review on all sub-topics. We then focus on next steps towards developing a framework of indicators/metrics for researcher assessment including Open Science, as well as a framework of interventions to implement the framework in research-performing and research-funding organisations. These next steps feed directly into the activities in OPUS WP2 (leading to Deliverable 2.1 - Interventions to Test in the Pilots - *Rewards and Incentives for Researchers*) and WP3 (leading to Deliverable 3.1 - Indicators and Metrics to Test in the Pilots - *Rewards and Incentives for Researchers*).

8.1 Conclusions from the review

Deliverable 1.2 presents the main findings of the initial state of the art on Open Science (OS) literature. In line with OPUS project objectives, it has considered OS in relation to rewards and incentives, precarity of research careers, gender equality, industry practices, and trust.

The findings of the review will feed directly into the activities of WP2 and WP3, especially on D2.1 on Interventions to Test in the Pilots and D3.1 on Indicators/Metrics to Test in the Pilots (see below in Chapter 8.2 Moving forward).

The literature on **incentives and rewards** has confirmed that the current researcher assessment system is too focused on bibliometrics, involving peer-reviewed publications and citations in top journals. The research community needs a more comprehensive approach of altmetrics, which includes research/non-research, open/closed, and quantitative/qualitative dimensions. The literature shows a wide range of relevant policy developments at international and European/national levels. It also offers proposals for frameworks including principles, guidelines, support, and indicators/metrics to reform researcher assessment that incentivises and rewards OS at research-performing and research-funding organisations.

Concerning **precarity of research careers**, the review did not find literature to answer whether OS has a positive/negative impact on precarity or whether precarity has a positive/negative impact on the uptake of OS. Supporters of OS believe that OS has the potential to improve research careers, if the transition is managed correctly. However, there is currently limited evidence demonstrating the link between these two topics. The review did not reveal specific input for WP2 and WP3, as direct input to a more comprehensive framework of interventions and indicators/metrics for researcher assessment including OS. Further research is needed, potentially taking a longitudinal approach, to assess the interplay between research precarity and OS. For WP2 and WP3, the project partners and key stakeholders may provide further input on this topic.

The literature review found some interesting interplays between OS and **gender equality**. The evidence for OS being a predictor of gender equality is, however, not immediately apparent. This is due to the presence of interrelated factors (such as gender, ethnicity, social status, and career stage) and differences emerging in varied cultural and institutional contexts. Research in the field has mostly addressed the relation between gender equality and the decision to publish in open access. Similar to research precarity, the literature does not provide an unequivocal answer to the relationship between gender equality and OS, and further research could seek to identify determinants and dismantle gender-related barriers to OS. The review has, nevertheless, identified input for WP2 and WP3 on interventions and indicators/metrics, which should go beyond gender equality to include diversity and inclusion. The interventions should be related to institutional procedures (such as human resources management) that could directly or indirectly address issues of gender equality, diversity, and inclusion, as well as increase female participation in OS. The indicators/metrics should incentivise and reward positive interactions between gender equality, diversity, and inclusion issues and OS.

For **industry practices**, the literature review sought to analyse opportunities, benefits, challenges, and concrete actions of OS and Open Innovation (OI) in an industry context. The literature highlights the need for collective action to encourage OS in industry. It identifies challenges to its uptake, related to knowledge, finance/strategy, organisation, collaboration and risk management for commercialisation of knowledge. The literature also points to drivers for openness, which include the potential for innovation, OS as a tool to address market failures and to accelerate commercialisation and the opportunity to access resources. The literature further proposes actions to facilitate OS and OI, which include commitment of management, employee training, academia-industry collaboration and funding. Such approaches will no doubt differ and require tailored approaches between companies. In relation to OPUS WP2 and WP3, the interventions and indicators/metrics should incentivise, support, and reward the free flow of information and collaboration between academia and industry, while at the same time ensuring protection of commercial interests.

The review on **trust** shows that the connection between trust and Open Science is a relatively unexplored topic of research. The literature did, however, provide some insights into the internal (trust among scientists) and external (trust by the public) dimensions of trust in the context of OS. While more research is required, it is reasonable to hypothesise that there is a connection between the trust researchers have in institutions and

procedures versus public trust in science and scientists. Regarding input for WP2 and WP3, the Tree of Trust model should be integrated into the frameworks of interventions and indicators/metrics to develop a trust perspective that can operationalise and measure trust at research-performing and research-funding organisations. It should incentivise and reward researchers directly or indirectly for trust-building activities and outputs driving OS.

8.2 Moving forward

The literature review has provided key input for subsequent OPUS activities in WP2 and WP3 and will feed directly into the development of D2.1 on *Interventions to Test in the Pilots* and D3.1 on *Indicators/Metrics to Test in the Pilots*. The following steps are proposed for the deliverables:

1. Develop a framework of interventions that builds on principles, guidelines, and examples from this review and the review of initiatives also carried out in WP1[147]. The framework will support the implementation of a revised researcher assessment system at research-performing and research-funding organisations;
2. Develop key performance indicators that directly map onto the framework of interventions to monitor the progress of and assess the implementation of the interventions over time at research-performing and research-funding organisations;
3. Develop a comprehensive framework of indicators/metrics for a revised researcher assessment system at research-performing and research-funding organisations that builds on the frameworks for indicators/metrics from the review, that includes research/non-research, open/closed, and quantitative/qualitative dimensions, and that incentivises and rewards researchers for Open Science activities and outputs;
4. Integrate relevant existing and planned interventions and indicators/metrics at the three pilot research-performing and two pilot research-funding organisations that have been collected in a detailed questionnaire to the pilots into the two frameworks;
5. Collect feedback from all project partners, especially the pilot organisations, on the first draft of the two frameworks and revise the two frameworks into a second draft;
6. Collect feedback from the members of the Advisory Board on the second main draft of the two frameworks and revise the two frameworks to finalise D2.1 and D3.1.

The two deliverables will form the basis for discussions with the pilot organisations, in order to identify which interventions and indicators/metrics they intend to implement in the pilots. They will prepare the benchmarking for monitoring, as well as the monitoring of implementation in the pilots. The deliverables will also form the basis for public consultation, whereby key stakeholder organisations and the research community will be invited to provide feedback on the two frameworks. This feedback will be analysed and integrated into further revisions of the frameworks and ensure both community involvement and buy-in of the final frameworks.

[147] Deliverable D.1.1 State of the Art on Open Science Initiatives, was prepared in parallel to D1.2 and provides an overview of a review of framework projects, networks/organisations and schemes.

9. Annexes

Annexe 1 –Articles reviewed for Incentives and Rewards

The full bibliography of articles reviewed for Incentives and Rewards is available below.

Authors	Title	Year	DOI or Link
Bradshaw C.J.A., Chalker J.M., Crabtree S.A., Eijkelkamp B.A., Long J.A., Smith J.R., et al.	A fairer way to compare researchers at any career stage and in any discipline using open-access citation data	2021	https://doi.org/10.1371/journal.pone.0257141
Bonn N.A., Pinxten W.	Advancing science or advancing careers? Researchers' opinions on success indicators	2021	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0243664
Adams J.	Assessing faculty performance for merit: An academic accomplishment index	2003	https://journals.sagepub.com/doi/10.1177/107769580305800303
Moed H.F.	Assessment and support of emerging research groups	2018	https://academic.oup.com/femsle/article/365/17/fny189/5062790
Ochsner M., Hug S.E., Daniel H.-D.	Assessment criteria for early career researcher's proposals in the humanities	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85036622194&partnerID=40&md5=e40a2eee433059e8b3e39d1ad47c2240
Vergoulis T., Chatzopoulos S., Vichos K., Kanellos I., Mannocci A., Manola N., Manghi P.	BIP! scholar: A service to facilitate fair researcher assessment	2022	https://dl.acm.org/doi/10.1145/3529372.3533296
Ignat T., Ayris P.	Built to last! Embedding open science principles and practice into European universities	2021	https://insights.uksg.org/articles/10.1629/uksg.501
Kelli A., Mets T., Vider K., Värv A.G.E., Jonsson L., Lindén K., Birštonas R.	Challenges of transformation of research data into open data: The perspective of social sciences and humanities	2018	https://intellectdiscover.com/content/journals/10.1386/tmsd.17.3.227_1
Lundwall R.A.	Changing institutional incentives to foster sound scientific practices: One department	2019	https://pubmed.ncbi.nlm.nih.gov/30933839/
Schmidt R., Curry S., Hatch A.	Research Culture: Creating SPACE to evolve academic assessment	2021	https://elifesciences.org/articles/70929
Hasani S., Stefanova E., Georgiev A., Stefanov K.	Current State of Open Science in Balkan Universities	2020	https://ieeexplore.ieee.org/document/9311337
Kim J., Hwang M., Jeong D.-H., Song S.-K., Gim J., Jung H., Xu S., Zhu L.	Diverse heterogeneous information source-based researcher evaluation model for research performance measurement	2014	https://doi.org/10.1007/978-3-642-40675-1_40

Holst M.R., Faust A., Strech D.	Do German university medical centres promote robust and transparent research? A cross-sectional study of institutional policies	2022	https://health-policy-systems.biomedcentral.com/articles/10.1186/s12961-022-00841-2
González-Teruel A., López-Borrull A., Santos-Hermosa G., Abad-García F., Ollé C., Serrano-Vicente R.	Drivers and barriers in the transition to open science: the perspective of stakeholders in the Spanish scientific community	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85138920274&doi=10.3145%2fepi.2022.may.05&partnerID=40&md5=e3b4b44edf9ddb524524d96dbc83b795
Allen C., Mehler D.M.A.	Correction: Open science challenges, benefits and tips in early career and beyond	2019	https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3000587
Dorta-González M.I., Dorta-González P.	Evaluation of the research career through the citation distribution: An application to the Nobel prizes in Economics [Evaluación de la trayectoria investigadora a través de la distribución de citas: Una aplicación a los Nobel de Economía]	2011	https://revistas.ucm.es/index.php/RGID/article/view/37431
Küsters U., Klages T.	Fostering Open Science at Fraunhofer	2019	10.1016/j.procs.2019.01.078
de Herde V., Björnmalm M., Susi T.	Game over: Empower early career researchers to improve research quality	2021	https://insights.uksg.org/articles/10.1629/uksg.548
Anger M., Wendelborn C., Winkler E.C., Schickhardt C.	Neither carrots nor sticks? Challenges surrounding data sharing from the perspective of research funding agencies-A qualitative expert interview study	2022	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0273259
Harnad, S.	Open Access Scientometrics and the UK Research Assessment Exercise	2007	http://issi2007.cindoc.csic.es/
Heck T.	Open science and the future of metrics	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85109653106&doi=10.1515%2f9783110646610-046&partnerID=40&md5=c3207403be6f52adcf0e7f4e79366261
von Mayer K.	Open science needs open infrastructures. On the discussion of the results of the european mutual learning exercise. open science – altmetrics and rewards [offene wissenschaft braucht offene infrastrukturen. Zur diskussion der ergebnisse der europäischen mutual learning exercise: open science – altmetrics and rewards]	2019	https://journals.univie.ac.at/index.php/voebm/article/view/3175
Papastefanatos G., Papadopoulou E., Meimaris M., Lempesis A., Martziou S., Manghi P., Manola N.	Open Science Observatory: Monitoring Open Science in Europe	2020	https://link.springer.com/chapter/10.1007/978-3-030-55814-7_29

Kuprienė J., Petrauskienė Ž.	Opening science with institutional repository: A case study of Vilnius University Library	2018	https://liberquarterly.eu/article/view/10825
Bracco L.	Promoting Open Science through Bibliometrics: A Practical Guide to Building an Open Access Monitor	2022	https://liberquarterly.eu/article/view/11545
Robson S.G., Baum M.A., Beaudry J.L., Beitner J., Brohmer H., Chin J.M., Jasko K., Kouros C.D., Laukkonen R.E., Moreau D., Searston R.A., Slagter H.A., Steffens N.K., Tangen J.M., Thomas A.	Promoting open science: A holistic approach to changing behaviour	2021	https://online.ucpress.edu/collabra/article/7/1/30137/119214/Promoting-Open-Science-A-Holistic-Approach-to
Hood A.S.C., Sutherland W.J.	The data-index: An author-level metric that values impactful data and incentivizes data sharing	2021	https://onlinelibrary.wiley.com/doi/full/10.1002/ece3.8126
Bardi A., Casarosa V., Manghi P.	The European project openUP: OPENing UP new methods, indicators and tools for peer review, impact measurement and dissemination of research results	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85041863443&doi=10.1007%2f978-3-319-73165-0_24&partnerID=40&md5=07cd495ec711b6bb3097e6cfad286abd
Schöpfel J., Prost H.	The scope of open science monitoring and grey literature	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85079048844&partnerID=40&md5=d3a29d62f04a50ef2919a44b07e89bb8
Dorta-González P., González-Betancor S.M., Dorta-González M.I.	To what extent is researchers' data-sharing motivated by formal mechanisms of recognition and credit?	2021	https://ideas.repec.org/a/spr/scient/v126y2021i3d10.1007_s11192-021-03869-3.html
Ross-Hellauer T., Klebel, T., Knoth P., Pontika N.	Value dissonance in research(er) assessment: Individual and institutional priorities in review, promotion and tenure criteria	2023	https://osf.io/preprints/socarxiv/dcr8v/
Kowalczyk O.S., Lautarescu A., Blok E., Dall'Aglio L., Westwood S.J.	What senior academics can do to support reproducible and open research: a short, three-step guide	2022	https://bmcresnotes.biomedcentral.com/articles/10.1186/s13104-022-05999-0
Cruz-Castro L., Sanz-Menendez L.	What should be rewarded? Gender and evaluation criteria for tenure and promotion	2021	https://www.sciencedirect.com/science/article/pii/S1751157721000675

Additional core articles identified by partners			
Overlaet, B.	A Pathway towards Multidemensional Academic Careers	2022	https://www.leru.org/files/Publications/LERU_PositionPaper_Framework-for-the-Assessment-of-Researchers.pdf
Science Europe	Agreement on Reforming Research Assessment	2022	https://www.scienceeurope.org/media/y41ks1wh/20220720-rra-agreement.pdf
Hicks D., Wouters P., Waltman L., de Rijcke S., Rafols I.	Bibliometrics. The Leiden Manifesto for Research Metrics	2015	https://www.nature.com/articles/520429a
European Council	Council Conclusions on Research Assessment and Implementation of Open Science. Conclusions adopted by the European Council at European Council Meeting 3877 in June 2022.	2022	https://www.consilium.europa.eu/media/56958/st10126-en22.pdf
European Commission	European Charter for Researchers and The Code of Conduct for the Recruitment of Researchers	2005	https://euraxess.ec.europa.eu/sites/default/files/am509774cee_en_e4.pdf
European Commission	Evaluation of Research Careers Fully Acknowledging Open Science Practices	2017	https://op.europa.eu/en/publication-detail/-/publication/47a3a330-c9cb-11e7-8e69-01aa75ed71a1
Moher, D., Bouter, L., Kleinert, S., Glasziou, P., Sham, M., Barbour, V., Coriat, A., Foeger, N., and Dirnagl, U.	Hong Kong Principles for Assessing Researchers. Fostering Research Integrity. Plos Biology 18(7), e3000737	2020	https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3000737
European Commission	Indicator Frameworks for Fostering Open Knowledge Practices in Science and Scholarship	2019	https://op.europa.eu/en/publication-detail/-/publication/b69944d4-01f3-11ea-8c1f-01aa75ed71a1
European Commission	Knowledge Ecosystems in the New ERA. Talent Circulation and Intersectoral Mobility. Pathways for a Balanced Talent Circulation in EU	2022	https://op.europa.eu/en/publication-detail/-/publication/8d536780-3025-11ed-975d-01aa75ed71a1#
European Commission	Knowledge Ecosystems in the New ERA. Talent Circulation and Intersectoral Mobility. Update of Intersectoral Mobility Schemes	2022	https://op.europa.eu/en/publication-detail/-/publication/94a6a2ca-00c1-11ed-b94a-01aa75ed71a1/language-en#
European Commission	Knowledge Ecosystems in the New ERA. Using a Competence-based Approach for Career Development in Academia and Beyond	2022	https://op.europa.eu/en/publication-detail/-/publication/8d536780-3025-11ed-975d-01aa75ed71a1#
European Commission	Mutual Learning Exercise. Open Science. Altmetrics and Rewards	2018	https://ec.europa.eu/research-and-innovation/sites/default/files/rio/report/MLE%2520OS_Final%2520Report_0.pdf
European Commission	Next-generation Metrics. Responsible Metrics and Evaluation for Open Science	2017	https://op.europa.eu/en/publication-detail/-/publication/b858d952-0a19-11e7-8a35-01aa75ed71a1/language-en

Universities Norway	NORCAM. A Toolbox for Assessment and Rewards	2022	https://www.uhr.no/en/_f/p3/i86e9ec84-3b3d-48ce-8167-bbae0f507ce8/nor-cam-a-tool-box-for-assessment-and-rewards.pdf
European Commission	Progress on Open Science. Towards a Shared Research Knowledge System. Final Report of the Open Science Policy Platform	2020	https://op.europa.eu/en/publication-detail/-/publication/d36f8071-99bd-11ea-aac4-01aa75ed71a1#
European Commission	Providing Researchers with the Skills and Competencies they Need to Practise Open Science	2017	https://op.europa.eu/en/publication-detail/-/publication/3b4e1847-c9ca-11e7-8e69-01aa75ed71a1
European Research Area and Innovation Committee	Research Evaluation in a Context of Open Science and Gender Equality. Triangle Task Force Guideline Paper	2021	https://data.consilium.europa.eu/doc/document/ST-1201-2021-INIT/en/pdf
Vitae	Researcher Development Framework	2010	https://www.vitae.ac.uk/vitae-publications/rdf-related/researcher-development-framework-rdf-vitae.pdf/@@download/file/Researcher-Development-Framework-RDF-Vitae.pdf
Lima G., Bowman S.	Researcher Impact Framework. Building Audience-Focused Evidence-Based Impact Narratives	2022	http://www.tara.tcd.ie/bitstream/handle/2262/98474/LimaG_BowmanS_ResearcherImpactFramework_Oct2022.pdf?sequence=9&isAllowed=y
Universities of the Netherlands, NFU, KNAW, NWO and ZonMw	Room for Everyone's Talent. Towards a New Balance in the Recognition and Rewards for Academics	2019	https://www.universiteitenvannederland.nl/recognitionandrewards/wp-content/uploads/2019/11/Position-paper-Room-for-everyone's-talent.pdf
DORA	San Francisco Declaration on Research Assessment	2012	https://sfdora.org/read/
European Commission	Technical Document on a European Framework for Research Careers. Unpublished document for ERAC Plenary Meeting in February 2023	2023	N/A
Whittle M., Rampton J.	Towards a 2030 Vision on the Future of Universities	2020	https://research-and-innovation.ec.europa.eu/document/download/4744958f-4269-472d-8f19-a253c665897d_en
UNESCO	UNESCO Recommendation on Open Science	2021	https://unesdoc.unesco.org/ark:/48223/pf0000379949.locale=en
UNESCO	UNESCO Recommendation on Science and Scientific Researchers	2017	https://unesdoc.unesco.org/ark:/48223/pf0000260889.page=116

Annexe 2 – Articles reviewed for Precarity

The full bibliography of articles reviewed for Precarity is available below.

Authors	Title	Year	DOI or Link
Mula J., Rodríguez C.L., Domingo Segovia J., Cruz-González C.	Early career researchers' identity: A qualitative review	2022	https://onlinelibrary.wiley.com/doi/full/10.1111/hequ.12348
Pownall M., Talbot C.V., Henschel A., Lautarescu A., Lloyd K.E., Hartmann H., Darda K.M., Tang K.T.Y., Carmichael-Murphy P., Siegel J.A.	Navigating Open Science as Early Career Feminist Researchers	2021	https://journals.sagepub.com/doi/10.1177/03616843211029255
Herschberg C., Benschop Y., van den Brink M.	Precarious postdocs: A comparative study on recruitment and selection of early-career researchers	2018	https://www.sciencedirect.com/science/article/pii/S095652211830040X
University and College Union, UK	Precarious work in higher education	2019	https://www.ucu.org.uk/heprecarity
Initiative for Science in Europe	ISE paper on precarity of academic careers	2020	https://initiative-se.eu/precarity-paper-2021/
OECD report	Reducing the precarity of academic research careers	2021	https://www.oecd.org/publications/reducing-the-precarity-of-academic-research-careers-0f8bd468-en.htm
ReMO Cost Action	Researcher Mental Health and Well-being Manifesto	2021	https://zenodo.org/record/5559806#.Y34pGi9Xb0o
Guy Standing	The Precariat	2014	https://journals.sagepub.com/doi/full/10.1177/1536504214558209
MCAA & Eurodoc	Declaration on Sustainable Researcher Careers	2019	https://zenodo.org/record/3082245#.Y9fAYy9Xb0o
Natalia N. Voronina, Artem M. Feigelman	Towards Open Science: The Precariat as a Subject of Scientific Creativity	2022	https://www.pdcnet.org/eps/content/eps_2022_0059_0003_0046_0054
ICoRSA	Position Statement on sustainability of research careers and precarity	2022	https://icorsa.org/wp-content/uploads/2022/09/Position-Statement-on-sustainability-of-research-careers-and-precarity_ICoRSA.pdf
CRAC-Vitae	Do researchers' careers have to be precarious?	2019	https://www.vitae.ac.uk/impact-and-evaluation/what-do-researchers-do/do-researchers-careers-have-to-be-precarious-research-article.pdf/view
Extended list - not directly relevant to Open Science			
Arday J.	'More to prove and more to lose': race, racism and precarious employment in higher education	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85131598134&doi=10.1080%2f01425692.2022.2074375&partnerID=40&md5=50a75ea3b2df20b61ea58066bdb22713

O'Keefe T., Courtois A.	'Not one of the family': Gender and precarious work in the neoliberal university	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85063376700&doi=10.1111%2fgwao.12346&partnerID=40&md5=3b751c33c0fb23d7df8e4efabaf491e3
Allmer T.	"I am a single mum. I don't feel like I can be as competitive as other people": Experiences of precariously employed staff at UK universities [«Sono una madre single. Non sento di poter essere competitiva quanto altri»: Esperienze di personale precario nelle università del Regno Unito]	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85080865211&doi=10.24434%2fj.scoms.2019.02.004&partnerID=40&md5=a8b5bf24208856cbb3217c710b2cfb9b
Stringer R., Smith D., Spronken-Smith R., Wilson C.	"My entire career has been fixed term": Gender and precarious academic employment at a New Zealand university	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85068436312&partnerID=40&md5=94e4cf16ed9f89b20e10787515125b2e
Portacolone E.	A framework to identify precarity in the social sciences: Insights from qualitative research	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85126074374&partnerID=40&md5=c7f903cbb93841a9733da1e2bd331118
Gil-Juárez A.	A tale of two subjectivities: An academic life story	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85075570264&doi=10.3390%2fsocsci8100267&partnerID=40&md5=cee853868c2b4b2587d11dcbfdc381db
Villar-Aguilés A., Obiol-Francés S.	Academic career, gender and neoliberal university in Spain: the silent precariousness between publishing and care-giving	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85133234443&doi=10.1080%2f01425692.2022.2042194&partnerID=40&md5=e4adf972c10129ee1ce4a671eb83c523
Aarrevaara T., Dobson I.R.	Academics under pressure: Fear and loathing in finnish universities?	2015	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84944097525&doi=10.1007%2f978-3-319-16080-1_11&partnerID=40&md5=339d327bc31513ea4cd73fb075d16bfe
Gill R.	Academics, Cultural Workers and Critical Labour Studies	2014	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84890857969&doi=10.1080%2f17530350.2013.861763&partnerID=40&md5=cd7f2e64dd19e8154d95c10106927276
Conesa Carpintero E., González Ramos A.M.	Accelerated researchers: Psychosocial risks in gendered institutions in academia	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85050264746&doi=10.3389%2ffpsyg.2018.01077&partnerID=40&md5=79ac798a408e0d12684b55af0e55ef71
Roxå T., Mårtensson K.	Agency and structure in academic development practices: are we liberating academic teachers or are we part of a machinery supressing them?	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84983233448&doi=10.1080%2f1360144X.2016.1218883&partnerID=40&md5=df2bb8db50f1a47da5a321cc31c39ebf
Frei I., Grund C.	Antecedents of overtime work: The case of junior academics	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85079423391&doi=10.1177%2f2397002220903247&partnerID=40&md5=ee6967039d57e184c8e2ec372042372b

Spina N., Smithers K., Harris J., Mewburn I.	Back to zero? Precarious employment in academia amongst 'older' early career researchers, a life-course approach	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85133283995&doi=10.1080%2f01425692.2022.2057925&partnerID=40&md5=e6519d1f5bd87e1702b55063182e4c1f
Swidler E.	Can the adjunct speak?: Precarity and academic unfreedom	2016	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85014959842&partnerID=40&md5=eb21bbb0d14cc053dfd9257a747f64cd
Santos G.G.	Career barriers influencing career success: A focus on academics' perceptions and experiences	2016	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84953931731&doi=10.1108%2fCDI-03-2015-0035&partnerID=40&md5=be59bde7de2ef60c362c7d5cf1be4653
McComb V., Eather N., Imig S.	Casual academic staff experiences in higher education: insights for academic development	2021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85091884275&doi=10.1080%2f1360144X.2020.1827259&partnerID=40&md5=10997a8f12dcbc17e766b6f552dbd625
Pavlin S., Sušanj Z.	Challenges in developing the academic profession in the Western Balkans	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85134976254&doi=10.1111%2fejed.12427&partnerID=40&md5=51798f32738a1b593bcc4dd9e03123b0
Barrett E., Bosse A.J.	Community geography for precarious researchers: examining the intricacies of mutually beneficial and co-produced knowledge	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85099797553&doi=10.1007%2fs10708-020-10358-2&partnerID=40&md5=53d06e73fbe84a663a50e1661ad3e108
Mulligan D.L., Danaher P.A.	Conceptualising Researchers' Risks and Synthesising Strategies for Engaging with Those Risks: Articulating an Agenda for Apprehending Scholars' Precarious Positions	2021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85099258174&doi=10.1007%2f978-3-030-53857-6_1&partnerID=40&md5=5e117274cc48b55a2677f9174cfa5a0c
Schwaller C.	Crisis, austerity and the normalisation of precarity in Spain – in academia and beyond	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85076755885&doi=10.1111%2f1469-8676.12691&partnerID=40&md5=72810a943fd0d530c0afbd98ff7ea927
Mulligan D.L.	Dangerous Decisions: The Precarity of Real-World Research—A Provocation	2021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85099248371&doi=10.1007%2f978-3-030-53857-6_20&partnerID=40&md5=cab44e520f2454466fb0641895244879
Enright B., Facer K.	Developing Reflexive identities through collaborative, interdisciplinary and precarious work: the experience of early career researchers	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84978069290&doi=10.1080%2f14767724.2016.1199319&partnerID=40&md5=ecc9cfff2e6de02b09e3514ef34785bb
Harris J., Smithers K., Spina N., Heffernan T.	Disrupting dominant discourses of the Other: examining experiences of contract researchers in the academy	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85135030538&doi=10.1080%2f03075079.2022.2105831&partnerID=40&md5=2be8902b2936debb612c1aced3ba44e1

Rao N., Hosein A., Raaper R.	Doctoral students navigating the borderlands of academic teaching in an era of precarity	2021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85102246751&doi=10.1080%2f13562517.2021.1892058&partnerID=40&md5=fbe2ce1aa3497a9626e724a56ac885a4
Nicholas D., Rodríguez-Bravo B., Watkinson A., Boukacem-Zeghmouri C., Herman E., Xu J., Abrizah A., Świgoń M.	Early career researchers and their publishing and authorship practices	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85016589095&doi=10.1002%2fleap.1102&partnerID=40&md5=ad9d4c64d5fa6d4b8cb8335b217ad836
Butler-Rees A., Robinson N.	Encountering precarity, uncertainty and everyday anxiety as part of the postgraduate research journey	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85094206422&doi=10.1016%2fj.emospa.2020.100743&partnerID=40&md5=f719f658bdbfbfea59415a4d9c4c75ce
Touhouliotis V.	Enforcing precarity: Bureaucratic machinations, complicity and hierarchies of academic lives	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85051958596&doi=10.3989%2frdtp.2018.01.001.04&partnerID=40&md5=7dd7a75c94ac1e957a81e9ceb6bf5c98
Jovanović D.	Engaging with precarity: The fatiguing job-seeking journey of an early career anthropologist	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85052001394&doi=10.3989%2frdtp.2018.01.001.03&partnerID=40&md5=377cddb26393c8c2d92c60f233eb5fb8
Smithers K., Harris J., Goff M., Spina N., Bailey S.	Ethical responsibilities of tenured academics supervising non-tenured researchers in times of neoliberalism and precarity	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85100562230&doi=10.1080%2f00220620.2021.1881458&partnerID=40&md5=33958c6a9f7bf33eba3701bcdc4bbc94
Mauri C.	Formulating the academic precariat	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85073865509&doi=10.4324%2f9780429465857-11&partnerID=40&md5=142f4ffec93ec80a07819607fcac0e61
Hofmann S.	Fragmented life: Being a precarious academic between two continents	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85051942277&doi=10.3989%2frdtp.2018.01.001.02&partnerID=40&md5=92702f517dfc24117ff1923466d662eb
Davi H., Modicom P.-Y., Durand J.-L., Eldin C.	How has neoliberalism weakened science?	2021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85122102865&doi=10.1051%2fnss%2f2021053&partnerID=40&md5=b350bd1038cd71dc752b711154206249
Rogler C.R.	Insatiable greed: performance pressure and precarity in the neoliberalised university	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85076736250&doi=10.1111%2f1469-8676.12689&partnerID=40&md5=3e06611023806b9024332098b94c9651
Carvalho T., Diogo S., Vilhena B.	Invisible researchers in the knowledge society–the Uberisation of scientific work in Portugal	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85135252752&doi=10.1080%2f21568235.2022.2105371&partnerID=40&md5=84389ae4a441d40cc6ee0ac09554cf9c
Bell S., May R.	Ladders of opportunity: Postgraduate equity, professions and the academic workforce	2016	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84978194847&doi=10.1007%2f978-981-10-0315-8_14&partnerID=40&md5=3d0e761b42aeee06786be2db936bf413

Papoulias S.C., Callard F.	Material and epistemic precarity: It's time to talk about labour exploitation in mental health research	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85132693484&doi=10.1016%2fj.socscimed.2022.115102&partnerID=40&md5=ed3fe5a590814f0c3a3416cf77e112b5
Feldman Z., Sandoval M.	Metric power and the academic self: Neoliberalism, knowledge and resistance in the british university	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85041739514&doi=10.31269%2fvol16iss1pp214-233&partnerID=40&md5=d4fbc1d2302186b975bdb7aac5152df6
Artamonova Y.D., Demchuk A.L., Karneyev A.N., Safonova V.V.	Modern strategies for the development of science and researchers training: International experience	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85062457797&partnerID=40&md5=50779757e94417ce4b419d1c4c68b046
Carpintero E.C., González Ramos A.M.	New managerialism and austerity in the Spanish and European academic context. Two sides of the same coin? [Neo-gerencialismo y austeridad en el contexto académico español y europeo. ¿Dos caras de la misma moneda?]	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85047440242&doi=10.5209%2fPOSO.55883&partnerID=40&md5=8c7c21d09c25ca4b8b45431602d2f2be
Steinþórsdóttir F.S., Brorsen Smidt T., Pétursdóttir G.M., Einarsdóttir Þ., Le Feuvre N.	New managerialism in the academy: Gender bias and precarity	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85052661183&doi=10.1111%2fgwao.12286&partnerID=40&md5=fa1dacec98451ed0018359ed3bdef743
Ma L.	No metrics for postdocs: Precarious labour in science policy	2021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85112615968&partnerID=40&md5=d0dd4f08457ccbcff8acc1640f55cf98
Antonucci L.	Not all experiences of precarious work lead to precarity: the case study of young people at university and their welfare mixes	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85049573683&doi=10.1080%2f13676261.2017.1421749&partnerID=40&md5=5afd2730e24bf7d2d25168579a63b389
Sigl L.	On the Tacit Governance of Research by Uncertainty: How Early Stage Researchers Contribute to the Governance of Life Science Research	2016	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84962185176&doi=10.1177%2f0162243915599069&partnerID=40&md5=92603547f5bdf9de5f7e875b8380b918
Gannon S., Powell S., Power C.	On the Thresholds of Legitimacy: A Collaborative Exploration of Being and Becoming Academic	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85065837136&doi=10.1007%2f978-3-319-64224-6_12&partnerID=40&md5=b2939534fb7383c70151723a5f6b6de9
Stoleroff A.D., Vicente M.A.	Performance assessment and change in the academic profession in Portugal	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85064733526&doi=10.7577%2fpp.2291&partnerID=40&md5=b4c2c201354c843479468cbae69e0d93
Nititham D.S.	Positionalities of Precarity An Autoethnography of "Making It" in the Neoliberal Academy	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85135465703&doi=10.1525%2fjoae.2022.3.1.38&partnerID=40&md5=07e44c00e59dae3c7add734e4465c9c4
Sutherland K.A.	Precarious but connected: the roles and identities of academic developers	2015	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84938389643&doi=10.1080%2f1360144X.2015.1066343&partnerID=40&md5=88cda9657031ca02daa580e2a4da8250

Álvarez Pérez X.A.	Precarious researchers and movements in Spain [La Precariedad en la investigación española]	2009	https://www.scopus.com/inward/record.uri?eid=2-s2.0-67249136195&partnerID=40&md5=2a45d6bcc0d634a66aee7f5264bbf94f
Biner Z.Ö.	Precarious solidarities: 'poisonous knowledge' and the Academics for Peace in times of authoritarianism	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85076779548&doi=10.1111%2f1469-8676.12701&partnerID=40&md5=40138a7d2432b0ffc969d55fa6824cf3
Bloemraad I., Menjívar C.	Precarious Times, Professional Tensions: The Ethics of Migration Research and the Drive for Scientific Accountability	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85107058029&doi=10.1177%2f01979183211014455&partnerID=40&md5=9fe3697dfef46f20e436eef45e8c6cfb
Allmer T.	Precarious, always-on and flexible: A case study of academics as information workers	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85041727387&doi=10.1177%2f0267323118783794&partnerID=40&md5=c955d7ff22fccbbabda154b491be7695
Mason O., Megoran N.	Precarity and dehumanisation in higher education	2021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85109968290&doi=10.3167%2flatiss.2021.140103&partnerID=40&md5=e9abf88ae02765d784dfde21f476b19b
Courtois A., O'Keefe T.	Precarity in the ivory cage: Neoliberalism and casualisation of work in the Irish higher education sector	2015	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84940758203&partnerID=40&md5=4c130f25113e4c9423f79cf614196eec
Zheng R.	Precarity is a Feminist Issue: Gender and Contingent Labor in the Academy	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85042553151&doi=10.1111%2fhypa.12401&partnerID=40&md5=e2549b623bb4831ffa13063de6f4f412
Ivancheva M., Lynch K., Keating K.	Precarity, gender and care in the neoliberal academy	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85063402823&doi=10.1111%2fgwao.12350&partnerID=40&md5=b45e2ce0890141dc69ff61b39acfd221
Ahmed N., Baker A.G., Bhattacharya A., Cawood S., Cabrera Pacheco A.J., Daniel M.M., Grandi M., Grimaldo-Rodríguez C.O., Guma P.K., Habermehl V., Higgins K., Lata L.N., Liu M., Luederitz C., Macktoom S., Macrorie R., Melgaço L., Morales I., Noterman E., Owen G., Oyalowo B., Purvis B., Robin E., Sawyer L., Terruhn J., Unnikrishnan H., Verbeek T., Villegas C., Westman L., Urban ECA Collective	Redefining the role of urban studies Early Career Academics in the post-COVID-19 university	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85134254463&doi=10.1080%2f13604813.2022.2091826&partnerID=40&md5=891360c2bea7e9d99a97d4e704c26d0a

Castiel L.D., Sanz-Valero J.	Scientific policy: To handle the precariousness of excesses and to denaturalize the omnipotent "publicationalist" ideology [Política científica: Manejar la precariedad de los excesos y desnaturalizar la ideología "publicacionista" todopoderosa]	2009	https://www.scopus.com/inward/record.uri?eid=2-s2.0-68549090615&doi=10.18294%2fsc.2009.227&partnerID=40&md5=5fe3124e337f3de1e52a4d0d22ace2a6
Astashova N.D.	Scientific Precariat: Individualism Versus Collectivism [НАУЧНЫЙ ПРЕКАРИАТ: ИНДИВИДУАЛИЗМ ПРОТИВ КОЛЛЕКТИВИЗМА]	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85139192515&doi=10.5840%2fEPS202259337&partnerID=40&md5=e95eae9056e209fc8f2c8ab9f68b6147
Ferri D., Murgia A.	Senza limiti, ma con passione. Senza riconoscimento, ma con ottimismo. Lavorare con un assegno di ricerca nell'università italiana	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85018161589&doi=10.3280%2fSL2017-145011&partnerID=40&md5=37d6d57af7b6af2cca5f99a190632499
Pavlin S.	Should higher education institutions worry about the precarisation of professional work?	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85060671188&doi=10.19233%2fASHS.2018.52&partnerID=40&md5=d7cabc5a673285c8e293b997c1b4d192
Bataille P., Le Feuvre N., Kradolfer Morales S.	Should I stay or should I go? The effects of precariousness on the gendered career aspirations of postdocs in Switzerland	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85019646455&doi=10.1177%2f1474904116673372&partnerID=40&md5=7703fb463a041212c528265b11c145e0
Lenk K., Gleirscher M., Nestler S., Rödiger S., Petersen T., Loebel J.-M.	Situation and future of junior scientists: A statement of the Advisory Board for Junior Scientific Staff (WiN) of the German Informatics Society (GI e.V.) [Lage und Zukunft des wissenschaftlichen Nachwuchses: Eine Stellungnahme des Beirats des Wissenschaftlichen Nachwuchses (WiN) der Gesellschaft für Informatik (GI e. V.)]	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85080076017&doi=10.1007%2fs00287-020-01250-x&partnerID=40&md5=98b38c2c56e0bba8a678bf7d1323abf2
Wysocki L.	Strike comics: Representing the inequities and absurdities of academic precarity	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85138110614&doi=10.4324%2f9781003225669-22&partnerID=40&md5=5a5580938655016fa9f07ee31bbdc461
Menard C.B., Shinton S.	The career paths of researchers in long-term employment on short-term contracts: Case study from a UK university	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85137665812&doi=10.1371%2fjournal.pone.0274486&partnerID=40&md5=48e077f256cb40960ff63e397b71d445
Deem R.	The Early Stage Academic and the contemporary university: communities of practice versus new managerialism	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85137441954&doi=10.4337%2f9781839102639.00041&partnerID=40&md5=0c03c3c9602be7135120f46b8c5482ea
Aubert Bonn N., De Vries R.G., Pinxten W.	The failure of success: four lessons learned in five years of research on research integrity and research assessments	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85138735731&doi=10.1186%2fs13104-022-06191-0&partnerID=40&md5=39b23a499dd31c384bcf7980b2e51f6d

Vatansever A.	The Making of the Academic Precariat: Labour Activism and Collective Identity-Formation among Precarious Researchers in Germany	2022	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85126246630&doi=10.1177%2f09500170211069830&partnerID=40&md5=da60276bbfc7e0cdfcaa3826963d4581
Muntaner C.	The missing link in precariousness research	2016	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84975303514&doi=10.1590%2f0102-311XCO060516&partnerID=40&md5=7ae26389e9ec369874327dccc9e2daf2
Pérez M., Montoya A.	The unsustainability of the neoliberal public university: Towards an ethnography of precarity in academia	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85052004704&doi=10.3989%2frdtp.2018.01.001.01&partnerID=40&md5=7c7be9b71459822288d27eb559e7cab6
Read B., Leathwood C.	Tomorrow's a mystery: constructions of the future and 'un/becoming' amongst 'early' and 'late' career academics	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85045031574&doi=10.1080%2f09620214.2018.1453307&partnerID=40&md5=a75ca0a06cebd7df6a020f20aade1fd5
Blackham A.	Unpacking precarious academic work in legal education	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85079395119&doi=10.1080%2f03069400.2020.1714276&partnerID=40&md5=bf2cb0938647e877afd9b501e166af08
Bataille P., Sautier M.	What Being a postdoc Entails: Postdoctoral pathways in Switzerland in around 2010 [Ce « qu'être postdoc» veut dire. Cheminements postdoctoraux en Suisse, circa 2010]	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85075625353&doi=10.4000%2fphilosophiascientiae.2048&partnerID=40&md5=154fbf59d64545327a33d3972085e8d5
Bozzon R., Murgia A., Poggio B., Rapetti E.	Work–life interferences in the early stages of academic careers: The case of precarious researchers in Italy	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85019631366&doi=10.1177%2f1474904116669364&partnerID=40&md5=bb48a755debc3c6d11b2ce260c92c312

Annexe 3 – Articles reviewed for Gender

The full bibliography of articles reviewed for Gender is available below.

Authors	Title	Year	DOI or Link
Brabeck, M. M.	Open Science and Feminist Ethics: Promises and Challenges of Open Access.	2021	https://doi.org/10.1177/03616843211030926
Brown, J. V. E., Crampton, P. E. S., Finn, G. M., & Morgan, J. E.	From the sticky floor to the glass ceiling and everything in between: Protocol for a systematic review of barriers and facilitators to clinical academic careers and interventions to address these, with a focus on gender inequality. Systematic Reviews, 9(1)	2020	https://doi.org/10.1177/03616843211032632
Gervais, S. J., Baildon, A. E., & Lorenz, T. K.	On Methods and Marshmallows: A Roadmap for Science That Is Openly Feminist and Radically Open. Psychology of Women Quarterly, 45(4), 430–447	2021	https://doi.org/10.1177/03616843211032632
Kinkorová, J.	Horizon Europe, research and innovation programme until 2027 – what is new comparing with Horizon 2020? | Horizont Evropa, rámcový program Evropské komise na období 2021–2027 – novinky ve srovnání s programem Horizont 2020. Casopis Lekaru Ceskych, 161(3–4), 163–166.	2022	https://pubmed.ncbi.nlm.nih.gov/36100458/
Kirtley, O. J.	Advancing credibility in longitudinal research by implementing open science practices: Opportunities, practical examples, and challenges. Infant and Child Development, 31(1)	2022	https://doi.org/10.1002/icd.2302
Lakomy, M., Hlavova, R., MacHackova, H., Bohlin, G., Lindholm, M., Berter, M. G., & Dettenhofer, M.	The motivation for citizens' involvement in life sciences research is predicted by age and gender. PLoS ONE, 15(8 August)	2020	https://doi.org/10.1371/journal.pone.0237140
Monsonís-Payá, I., García-Melón, M., & Lozano, J.-F.	Indicators for responsible research and innovation: A methodological proposal for context-based weighting. Sustainability (Switzerland), 9(12)	2017	https://doi.org/10.3390/su9122168
Nguyen, H. T. T., Nguyen, M.-H., Le, T.-T., Ho, M.-T., & Vuong, Q.-H.	Open access publishing probabilities based on gender and authorship structures in Vietnam. Publications, 9(4).	2021	https://doi.org/10.3390/publications9040045
Nguyen, M.-H., Nguyen, H. T. T., Ho, M.-T., Le, T.-T., & Vuong, Q.-H.	The Roles of Female Involvement and Risk Aversion in Open Access Publishing Patterns in Vietnamese Social Sciences and Humanities. Journal of Data and Information Science, 7(1), 76–96.	2022	https://doi.org/10.2478/jdis-2022-0001
O'Callaghan, E., & Douglas, H. M.	#MeToo Online Disclosures: A Survivor-Informed Approach to Open Science Practices and Ethical Use of Social Media Data. Psychology of Women Quarterly, 45(4), 505–525.	2021	https://doi.org/10.1177/03616843211039175
Okret-Manville, C.	Academic social networks and Open Access: French researchers at the crossroads. LIBER Quarterly, 25(3), 118–135	2016	https://doi.org/10.18352/lq.10131

Olejniczak, A. J., & Wilson, M. J.	Who's writing open access (OA) articles? characteristics of OA authors at PhD.-granting institutions in the United States. Quantitative Science Studies, 1(4), 1429–1450.	2020	https://doi.org/10.1162/qss_a_00091
Owen, R., von Schomberg, R., & Macnaghten, P.	An unfinished journey? Reflections on a decade of responsible research and innovation. Journal of Responsible Innovation, 8(2), 217–233	2021	https://doi.org/10.1080/23299460.2021.1948789
Persson, S., & Pownall, M.	Can Open Science be a Tool to Dismantle Claims of Hardwired Brain Sex Differences? Opportunities and Challenges for Feminist Researchers. Psychology of Women Quarterly, 45(4), 493–504	2021	https://doi.org/10.1177/03616843211037613
Raffaghelli, J. E., & Manca, S.	Exploring the social activity of open research data on ResearchGate: implications for the data literacy of researchers. Online Information Review	2022	https://doi.org/10.1108/OIR-05-2021-0255
Raine, G., Evans, C., Uphoff, E. P., Brown, J. V. E., Crampton, P. E. S., Kehoe, A., Stewart, L. A., Finn, G. M., & Morgan, J. E.	Strengthening the clinical academic pathway: a systematic review of interventions to support clinical academic careers for doctors and dentists. BMJ Open, 12(9)	2022	https://doi.org/10.1136/bmjopen-2021-060281
Soeharjono, S., & Roche, D. G.	Reported Individual Costs and Benefits of Sharing Open Data among Canadian Academic Faculty in Ecology and Evolution. BioScience, 71(7), 750–756.	2021	https://doi.org/10.1093/biosci/biab024
Stieglitz, S., Wilms, K., Mirbabaie, M., Hofeditz, L., Brenger, B., López, A., & Rehwald, S.	When are researchers willing to share their data? – Impacts of values and uncertainty on open data in academia. PLoS ONE, 15(7 July)	2020	https://doi.org/10.1371/journal.pone.0234172
Stürmer, S., Oeberst, A., Trötschel, R., & Decker, O.	Early-Career Researchers' Perceptions of the Prevalence of Questionable Research Practices, Potential Causes, and Open Science. Social Psychology, 48(6), 365–371	2017	https://doi.org/10.1027/1864-9335/a000324
Tzovara, A., Amarreh, I., Borghesani, V., Chakravarty, M. M., DuPre, E., Grefkes, C., Haugg, A., Jollans, L., Lee, H. W., Newman, S. D., White, T., & Badhwar, A.	Embracing diversity and inclusivity in an academic setting: Insights from the Organization for Human Brain Mapping. NeuroImage, 229	2021	https://doi.org/10.1016/j.neuroimage.2021.117742
Vuong, Q.-H., Nguyen, H. T. T., Ho, M.-T., & Nguyen, M.-H.	Adopting open access in an emerging country: Is gender inequality a barrier in humanities and social sciences? Learned Publishing, 34(4), 487–498	2021	https://doi.org/10.1002/leap.1387
Waddell, A., Lennox, A., Spassova, G., & Bragge, P.	Barriers and facilitators to shared decision-making in hospitals from policy to practice: a systematic review. Implementation Science, 16(1)	2021	https://doi.org/10.1186/s13012-021-01142-y
Welch, E. W., Taggart, G., Feeney, M. K., & Siciliano, M.	Navigating the labyrinth: Academic scientists' responses to new regulatory controls on biological material inputs to research. Environmental Science and Policy, 101, 136–146	2019	https://doi.org/10.1016/j.envsci.2019.08.001

Wilson, K., Huang, C.-K., Montgomery, L., Neylon, C., Handcock, R. N., Ozaygen, A., & Roelofs, A.	Changing the Academic Gender Narrative through Open Access. Publications, 10(3).	2022	https://doi.org/10.3390/publications10030022
Zhu, Y.	Who support open access publishing? Gender, discipline, seniority and other factors associated with academics' OA practice. Scientometrics, 111(2), 557–579.	2017	https://doi.org/10.1007/s11192-017-2316-z
Zhu, Y.	Open-access policy and data-sharing practice in UK academia. Journal of Information Science, 46(1), 41–52.	2020	https://doi.org/10.1177/0165551518823174

Annexe 4 – Articles reviewed for Industry Practices

The full bibliography of articles reviewed for Industry Practices is available below.

Authors	Title	Year	DOI or Link
Aguinis H., Banks G.C., Rogelberg S.G., Cascio W.F.	Actionable recommendations for narrowing the science-practice gap in open science	2020	https://www.sciencedirect.com/science/article/pii/S074959781930740X
Alassaf D., Dabić M., Shifrer D., Daim T.	The impact of open-border organization culture and employees' knowledge, attitudes, and rewards with regards to open innovation: an empirical study	2020	https://www.emerald.com/insight/content/doi/10.1108/JKM-02-2020-0122/full/html
Bergman E.M.	Knowledge links between European universities and firms: A review	2010	https://rsaiconnect.onlinelibrary.wiley.com/doi/abs/10.1111/j.1435-5957.2010.00310.x
Bertello A., Ferraris A., De Bernardi P., Bertoldi B.	Challenges to open innovation in traditional SMEs: an analysis of pre-competitive projects in university-industry-government collaboration	2022	https://link.springer.com/article/10.1007/s11365-020-00727-1
Bigliardi B., Galati F.	Which factors hinder the adoption of open innovation in SMEs?	2016	https://www.tandfonline.com/doi/abs/10.1080/09537325.2016.1180353?journalCode=ctas20
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Chataway J., Parks S., Smith E.	How will open science impact on university-industry collaboration?	2017	https://foresight-journal.hse.ru/en/2017-11-2/207100766.html
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Chiaroni D., Chiesa V., Frattini F.	Unravelling the process from Closed to Open Innovation: Evidence from mature, asset-intensive industries	2010	https://onlinelibrary.wiley.com/doi/10.1111/j.1467-9310.2010.00589.x
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Farge M., Gasnault J.	Open science, open doctrine, how to share knowledge?	2019	https://ebooks.iospress.nl/volumearticle/51779
Felderer M., Garousi V.	Together We Are Stronger: Evidence-Based Reflections on Industry-Academia Collaboration in Software Testing	2020	https://pureadmin.qub.ac.uk/ws/files/199651060/SWQD_IAC_SoftwareTesting_Sept_2_pre_print.pdf
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Gerbin A., Drnovsek M.	Determinants and public policy implications of academic-industry knowledge transfer in life sciences: a review and a conceptual framework	2016	https://link.springer.com/article/10.1007/s10961-015-9457-0
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Jong S., Slavova K.	When publications lead to products: The open science conundrum in new product development	2014	https://www.sciencedirect.com/science/article/pii/S0048733313002382
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Leitner K.H.	Digital and open innovation: Implications for business models and research strategies of private and public organizations	2015	https://dl.acm.org/doi/10.1145/2809563.2809609
Leonelli S., Spichtinger D., Prainsack B.	Sticks and carrots: encouraging open science at its source	2015	https://rgs-ibg.onlinelibrary.wiley.com/doi/10.1002/geo2.2
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Nestle V., Täube F.A., Heidenreich S., Bogers M.	Establishing open innovation culture in cluster initiatives: The role of trust and information asymmetry	2019	https://www.sciencedirect.com/science/article/abs/pii/S0040162518309260
Ofenheimer A., Schuster K., Stocker A., Weiss W.	Potentials and pitfalls of open innovation and open science projects between industry, science, and society	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85080882580&partnerID=40&md5=ee33ba6b34199052d0d3d735f5e72bcc
Onetti A.	Turning open innovation into practice: trends in European corporates	2021	https://www.emerald.com/insight/content/doi/10.1108/JBS-07-2019-0138/full/html
Ottonicar S.L.C., Arraiza P.M., Armellini F.	Opening science and innovation: Opportunities for emerging economies	2020	https://foresight-journal.hse.ru/en/2020-14-4/425750243.html
Päällysaho S., Latvanen J., Lehto A., Riihimaa J., Lahti P., Kärki A., Puhakka-Tarvainen H.	Key aspects of open data in Finnish RDI cooperation between higher education and businesses	2021	https://direct.mit.edu/dint/article/3/1/176/94901/Key-Aspects-of-Open-Data-in-Finnish-RDI
Quintanilha T.L., Trishchenko N.	Open Access and Scientific Knowledge: Between the Public Interest and the Business Model. A Literature Review	2021	https://journals.openedition.org/cs/5428
Radziwon A., Bogers M.	Open innovation in SMEs: Exploring inter-organizational relationships in an ecosystem	2019	https://www.sciencedirect.com/science/article/abs/pii/S0040162518306255

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Rodriguez V.	Material transfer agreements: Open science vs. proprietary claims. For academia and industry, MTAs are the means to widely differing ends	2005	https://www.nature.com/articles/nbt0405-489
Roman M., Liu J., Nyberg T.	Advancing the open science movement through sustainable business model development	2018	https://journals.sagepub.com/doi/10.1177/0950422218777913
Rouleau G.	Open Science at an institutional level: An interview with Guy Rouleau	2017	https://genomebiology.biomedcentral.com/articles/10.1186/s13059-017-1152-z
Schneckenberg D.	Strategic incentive systems for open innovation	2014	https://clutejournals.com/index.php/JABR/article/view/8283
Shibayama S.	Conflict between entrepreneurship and open science, and the transition of scientific norms	2012	https://link.springer.com/article/10.1007/s10961-010-9202-7
Simeth M., Cincera M.	Corporate science, innovation, and firm value	2016	https://pubsonline.informs.org/doi/abs/10.1287/mnsc.2015.2220
Simeth M., Raffo J.D.	What makes companies pursue an Open Science strategy?	2013	https://www.sciencedirect.com/science/article/abs/pii/S0048733313000929
Slavova K.	When firms embrace science: University alliances and firm drug development pipeline	2022	https://onlinelibrary.wiley.com/doi/abs/10.1111/jpim.12611
Spithoven A., Vanhaverbeke W., Roijakkers N.	Open innovation practices in SMEs and large enterprises	2013	https://link.springer.com/article/10.1007/s11187-012-9453-9
Sun X., Ding K., Lin Y., Lin H.	Open science behavior of AI industry: Collaboration patterns and topics from the perspective of cross-institutional authors	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85076919931&partnerID=40&md5=b7fc8f0166883bdf0a0fa62ed24b98a3
Tobiassen A.E., Pettersen I.B.	Exploring open innovation collaboration between SMEs and larger customers: The case of high-technology firms	2018	https://www.emerald.com/insight/content/doi/10.1108/BJM-01-2017-0018/full/html
Traitler H., Watzke H.J., Saguy I.S.	Reinventing R&D in an Open Innovation Ecosystem	2011	https://ift.onlinelibrary.wiley.com/doi/full/10.1111/j.1750-3841.2010.01998.x
van de Vrande V., de Jong J.P.J., Vanhaverbeke W., de Rochemont M.	Open innovation in SMEs: Trends, motives and management challenges	2009	https://www.sciencedirect.com/science/article/abs/pii/S0166497208001314
Walsh J.P., Huang H.	Local context, academic entrepreneurship and open science: Publication secrecy and commercial activity among Japanese and US scientists	2014	https://www.sciencedirect.com/science/article/abs/pii/S0048733313001820

Annexe 5 – Articles reviewed for Trust

The full bibliography of articles reviewed for Trust is available below.

Search group 1			
Authors	**Title**	**Year**	**DOI or Link**
Miyakawa T.	No raw data, no science: Another possible source of the reproducibility crisis	2020	10.1186/s13041-020-0552-2
Agley J., Xiao Y.	Misinformation about COVID-19: evidence for differential latent profiles and a strong association with trust in science	2021	10.1186/s12889-020-10103-x
Vazire S.	Quality uncertainty erodes trust in science	2017	10.1525/collabra.74
Anvari F., Lakens D.	The replicability crisis and public trust in psychological science	2018	10.1080/23743603.2019.1684822
Gabrielsen A.M.	Openness and trust in data-intensive science: the case of biocuration	2020	10.1007/s11019-020-09960-5
Agley J., Xiao Y., Eldridge L., Meyerson B., Golzarri-Arroyo L.	Beliefs and misperceptions about naloxone and overdose among U.S. laypersons: a cross-sectional study	2022	10.1186/s12889-022-13298-3
Joseph H.	Building momentum to realign incentives to support open science	2021	10.1162/dint_a_00079
Mancini D., Lardo A., De Angelis M.	Efforts towards openness and transparency of data: A focus on open science platforms	2020	10.1007/978-3-030-23665-6_6
Rosman T., Bosnjak M., Silber H., Koßmann J., Heycke T.	Open science and public trust in science: Results from two studies	2022	10.1177/09636625221100686
Wright D.B.	Improving Trust in Research: Supporting Claims with Evidence	2020	10.1515/edu-2020-0106
Timmermann C.	Agriculture and Non-proprietary Science	2020	10.1007/978-3-030-56193-2_3
Larrick B.M., Dwyer J.T., Erdman J.W., D'aloisio R.F., Jones W.	An Updated Framework for Industry Funding of Food and Nutrition Research: Managing Financial Conflicts and Scientific Integrity	2022	10.1093/jn/nxac106
Laakso M.	Open science and open access publishing in social sciences	2022	10.4337/9781800372559.00013
Zhang X., Reindl S., Tian H., Gou M., Song R., Zhao T., Jackson L., Jandrić P.	Open science in China: Openness, economy, freedom & innovation	2022	10.1080/00131857.2022.2122440
Huma B., Joyce J.B.	'One size doesn't fit all': Lessons from interaction analysis on tailoring Open Science practices to qualitative research	2022	10.1111/bjso.12568
Gordon T.	The COVID Pandemic and Surgical Innovation in the United States	2021	10.1177/15533506211005364
Search Group 02			
Ali Mercan B., Yalçıntaş A.	Deconstructing the Discourse of Self-Corrective Intellectual Property Markets	2021	10.1080/08935696.2020.1857643

Anderson J.M., Niemann A., Johnson A.L., Cook C., Tritz D., Vassar M.	Transparent, Reproducible, and Open Science Practices of Published Literature in Dermatology Journals: Cross-Sectional Analysis	2019	10.2196/16078
Benea C., Turner K.A., Roseman M., Bero L.A., Lexchin J., Turner E.H., Thombs B.D.	Reporting of financial conflicts of interest in meta-Analyses of drug trials published in high-impact medical journals: Comparison of results from 2017 to 2018 and 2009	2020	10.1186/s13643-020-01318-5
Betts A.J., Green T.A.	Research integrity in corrosion research	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85047339732&partnerID=40&md5=edafbe573fd0e731c1d265d762062154
Cashin A.G., Bagg M.K., Richards G.C., Toomey E., Mcauley J.H., Lee H.	Limited engagement with transparent and open science standards in the policies of pain journals: a cross-sectional evaluation	2021	10.1136/bmjebm-2019-111296
Coyne J.C.	Replication initiatives will not salvage the trustworthiness of psychology	2016	10.1186/s40359-016-0134-3
Ferguson C.J.	The fame monster: Unintended consequence of fame for psychological science	2019	10.1016/j.newideapsych.2019.01.003
Goldstein H., Bergman E., Maier G.	Regional engagement or knowledge commercialization?: A comparison of university faculty norms in the U.S. and Europe	2013	10.2457/srs.43.25
Gorman D.M.	Use of publication procedures to improve research integrity by addiction journals	2019	10.1111/add.14604
Halchenko Y.O., Hanke M.	Four aspects to make science open "by design" and not as an after-thought	2015	10.1186/s13742-015-0072-7
Hardwicke T.E., Wallach J.D., Kidwell M.C., Bendixen T., Crüwell S., Ioannidis J.P.A.	An empirical assessment of transparency and reproducibility-related research practices in the social sciences (2014-2017)	2020	10.1098/rsos.190806
Hardwicke T.E., Thibault R.T., Kosie J.E., Wallach J.D., Kidwell M.C., Ioannidis J.P.A.	Estimating the Prevalence of Transparency and Reproducibility-Related Research Practices in Psychology (2014–2017)	2022	10.1177/1745691620979806
Hengartner M.P., Amendola S., Kaminski J.A., Kindler S., Bschor T., Plöderl M.	Suicide risk with selective serotonin reuptake inhibitors and other new-generation antidepressants in adults: A systematic review and meta-analysis of observational studies	2021	10.1136/jech-2020-214611
Hynek P.	The Hyper-Commons: How open science prizes can expand and level the medical research playing field	2008	10.1089/rej.2008.0822
Krumholz H.M., Ross J.S., Gross C.P., Emanuel E.J., Hodshon B., Ritchie J.D., Low J.B., Lehman R.	A historic moment for open science: The Yale University open data access project and Medtronic	2013	10.7326/0003-4819-158-12-201306180-00009
Larrick B.M., Dwyer J.T., Erdman J.W., D'aloisio R.F., Jones W.	An Updated Framework for Industry Funding of Food and Nutrition Research: Managing Financial Conflicts and Scientific Integrity	2022	10.1093/jn/nxac106

Low J.B., Ross J.S., Krumholz H.M.	Moving forward from rhBMP-2: Open science and data sharing	2014	10.1097/BRS.0000000000000256
Mayo-Wilson E., Grant S., Supplee L.H.	Clearinghouse Standards of Evidence on the Transparency, Openness, and Reproducibility of Intervention Evaluations	2022	10.1007/s11121-021-01284-x
Mialon M., Vandevijvere S., Carriedo-Lutzenkirchen A., Bero L., Gomes F., Petticrew M., McKee M., Stuckler D., Sacks G.	Mechanisms for addressing and managing the influence of corporations on public health policy, research and practice: A scoping review	2020	10.1136/bmjopen-2019-034082
Molloy I., Tripunitara M., Lotz V., Kuhlmann M., Schaufler C., Atluri V.	Panel on granularity in access control	2013	10.1145/2462410.2462889
Munafò M.R., West R.	E-cigarette research needs to adopt open science practices to improve quality	2020	10.1111/add.14749
Nutu D., Gentili C., Naudet F., Cristea I.A.	Open science practices in clinical psychology journals: An audit study	2019	10.1037/abn0000414
Ostiz-Blanco M., Bernacer J., Garcia-Arbizu I., Diaz-Sanchez P., Rello L., Lallier M., Arrondo G.	Improving Reading Through Videogames and Digital Apps: A Systematic Review	2021	10.3389/fpsyg.2021.652948
Petranker R., Anderson T., Farb N.	Psychedelic Research and the Need for Transparency: Polishing Alice's Looking Glass	2020	10.3389/fpsyg.2020.01681
Pinto M.F.	Open science for private interests? How the logic of open science contributes to the commercialization of research [¿Ciencia abierta para intereses privados? la lógica de la ciencia abierta y la comercialización de la investigación] [Ciência aberta para interesses privados? a lógica da ciência aberta e a comercialização da pesquisa]	2022	10.18601/01245996.v24n47.08
Prager E.M., Chambers K.E., Plotkin J.L., McArthur D.L., Bandrowski A.E., Bansal N., Martone M.E., Bergstrom H.C., Bespalov A., Graf C.	Improving transparency and scientific rigor in academic publishing	2019	10.1002/jnr.24340
Rasmussen S., Mangalagiu D., Ziock H., Bollen J., Keating G.	Collective intelligence for decision support in very large stakeholder networks: The future US energy system	2007	10.1109/ALIFE.2007.367832
Rockhold F., Bromley C., Wagner E.K., Buyse M.	Open science: The open clinical trials data journey	2019	10.1177/1740774519865512
Rowaihy H., Eswaran S., Johnson M., Verma D., Bar-Noy A., Brown T., La Porta T.	A survey of sensor selection schemes in wireless sensor networks	2007	10.1117/12.723514

Tijdink J.K., Horbach S.P.J.M., Nuijten M.B., O'Neill G.	Towards a Research Agenda for Promoting Responsible Research Practices	2021	10.1177/15562646211018916
Toom K., Miller P.F.	Ethics and Integrity	2018	10.1016/B978-0-12-805059-0.00013-4
Wilkinson D.J., Brook M.S., Smith K.	Erratum to "Principles of Stable Isotope Research – with Special Reference to Protein Metabolism" [Clinical Nutrition Open Science 36C (2021) 111–125, (S2667268521000097), (10.1016/j.nutos.2021.02.005)]	2022	10.1016/j.nutos.2022.04.001
Yoder W.R., Karyotaki E., Cristea I.-A., Van Duin D., Cuijpers P.	Researcher allegiance in research on psychosocial interventions: Meta-research study protocol and pilot study	2019	10.1136/bmjopen-2018-024622
[No author name available]	2012 3rd International Workshop on Managing Technical Debt, MTD 2012 - Proceedings: Foreword	2012	10.1109/MTD.2012.6225992
[No author name available]	Corrigendum to "Microdosing as a response to the meaning crisis: a qualitative analysis" (Journal of Humanistic Psychology, (2022), 10.1177/00221678221075076)	2022	10.1177/00221678221118801
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Arimoto T., Sato Y.	Rebuilding public trust in science for policy-making	2012	10.1126/science.1224004
Barber B.	Trust in science	1987	10.1007/BF01096860
Bazac A.	In science we trust. really?	2016	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84992154418&partnerID=40&md5=0dfbaded40b6103990643431d5ac6bc3
Burrage J.	Shooting the messenger: the erosion of trust in science and what to do about it	2015	10.1007/s13246-015-0335-8
Carvallo S.	Research ethics: Between regulation and reflexivity [Ética De la investigación entre regulación y reflexividad]	2019	10.3917/rac.043.0353
Cunningham-Burley S.	Public knowledge and public trust	2006	10.1159/000092658
Estupinyà P.	Trust in science - Not in scientists	2013	10.1386/cjcs.5.2.303_1
Ezrahi Y.	Science and The State	2015	10.1016/B978-0-08-097086-8.85051-5
Friedman P.J.	The Impact of Conflict of Interest on Trust in Science	2002	10.1007/s11948-002-0063-9
Fuchs S., Westervelt S.D.	Fraud and trust in science	1996	10.1353/pbm.1996.0043
Furman K.	Emotions and Distrust in Science	2020	10.1080/09672559.2020.1846281
Gauchat G.	Politicization of science in the public sphere: A study of public trust in the United States, 1974 to 2010	2012	10.1177/0003122412438225
Grimes D.R., Bauch C.T., Ioannidis J.P.A.	Modelling science trustworthiness under publish or perish pressure	2018	10.1098/rsos.171511

Haerlin B., Parr D.	How to restore public trust in science	1999	10.1038/22867
Hendriks F., Kienhues D., Bromme R.	Replication crisis = trust crisis? The effect of successful vs failed replications on laypeople's trust in researchers and research	2020	10.1177/0963662520902383
Huber B., Barnidge M., Gil de Zúñiga H., Liu J.	Fostering public trust in science: The role of social media	2019	10.1177/0963662519869097
Irzik G., Kurtulmus F.	What Is Epistemic Public Trust in Science?	2019	10.1093/bjps/axy007
Kovach C.R.	Maintaining trust in science	2018	10.3928/19404921-20180628-02
Kreps S.E., Kriner D.L.	Model uncertainty, political contestation, and public trust in science: Evidence from the COVID-19 pandemic	2020	10.1126/sciadv.abd4563
Lewandowsky S., Ecker U.K.H., Cook J.	Beyond Misinformation: Understanding and Coping with the "Post-Truth" Era	2017	10.1016/j.jarmac.2017.07.008
Longo G.	Information, science and democracy, for an ethics of scientific knowledge	2020	10.1007/978-3-030-44018-3_5
Macnaghten P., Chilvers J.	The future of science governance: Publics, policies, practices	2014	10.1068/c1245j
McCright A.M., Dentzman K., Charters M., Dietz T.	The influence of political ideology on trust in science	2013	10.1088/1748-9326/8/4/044029
Master Z., Resnik D.B.	Hype and Public Trust in Science	2013	10.1007/s11948-011-9327-6
Preiser W., Preiser R.	Academic publishing in pandemic times	2020	10.17159/sajs.2020/8803
Ravetz J., Saltelli A.	Policy: The future of public trust in science	2015	10.1038/524161d
Resnik D.B.	Scientific Research and the Public Trust	2011	10.1007/s11948-010-9210-x
Schafer M.S.	Mediated trust in science: Concept, measurement and perspectives for the 'science of science communication'	2016	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85009919887&partnerID=40&md5=7d517fe5e5896e978dd16087a2a1edba
Wilholt T.	Epistemic trust in science	2013	10.1093/bjps/axs007
Wynne B.	Public engagement as a means of restoring public trust in science - Hitting the notes, but missing the music?	2006	10.1159/000092659
Search Group 04			
Ancker, J.S., Flanagin, A.	A comparison of conflict of interest policies at peer-reviewed journals in different scientific disciplines	2007	10.1007/s11948-007-9011-z
Bauchner, H., Golub, R.M., Fontanarosa, P.B.	Data sharing: An ethical and scientific imperative	2016	10.1001/jama.2016.2420
Brody, H.	Clarifying Conflict of Interest	2011	10.1080/15265161.2010.534530
DeAngelis, C.D.	Conflict of interest and the public trust	2000	10.1001/jama.284.17.2237

Elliott, K.C., Resnik, D.B.	Science, policy, and the transparency of values	2014	10.1289/ehp.1408107
Fang, F.C., Casadevall, A.	Competitive science: Is competition ruining science?	2015	10.1128/IAI.02939-14
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