



Comparative analysis of the strengths and weaknesses of existing open access strategies

RTD-B6-PP-2011-2: Study to develop a set of indicators to measure open access

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Executive Summary

This report discusses the strengths and weaknesses of the major strategies aiming to foster, monitor and enforce OA to scholarly literature and research data that have been employed in the European Research Area (ERA), Brazil, Canada, Japan and the US from 2000 onwards and highlights prominent examples. The report shows that the prevalence and success of the approaches used vary widely across the examined countries.

National Legislation Requiring Open Access

National and regional legislation that directly addresses OA has been enacted in five of the examined countries—the United States, Spain, Germany, Italy, and Lithuania —and is being developed or has been proposed in Brazil, Poland, and Denmark. Most national governments address OA through less formal instruments, such as establishing policies at national research funding bodies.

Main strengths: National legislations mandating OA have the greatest potential to influence the adoption of OA in a country and make OA the ‘default’ in this country’s scholarly communication system. Theoretically, greater access to research results and data leads to accelerated adoption and commercialisation of research findings, the development of new products and services, increased productivity and greater returns on public investment in research and development (R&D). OA laws would also help to ensure that taxpayers have access to the results of the research that they collectively fund.

Main weaknesses: Legal directives on OA can be difficult to formulate due to their inherent complexity and potentially significant implications for many key stakeholder groups. Proposed laws on OA can sometimes generate controversy and can face pushback from powerful bodies that hinder implementation. Governments are in the business of prioritizing the promotion of innovation, but the extent to which unrestricted access to primary research outputs is actually an important component of innovation remains unclear.

National Projects, Programmes and Initiatives Promoting Open Access

Initiatives launched across the examined countries have resulted in the development of a range of mechanisms—including policies, statements and principles, strategic documents, action plans and guidelines—that espouse and provide a framework for OA on a national level. In a number of countries, awareness activities remain limited, and there is no centralised, uniform OA policy or national-level official position concerning the publication of scientific research.

Main strengths: Projects, programmes and initiatives—both small- and large-scale—help to raise awareness of OA. These initiatives provide a good opportunity to address the concerns and correct the misconceptions that many have about OA. They can potentially bring together a range of stakeholders in the debate on scientific information.

Main weaknesses: While the vast majority of initiatives are led by policy makers or institutional libraries and library associations, comparatively few researchers are participating in the debate. Far fewer initiatives are dedicated to open access to data than open access to publications. A number of countries remain without national-level initiatives.

Funders’ Mandates Requiring Green Self-Archiving in Open Access Repositories

OA mandates issued by funding bodies typically require funded researchers to make their published, peer-reviewed journal and conference papers OA by self-archiving them in a freely

accessible repository. While most funders do not currently have such a mandate, they are increasingly being established to ensure the widespread dissemination of their authors' research.

Main strengths: Mandates issued by funders vastly improve awareness of OA among researchers and compliance with a self-archiving policy. Increased compliance allows funders to better monitor the outcomes of their investments and raises the visibility and impact of the funded research. Greater levels of self-archiving also help to ensure the long-term preservation and accessibility of the research and scientific data.

Main weaknesses: While many funding bodies look favourably on OA, most policy statements encourage, rather than mandate, the use of green or gold OA. Few funding bodies track compliance rates with OA policies. Startling inequalities exist in the level of detail provided in funder policies, and many funders' policies omit important information for users. Mandates requiring the use only of journals that comply with policies can cut off potential publishing avenues for researchers.

Institutions' Mandates Requiring Green Self-Archiving in Open Access Repositories

Universities and research institutions are increasingly establishing digital repositories and promoting the green self-archiving of their authors' works into these repositories or into central (subject-based) repositories.

Main strengths: Mandates issued by institutions vastly improve awareness of OA among researchers and compliance with a self-archiving policy. Institutions mandating OA to research outputs have immediate, free access to the outputs of their researchers without having to pay a subscription or access fee. They are better able to form a complete record of and showcase their intellectual effort and output, and share, measure and analyse their research output, and subsequently manage research programmes. Researchers will maximise the visibility and impact of their research. OA to scientific data has the potential to strengthen the credibility of scholarly publications and research institutions, as it opens peer review to the entire scientific community.

Main weaknesses: There are many more repositories than there are mandates requiring their use. Institutions may hesitate to enact OA mandates out of reluctance to raise the administrative burden of researchers and staff. Institutions rarely monitor compliance with OA policies. Institutional repositories often have poor interoperability with other repositories. Most repositories guarantee only medium-term availability of their collections. The academic community continues to have persistent reservations about OA with respect to copyright issues, quality control, the authenticity of OA documents, and the time and effort needed to deposit works. OA to scientific data lacks the championing efforts made for OA to scientific publications.

Funders' or Institutions' Policies and Mandates to Publish in Open Access Journals

Major funders and institutions may require the submission of a manuscript to a gold or hybrid OA journal, either in addition to or as an alternative to Green OA self-archiving.

Main strengths: Researchers who publish in Gold OA journals have enhanced visibility, wider dissemination and, at least potentially, greater usage and citation of their research. Speed of dissemination can be much faster. Mandates increase compliance of researchers and publishing rates in Gold OA journals, increasing the credibility of OA peer-reviewed publications. Research funders have access to the outputs they have funded, allowing them to monitor these outputs and adjust programming accordingly. Indirect costs of publishing in OA journals are increasingly being subsidised by funding bodies or administered at the faculty/department level of institutions.

Main weaknesses: Except for the UK, few funding bodies or institutions currently favour Gold OA over the green posting of articles in repositories, though many provide a choice. Research funders may be hesitant to dictate where funded researchers may publish. The publication-fee Gold OA model is hampered by the dissuasive influence of author-side fees. Researchers may also resist publishing in OA journals due to lack of knowledge about relevant copyright issues or concerns about the quality, prestige or impact of OA journals.

Development of Open Access Infrastructure

OA infrastructure strategies typically focus on the growth, sustainability and interoperability of repositories of scientific information, though they may also address OA journals, repository or journal management software, text- and data-mining tools, OA journal or repository directories, directories of university and funder policies, or other tools. A number of large-scale national and international programmes (such as DRIVER and e-SciDR) have brought greater awareness to the critical role of repositories in the OA scholarly communication system and the importance of tackling technical challenges.

Main strengths: Digital repository development is being undertaken for a range of uses and users, and guidelines, protocols and standards are currently being written for the establishment of document and data repositories. Universities are pioneering software and application development for OA repositories. Progress has also been made in all aspects related to improving repository interoperability. Several free software packages are available for the creation and management of institutional repositories. Such technological developments ensure that the marginal costs of providing online access to documents remain minimal.

Main weaknesses: Although many European national repository infrastructures have been created, they are not yet sufficiently interconnected or searchable by machines (crawlers), isolating repository contents from readers and harvesters. Technical challenges facing repositories include the non-uniformity of manuscript files and metadata formats, embargo management and author authentication for repository deposit, and the long-term availability of collections. The costs of setting up and maintaining repositories can be prohibitive, in some cases. There are relatively few institutional repositories dedicated to research data.

Success factors facilitating the growth of open access at the national level include

- the fact of being a signatory to the Berlin Declaration on Open Access;
- legislation requiring the results of funded scientific activity to be made publicly available;
- a coordinated, national platform (e.g., initiative, programme) or body (e.g., working group, council, network, advisory board, consortia, committee, etc.) with an objective to increase awareness of OA;
- a common national OA research database or portal and/or a centralised source of information on OA;
- national funding mandates related to OA, including those implemented by major public research funding bodies;
- institutional mandates to green self-archive in an OA repository;
- central funds or grant support to cover some or all of the indirect costs of publishing in OA journals;
- sustained public funding of OA programmes or infrastructure;
- high levels of awareness among and balanced involvement of stakeholders across sectors and disciplines in OA debate and advocacy;

- participation in regional and international initiatives (e.g., OpenAIRE and COAR [the Confederation of Open Access Repositories]);
- a high prevalence of OA repositories at universities; and
- a vibrant and well-funded OA journal publishing environment, where publishers are further encouraged to develop OA models.

Barriers hindering the progress of open access in some countries include

- the lack of a national OA mandate;
- no coordinated national body, platform or strategy for OA;
- limited public funding for OA projects and programmes;
- little interest in or budgeting for OA in relevant institutions;
- voluntary (not mandated) deposit of research articles or data in OA repositories;
- a lack of awareness and persistent misperceptions surrounding OA in the research community, particularly with respect to the cost of OA, the time and effort needed to deposit, copyright and digital rights, long term digital preservation, and quality assurance.
- the lack of a national infrastructure for OA and limited funding for the development of digital infrastructures;
- a lack of OA journals of sufficient quality in specific fields;
- costs to researchers of OA publishing;
- self-archived material that is not Open Access Initiative (OAI) compliant or retrievable;
- active publishing lobbies;
- concerns surrounding the viability of national scholarly publishing alongside OA; and
- a lack of financial support and business models for OA publishing.

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1 Introduction

This report discusses the major strategies aimed at fostering, monitoring and enforcing OA to scholarly literature and research data that have been employed in the European Research Area (ERA), Brazil, Canada, Japan and the US from 2000 onwards, as well as the strengths and weaknesses of these various strategies. The strategies were identified in the current literature on OA and findings from the adjoining reports *State-of-art analysis of OA strategies to peer-review publications* (April 2014, D2.1) and *State-of-art analysis of OA strategies to scientific data* (April 2014, D2.2). Another Science-Metrix report (Proportion of Open Access Papers Published in Peer-Reviewed Journals at the European and World Levels—1996–2013, April 2014, D1.8) found that all ERA countries have already reached a ‘tipping point’ and have more than 50% of papers in OA. As discussed in the present report, the prevalence and success of the different strategies to promote OA and integrate it into the existing research system vary widely across the examined countries. Prominent examples and best practices of the strategies enacted in the examined countries are also provided.

2 National Legislation Requiring Open Access

National and regional legislation that directly addresses OA typically aims to maximise the impact of federally funded research by making it freely available and allowing for the wide reuse of the material. Governments have become increasingly responsive to the fact that free access to research results will broaden the potential for adoption and commercialisation, lead to greater productivity in certain sectors of the economy and facilitate the emergence of new industries based upon OA content (e.g., those built on publicly accessible data) (Houghton & Sheehan, 2009). They may also be aware that enhanced access to scientific literature and data can lead to more informed debate among policymakers, positively impacting the policy development process. Additionally, the open exchange of the data generated by various agencies and ministries can mitigate research duplication and generate richer data through the crossing of various datasets. By unlocking the potential of big data, European developed economies could save an estimated €150 billion to €300 billion annually in the form of operational efficiency gains and increased actual-versus-potential collection of tax revenue (Manyika *et al.*, 2011).

Currently, legislation that has direct implications for OA on a national level has been implemented in the United States, Spain, Germany, Italy, and Lithuania. However, most national governments currently address OA, if they address it at all, through less formal instruments, such as policies at federal research funding bodies (mandates implemented at the funding agency level are discussed in another section).

2.1 Main Strengths

- The development, proposal and implementation of national legislative frameworks mandating OA have the greatest potential to influence the adoption of OA in a country.
- Theoretically, greater access to research results and data could lead to accelerated adoption and commercialisation of research findings, result in the development of new products and services, increase productivity and spur greater returns on public investment in R&D.
- The presence of national legislation exhibits a significant and long-term commitment to OA and could help to make OA the ‘default’ in a country’s scholarly communication system.
- Such laws would also help to ensure that taxpayers have access to the results of the research that they collectively fund.

2.2 Main Weaknesses

- Legal directives on OA can be difficult to formulate due to their inherent complexity and potentially significant implications for many key stakeholder groups.
- When proposed, laws on OA can generate controversy and face pushback from powerful bodies (such as publishers' associations) that hinder implementation. Some stakeholders may, for example, perceive a strong government mandate as dictating where researchers must publish outputs, raising fundamental issues of academic freedom.
- Governments are in the business of prioritizing the promotion of innovation, but it is as yet unclear to what extent unrestricted access to primary research outputs is actually an important component of innovation (SQW Consulting & LISU, Loughborough University, 2008).

2.3 Status in Examined Countries and Examples

Among the examined countries, five have enacted national legislation directly related to OA.

- The US was the first country to adopt a national OA mandate with the Consolidated Appropriations Act 2008, the legislative basis for the OA policy of the National Institutes of Health (NIH).
- The country has also proposed three key pieces of relevant legislation.
 - Proposed in 2006, 2010 and again in 2012, the Federal Research Public Access Act (FRPAA) would have required that the 11 agencies with research expenditures over \$100 million create online repositories of journal articles of their research and make them publicly available.
 - In February 2013, the Fair Access to Science and Technology Research Act (FASTR) was introduced, succeeding the FRPAA. If passed, FASTR would advance and expand the NIH Public Access Policy and require free public access to federally funded research for, again, those departments with research budgets of \$100 million or more.
 - Also in February 2013, the White House's Office of Science and Technology Policy (OSTP) issued a policy memorandum (the OSTP Directive on Public Access) directing all federal agencies with R&D expenditures of over US\$100 million to develop open access strategies.
 - In September 2013, new public access legislation was introduced in the US House of Representatives, the Public Access to Public Science Act (PAPS), which intends to build on the White House Office of Science and Technology Policy (OSTP) Directive (OSTP, 2013).
- In 2011, Spain passed the Law on Science, Technology and Innovation (2011), which includes an OA mandate. The law calls for publicly funded research to be deposited within six months of publication in an OA repository and allows authors to make any of their articles stemming from publicly funded research openly accessible and available for non-commercial purposes without the consent of the publishers 12 months after first publication.
- October 1, 2013, saw the enactment of a new national German law (BGB1. I S. 3714) that modified section 38 of the German Copyright Act. The copyright reform directly targets OA to scientific publications (Buch Report, 2013).
- In October 2013, the Italian Parliament approved a law (Law of 7 October 2013, no 112) that includes a regulation for OA to scientific publications. Researchers whose research has been publicly funded (at least 50%) are required to either publish their work in an OA journal or deposit their work in OA archives no later than 18 months from first publication for scientific, technical and medical disciplines or 24 months for the humanities and social sciences (Moscon, 2013).

- In Lithuania, national legislation took effect on May 12, 2009, mandating that the results of scientific activity be made publicly available. Article 45 of the 2009 Law on Science and Studies of the Republic of Lithuania states that all results of the scientific activity carried out in the state science and study institutions as well as at non-governmental institutions of science using state funds must be made public (Republic of Lithuania, 2009).

A number of countries are in the process of developing or have proposed OA legislation.

- Brazil introduced a bill (PL 1120/2007) in May 2007 proposing that all public institutions of higher education and research units be required to establish institutional repositories; however, this bill has since been archived.
- The government of Poland has been working on legislation to make the results of publicly funded research OA available. A campaign was launched in support of a national OA mandate. In January 2013, the Polish Ministry of Administration and Digitisation published Draft Guidelines for the Proposal of the Act on Open Public Resources. The aim of the draft bill is to ensure that as much material, particularly that resulting from public subsidies, is made openly accessible on the internet.
- In March 2011, Denmark's Open Access Committee issued a series of OA policy recommendations (Danish Agency for Libraries and Media, 2011). The paper includes 16 recommendations in total, the first being that "a national Open Access policy be phrased on the basis of green Open Access with continual quality assurance by the scientific journals" and "that there should be Open Access to the results of publicly funded research to as great an extent as possible".

Copyright and licensing laws, although not directly mandating OA, are highly relevant to it. The study found that all of the examined countries, with the exception of Cyprus, had copyright legislation that may apply to peer-reviewed publications. Additionally, countries outside of those included in this study—namely Argentina and Peru—have enacted legislation requiring that government-funded research results be available in OA digital repositories.

3 National Projects, Programmes and Initiatives Promoting Open Access

Awareness of OA varies not only among nations, but also among stakeholders in different scientific disciplines. Since many studies have shown that a major hindrance to the uptake of OA is a lack of knowledge of the relevant issues (Cummins, 2012), major initiatives, programmes and projects have been critical for stimulating widespread understanding, debate and activity around OA and have acted as catalysts for further developments. These include major national and international organisations and projects, such as OpenAIRE (Open Access Infrastructure for Research in Europe), SPARC (the Scholarly Publishing and Academic Resources Coalition), and SHERPA.

3.1 Main Strengths

- Projects, programmes and initiatives—both small- and large-scale—help to raise awareness of OA.
- These initiatives provide a good opportunity to address the concerns and correct the misconceptions that many have about OA.
- They can bring together a range of main stakeholders in the debate on scientific information.

3.2 Main Weaknesses

- While the vast majority of initiatives are led by policy makers or institutional libraries and library associations, comparatively few researchers are participating in the debate.
- Far fewer initiatives are dedicated to OA to data than OA to publications.
- A number of countries remain without national-level initiatives.

3.3 Status in Examined Countries and Examples

A range of initiatives have been launched across the examined countries, many of which have resulted in the issuance of policies, strategic documents, action plans, guidelines, tools, statements or principles that espouse OA on a national level. Implementing organisations may include government agencies, ministries or councils; large funding bodies; associations (often library associations); working groups; research groups; networks; or consortia that deal with OA issues, either exclusively or as one issue relevant to their mandate.

Most countries are signatories of the 2003 Berlin Declaration on OA, and many national and regional declarations and statements have since been issued.

- In Belgium, government representatives (three ministers of Science and Research) signed the 'Brussels Declaration on Open Access' in October 2012 in which they agreed to make OA the default for all Belgian research output.
- In Ireland, the 'National Principles for Open Access Policy Statement', released in 2012, stated that the outputs from publicly-funded research should be publicly available to researchers and to potential users in education, business, charities and the public sector, and to the general public.
- Other examples include the 'Salvador Declaration' (2005), 'Bogotá Declaration' (2010), the 'Croatia Declaration on Open Access' (2012), the 'Aachen Declaration' (2012), and the 'Toronto Statement' on open data sharing (2009).

The efforts of many countries have culminated in national information platforms that aggregate all detailed information on national OA issues for stakeholders; some also act as national portals for OA documents.

- Spain's Open Access to Science (acceso abierto a la ciencia) Research Group, composed of staff from universities and the Spanish National Research Council, has developed a number of tools including a directory of Spanish scientific journals (Dulcinea), an updated directory of Spanish institutional open access repositories (BuscaRepositorios) and an international directory of institutional open access policies (Melibea). Its web portal, accesoabierto.net, is used to disseminate its work.
- In Finland, the Finnish OA Working Group (FinnOA) is an informal group of researchers, scientific publishers and research libraries launched in 2003. It regularly publishes protocols on its website, finnoa.fi.
- In Germany, the open-access.net project is a collaboration between universities and the German Research Foundation (DFG). Its aim is to provide comprehensive information on the subject of OA and offers practical implementation advice.
- The Netherlands' openaccess.nl is the Dutch national website aimed at providing academics with information on the advantages of OA. It was established by SURF, the collaborative organisation for research universities, research institutions and universities of applied sciences in the Netherlands.
- Sweden's openaccess.se programme promotes OA to the Swedish research works by supporting publishing in OA repositories and OA journals at Swedish institutions of higher

education. The programme provides information and advice, aids in the development of infrastructure and services and is involved in the coordination of policy. It is run by the National Library of Sweden and managed by the Expert Group for OpenAccess.se.

- In Ireland, the Open Access to Irish Research Project, managed by the Irish Universities Association Librarians' Group, culminated in the development of RIAN, Ireland's new national portal for Open Access to Irish published research (rian.ie).
- The main aim of the Danish Open Access Network is to establish open-access.dk, a communication channel for open access news and information in Denmark and a forum for communication on open access issues in Denmark.
- The Portugal Open Access Science Repository Initiative (Repositório Científico de Acesso Aberto de Portugal, RCAAP) aims to increase the visibility, accessibility and dissemination of Portuguese research outputs through its website (projeto.rcaap.pt). The RCAAP put together an Open Access Policies Kit that identifies four key stages for the effective implementation of an Open Access Policy: analysis and planning; definition and approval; promotion; implementation; and follow-up, support and monitoring.¹

In some countries, awareness activities remain limited, and there is no centralised, uniform OA policy or national-level official position concerning the publication of scientific research. These countries include Cyprus, the Czech Republic, Estonia, Greece, Hungary, Japan, Luxembourg, Malta, Romania, Slovakia, and Slovenia. However, policies are only one factor in the spread of OA, as evidenced by the fact that OA represents close to or more than 50% of publications in countries for which there was no evidence of infrastructure or policies.

4 Funders' Mandates Requiring Green Self-Archiving in Open Access Repositories

OA mandates issued by funding bodies typically require funded researchers to make their published, peer-reviewed journal and conference papers OA by self-archiving the final draft in a freely accessible central or institutional repository. Along with institutional mandates, these are among the most, if not the most important and influential of policies in aiding the spread of OA. Studies have shown the ripple effect of mandating OA archiving by research funders to be significant: researcher compliance rises dramatically with the implementation of mandates (Harnad *et al.*, 2009; NIH Health Manuscript Submission System, 2013) and funders can collect more abundant, richer information and use it to help them target their investments. However, broader impacts may also be realised. For instance, one 2010 study projected that openly archiving all Federal Research Public Access Act (FRPAA) agencies' funded R&D article outputs would result in US national benefits equalling around eight times the cost (Houghton, Rasmussen, & Sheehan, 2010).

Major research funders in a number of countries have adopted such mandates to ensure the widespread dissemination of their authors' research, and while most funders do *not* currently have one, the number of these mandates is increasing. Additionally, the number of publishers' OA policies that allow some form of archiving grew steadily, from 80 in January 2004 to close to 1,700 in April 2014.

¹ The RCAAP Open Access Policies Kit can be accessed at <http://projeto.rcaap.pt/index.php/lang-en/consultar-recursos-de-apoio/repository?func=startdown&id=336>.

4.1 Main Strengths

- Evidence and experience has suggested that mandates issued by funders and institutions vastly improve awareness of OA among researchers and compliance with a self-archiving policy. While about 15% of articles are spontaneously self-archived, institutions with mandates can achieve far higher compliance (Harnad et al., 2009).
- Increased compliance as a result of mandates requiring the deposit of funded works into repositories allows funders to better monitor the outcomes of their investments.
- The visibility and impact of the funded research is greatly increased.
- Greater levels of self-archiving can also help to ensure the long-term preservation and accessibility of the research and scientific data.

4.2 Main Weaknesses

- While many funding bodies look favourably on OA, most policy statements encourage, rather than mandate, the use of green or gold OA.
- Few funding bodies track compliance rates with OA policies, perhaps because of the challenges involved in defining and developing tools and mechanisms to monitor compliance.
- Startling inequalities exist in the level of detail provided in funder policies. Many funders' policies omit important information for users (such as on sanctions or the transfer of rights).
- Concerns about academic freedom have been voiced because mandates requiring the use of only those journals that comply with policies can cut off potential publishing avenues for researchers (Ferguson et al., 2013).

4.3 Status in Examined Countries and Examples

Public and private funders have implemented diverse policies encouraging or mandating the deposit of their funded research outputs in open online archives so that they be made freely available on the internet.

- Based on the data available in JULIET, as well as in BioMed Central (Funder Policies), ROARMAP and MELIBEA, the adjoining study (D2.1) found that the country with the highest number of OA policies among the examined countries is the UK, with 34 mandates. In the UK, most of the individual councils, including the Higher Education Funding Council for England (HEFCE) and the Research Councils UK (RCUK), have now adopted mandates for OA dissemination of the research outputs that they fund.
- The UK is followed by Canada, with 14 mandates. The first federal funding agency in Canada to adopt a mandate was the Canadian Institutes of Health Research (CIHR), following the model set by the NIH in the US. In October 2013, the CIHR, along with Canada's two other funding agencies—the Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC)—released a draft OA policy requiring funded publications to be accessible within 12 months of publication, either through the publisher's website (Option #1) or an online repository (Option #2) (NSERC, 2014).
- Similar mandates have been issued by funding bodies in the US (9 mandates), Denmark (6) Ireland (5 mandates) and France (5 mandates).
- No funder mandates could be found for Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, Greece, Latvia, Lithuania, Luxembourg, Malta, Poland, Romania, Slovakia, Slovenia, Liechtenstein, Turkey, or the Former Yugoslav Republic of Macedonia.
- At the pan-European level:

- The European Research Council (ERC) implemented its new OA policy on July 13, 2012. All papers resulting from ERC grants from 2014 must be OA within six months of publication. Furthermore, the organisation “strongly encourages the use of discipline-specific repositories,” such as arXiv and Europe PubMed Central (Van Noorden, 2013).
- In August 2008, the European Commission launched the Open Access Pilot in its Seventh Framework Programme (FP7), mandating all new projects in seven FP7 areas to deposit peer-reviewed research articles or final manuscripts resulting from their projects into an online repository and make them OA (European Commission, 2012b).
- Additionally, in July 2012, the EC issued a Communication and a Recommendation to member states proposing to define clear policies to make all publicly funded research conducted within the EU open access under Horizon 2020 (European Commission, 2012a).

The present study also found that few funding bodies mandate or encourage the publication of OA research data. An analysis of 48 funders’ OA policies listed in ROARMAP found that 29% of policies mandated open data archiving and 10% encouraged it without mandating it. On the other hand, 23% explicitly excluded data from OA requirements and 38% did not mention data at all.

5 Institutions’ Mandates Requiring Green Self-Archiving

Universities and research institutions have an interest in managing their intellectual assets, enhancing their competitive profile by showcasing their research output and maximising and attracting research income and performance (Van der Graaf, 2008). As such, they are increasingly establishing institutional digital repositories and promoting Green OA self-archiving of their authors’ works into these repositories or into central (subject-based) repositories. Those institutions that explicitly *mandate* deposit are reaping multiple benefits over those who merely encourage it, ranging from greater visibility and impact of research outputs to the ability to better design academic programmes (Swan & Carr, 2008). The 10-year review of the Budapest Open Access Initiative (BOAI) included a recommendation that “universities with institutional repositories should require deposit in the repository for all research articles to be considered for promotion, tenure, or other forms of internal assessment and review” (BOAI, 2013).

Institutions are also playing a leading role in national OA initiatives and signing international agreements and declarations that promote OA (Chantavaridou, 2009). Academic librarians, in particular, have long been in the vanguard in fighting increases to journal costs, promoting the development of repositories, organising and operating OA journals and communicating OA-related developments to user groups, faculty and administration. The latter role is critically important, as studies show that low levels of awareness and concerns regarding copyright represent substantial barriers to self-deposit in repositories (European Commission Directorate-General for Research and Innovation, 2011b; Hubbard, Hodgson, & Fuchs, 2011).

Universities are also pioneering software and application development for OA repositories. While technical advances are allowing universities to more easily and cheaply establish and maintain their own repositories, significant challenges remain, including low repository interoperability, issues with long-term preservation and difficulties tracking compliance with a self-archiving policy.

5.1 Main Strengths

- Evidence and experience has suggested that mandates issued by funders and institutions vastly improve awareness of OA among researchers and compliance with a self-archiving policy. While about 15% of articles are spontaneously self-archived, institutions with

mandates can achieve far higher compliance (Harnad et al., 2009), making it the only truly effective route to collecting the institutions' entire research output.

- Institutions mandating OA to research outputs have immediate, free access to the outputs of their researchers without having to pay a subscription fee.
- Those that mandate self-archiving are better able to form a complete record of and showcase their intellectual effort and output.
- They are also better able to share, measure and analyse their research output and subsequently manage its research programmes more effectively.
- A number of studies cite the 'citation advantage', suggesting that the visibility and impact of the research conducted by an institution's researchers will be maximised (Gargouri et al., 2010; Swan, 2010; Wagner, 2010).
- OA to scientific data has the potential to strengthen the credibility of scholarly publications and research institutions, as it opens peer review to the entire scientific community.

5.2 Main Weaknesses

- There are many more repositories than there are mandates requiring their use.
- Institutions rarely monitor compliance with OA policies, perhaps because of the challenges involved in defining and developing tools and mechanisms to monitor compliance.
- Institutional repositories often have poor interoperability with other repositories, limiting the potential to create a value-added, unified body of scholarly materials (Confederation of Open Access Repositories [COAR], 2012).
- Institutions may hesitate to enact OA mandates out of a reluctance to raise the administrative burden of researchers and require certain behaviours from their staff.
- Universities are challenged with overcoming persistent misconceptions and reservations among the academic community with respect to OA issues, namely:
 - copyright issues,
 - lack of quality control,
 - the authenticity of OA documents, and
 - the time and effort needed to deposit works.
- Most repositories guarantee only medium-term availability of their collections.
- OA to scientific data, in particular, lacks the championing efforts made for OA to scientific publications.
- Data repositories are more technically complex for institutions to implement.

5.3 Status in Examined Countries and Examples

Within the ERA, Brazil, Canada, Japan, and the US, nearly 40 million records are spread across 1,450 institutional repositories in April 2014 in OpenDOAR alone. Over 100 universities around the world have issued mandates requiring green posting from authors who have received funding from them (Björk & Paetau, 2012). Fewer databases exist for institutional OA policies than for funders' OA policies: only ROARMAP and MELIBEA maintain extensive lists. According to these directories, Brazil, Canada, Japan, the US, and ERA countries collectively have 293 institutional, multi-institutional, sub-institutional, and thesis OA mandates presently in place and 70 institutional, multi-institutional, and sub-institutional OA mandates and non-mandates have been proposed. Either these directories are incomplete, or the number of mandates remains extremely low considering there are more than 20,000 universities and other types of higher education institutions around the world (meaning about 2% only would have mandates).

According to this analysis, the largest number of institutional mandates is in the US, followed by the UK, Italy, Finland, and Portugal. More prominent examples include the following.

- In the US, Harvard's Open Access Policy (2010) for the deposit of scholarly articles in OA repositories is considered a model of good practice, and this type of policy has since been adopted by other universities around the world. The University of California (UC), the largest public research university in the world, adopted an OA mandate in August 2013, committing all 10 of its campuses to OA.
- In Portugal, OA was initiated by the University of Minho with the creation of its institutional repository, RepositóriUM, in 2003 and its pioneering self-archiving policy in 2005.
- Considered another early adopter and good practice model, the University of Southampton in the UK announced its University Policy on Self-Archiving and Open Access Provision in 2008 requiring all academic staff to make their published research available online. Also in the UK, the University of Nottingham adopted an OA mandate in 2009.

However, currently most universities do not mandate deposit in repositories. In a survey of head librarians at universities and higher learning institutions conducted by Science-Metrix, 42% of respondents indicated that their institution has an OA policy, and only 15% noted that self-archiving was mandatory at their institution. Additionally, survey results suggested that direct advantages for researchers who make their work available in OA form remain rare at the level of institutions. Of survey respondents, 49% indicated that researchers in their organisation were encouraged to archive their scholarly work but without any formal reward, and 36% indicated that their institution had no policy in this regard.

While many institutions are also drawing up Research Data Management policies, and digital repository services for open data are emerging at universities across the world, even fewer institutional repositories are dedicated exclusively to research data. Only 36% of respondents to the survey indicated that their organisation maintains one or more repositories for OA scientific data, and only 11% of respondents indicated that their institution has an OA policy for scientific data (as opposed to 42% for scholarly publications). It is more common for institutions to support datasets on repositories otherwise devoted to books, theses, peer-reviewed publications and multimedia objects. However, it is possible that a significant number of existing OA repositories for scientific data is not indexed in ROAR and OpenDOAR.

6 Funders' or Institutions' Policies and Mandates to Publish in Open Access Journals

Some major funders and institutions require the submission of a manuscript to a gold or hybrid OA journal, either in addition to or as an alternative to green self-archiving. Those who publish in OA journals benefit from wider dissemination, maximised market reach, greater visibility and higher journal citation impact factors of their articles (Crow, 2009). Publishing in an OA journal can also lead to time savings by shortening the delay between acceptance and publication. For authors and institutions that are not comfortable with the self-archiving process or lack the appropriate infrastructure, OA journals can offer a simple solution, as they are responsible for the preservation and circulation of articles. In recent years, a number of professionally run, high-quality OA journals have been launched, and many traditional commercial publishers have established sizable OA journal operations or have extended their hybrid OA operations. The success of major Gold OA publishers, such as BioMed Central, Hindawi and PLoS, has had a positive impact on the credibility of OA peer-reviewed publications.

However, misconceptions persist among researchers relating to OA journals' impact, prestige, quality of peer review, quality of authors, quality of editors or quality of referees that have limited author acceptance to some degree (Björk & Solomon, 2012). OA may also be seen as imperilling the activities of learned societies that use publication revenues to fund their wider activities, as well as existing publishing business models, particularly if embargo periods and other restrictions on use and re-use rights are reduced (Finch, 2012). Additionally, in the pay-to-publish system, researchers may be deterred from publishing in OA journals by article processing charges. Many authors pay out of pocket, using personal funds or funds from their research grants to pay for publication, a disincentive that frequently dissuades researchers from embracing OA. However, research funders and institutions are increasingly establishing central funds to cover the indirect costs of publishing in OA journals, reducing the barriers for those researchers wishing to publish in an OA journal (BioMed Central, 2013).

While the global transition towards OA is characterised by a mixed Green OA and Gold OA economy, a prominent approach that many consider to display a preference towards Gold OA can be found in the UK, largely as a result of the recommendations made in the 2012 report by the Working Group on Expanding Access to Published Research Findings, which have experienced rapid institutional uptake.

6.1 Main Strengths

- Researchers who publish in OA journals have enhanced visibility, wider dissemination and greater usage and citation of their research (Gargouri et al., 2010; Swan, 2010; Wagner, 2010).
- Mandates increase compliance of researchers and publishing rates in gold OA journals. Greater usage and success of these journals increases the credibility of OA peer-reviewed publications.
- Research funders that mandate OA to research outputs (whether via Green or Gold OA) will ensure that they have access to all of the outputs they have funded, allowing them to monitor these outputs and adjust programming accordingly.
- The indirect costs of publishing in Gold pay-to-publish OA are increasingly being subsidised by funding bodies or administered at the faculty/department level of institutions (SQW Consulting & LISU, Loughborough University, 2008). Additionally, some publishers may accept author requests to waive fees. Those funders and institutions that do not already do so are being urged to discuss the basis for publication subsidies and put arrangements in place to enable their academics to access and deploy funds for OA publication charges (Open Access Implementation Group [OAIG], 2012).

6.2 Main Weaknesses

- Few funding bodies or institutions currently favour Gold OA over the Green OA self-archiving of articles in repositories, though many provide a choice.
- Research funders may be hesitant to dictate where funded researchers may publish.
- The publication-fee Gold OA model is hampered by the dissuasive influence of author-side fees, requiring scholars and scientists, universities and research organisations to pay publications costs up front. Many scholars, in particular, can be at a disadvantage if they cannot have publication fees subsidised through project grants—particularly researchers in the humanities and social sciences, where significant research is undertaken without project funding.
- Researchers may also resist publishing in Gold OA journals due to lack of knowledge about relevant copyright issues, the persistent misconception that OA journals are not high impact

(which is currently true to a large extent due to the youth of these journals), and concerns about quality control and receiving proper recognition when publishing in OA journals.

6.3 Status in Examined Countries and Examples

According to ROARMAP data, almost none of the funding bodies in the examined countries favoured Gold OA (as opposed to the 40% that favoured green and the 57% that expressed no preference), 2% of funders mandated both Green and Gold OA.

- The most prominent example can be found in the UK in the form of the 'Finch Report', produced by the Working Group on Expanding Access to Published Research Findings chaired by Dame Janet Finch (2012). The report strongly advocates Gold OA based on article processing charges (APCs) (green also allowed with embargos). While the report was somewhat controversial, the UK government accepted the report's recommendations, resulting in rapid institutional uptake. Initially, the Research Councils United Kingdom (RCUK) will pay universities an annual block grant to support publication charges, and universities are in turn expected to establish and manage their own publication funds. The Policy on Open Access, which came into force on April 1, 2013, expresses the Councils' preference for "immediate Open Access with the maximum opportunity for re-use". It will make all UK government-funded research OA within 5 years, with a target of 45% in the first year.
- As of 2010, in Sweden, researchers who receive funding from the Swedish Research Council must publish directly in OA journals or archive their articles in open databases within six months of publication.
- Canada's two major federal funding agencies, the Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC) have also proposed a mandatory OA policy for peer-reviewed journal articles. The 'tri-council' policy would make journal articles freely available within a year of publication (NSERC, 2014). Additionally, SSHRC created an Aid to Open-Access Research Journals programme whereby funds are awarded to help defray the costs of publishing scholarly articles.
- In Germany, through the Open Access Publishing programme, the DFG helps research universities set up publication funds, which can be used by authors from these universities to pay the fees required to publish articles in some open access journals. DFG-funded authors can also take advantage of the publication allowances available through individual grants and coordinated programmes.

However, only 14% of respondents to the Science-Metrix survey of head librarians at universities and higher learning institutions indicated that financial support was available for researchers who published in OA journals to meet specific indirect costs and expenditures.

More generally, while Green and hybrid OA (individual Gold OA articles in Paid Access journals) account for the majority of available articles in all countries, publishing in Gold OA journals is much more frequently encountered in Eastern Europe. A clear pattern can be observed, as the percentage of papers in gold journals is greater (though not dominant) in Macedonia, Croatia, Turkey, Malta, Lithuania, Estonia, Slovenia, Poland, Latvia, Slovakia, Spain, the Czech Republic and Romania.

7 Development of Open Access Infrastructure

OA infrastructure strategies typically focus on the growth, sustainability and interoperability of repositories of scientific information. A number of large-scale national and international programmes have brought greater awareness to the critical role of repositories in the OA scholarly communication system and the importance of tackling the technical challenges facing e-Infrastructure. These challenges include difficulties achieving the long-term preservation of data, the non-uniformity of manuscript files and metadata formats, embargo management, author authentication for repository deposit, data curation and poor indexation of data by internet browsers, and the scarcity of directories or registries that could make data more visible (Pinfield, 2009; Wallace, 2011).

One of the most critical issues at hand involves the interoperability of repositories, or allowing all types of repositories to communicate and connect with and transfer information, metadata, and digital objects between each other. In developing countries, an accentuated lack of access is also common due to inadequate and unreliable infrastructure and internet connectivity, and this lack of availability will continue to hamper access in these countries, even to OA material.

Aside from repositories, OA infrastructure can also refer to OA journals, free and open-source repository software, free and open-source journal management software, tools for text- and data-mining, directories of OA journals and repositories, directories of university and funder policies, providers of open licenses, digital preservation services, current awareness services, services for cross-linking and persistent URLs and search engines (BOAI, 2013).

7.1 Main Strengths

- The number of institutional and central (subject-based) OA repositories is increasing rapidly, both as a result of and contributing to a greater focus on e-Infrastructure supporting OA.
- Digital repository development is being undertaken for a range of uses and users, including researchers, educators, public bodies and companies who need contemporary scientific and educational information and resources.
- Guidelines, protocols and standards are currently being written for the establishment of document and data repositories.
- Progress has been made in increasing the interoperability landscape of repositories, including metadata harvesting, usage statistics, cross system content transfer, the creation of unique identifiers, increasing visibility of repository contents and support services for repository networks.
- Several free software packages available for the creation and management of institutional repositories (the most widely used include DSpace, Eprints, and Fedora), which support the vast majority of the repositories currently in existence worldwide.
- Technological developments ensure that the marginal costs of providing online access to documents remain minimal.
- Strategies are helping to guarantee the long-term archiving of documents, primarily by assigning so-called persistent identifiers (e.g., URN, PURL and DOI).

7.2 Main Weaknesses

- Repository structure development is still relatively new, and the landscape is evolving (COAR, 2012).

- Although many European national repository infrastructures have been created, they are not yet sufficiently interconnected or searchable by machines (crawlers), which could lead to the isolation of the repository's contents from readers and harvesters (European Commission Directorate-General for Research and Innovation, 2011a).
- Other technical challenges facing repositories include the non-uniformity of manuscript files and metadata formats, embargo management and author authentication for repository deposit, and the long-term availability of collections.
- The costs of setting up and maintaining repositories can, in some cases, be unsustainable given lack of a proper line item.
- Other concerns about repositories that may impede their growth or use include quality control (no direct peer review) and version control (most journals do not allow the final published version of the paper to be deposited, but do allow the author's version, and the two may have minor differences).
- There are relatively few institutional repositories dedicated to research data (though ROAR and OpenDOAR fail to provide a complete inventory of scientific data).

7.3 Status in Examined Countries and Examples

The survey of head librarians at universities and higher learning institutions asked respondents to identify every type of repository maintained by their institution for OA scholarly publications. Central repositories proved to be the most common choice by far; this option was selected by 72% of respondents, followed by faculty/departmental repositories (72%) and systematic researcher-level archiving (7%). Only 15% of respondents indicated that their institution has no institutional repository or systematic archiving. Thus, surprisingly, many institutions appear to have at least one OA repository but no OA policy.

Notable infrastructure developments include the following.

- In Germany, the German Initiative for Network Information (DINI) has launched several projects to support the technical development of a network of digital repositories and actively encourages the process of DINI certification. One such project includes the Network of Certified Open Access Repositories, which seeks to intensify the national networking of repositories, integrate all document and publication services with a DINI certificate and increase the number of DINI certified repositories. Germany also has a number of projects addressing digital preservation, such as nestor and kopal.
- In the UK, ERIS (Enhancing Repository Infrastructure in Scotland) is an initiative funded by the Jisc for the development of user-led solutions that will motivate researchers to deposit their work in repositories, and facilitate the integration of repositories into research and institutional processes.
- In France, the Centre pour la communication scientifique directe is dedicated to the realisation of open archives. An organisation of the Centre national de la recherche scientifique (CNRS), it has developed the HAL, TEL and MediHal repositories. The platform developed to create the HAL multi-disciplinary open archive, which was launched in 2001, has been used by many research organisations around the world as a model to build their institutional repositories.
- The Netherlands is considered a pioneer in the development of research repositories, starting with the DARE programme (2003–2006) to ensure public access to the research results produced by the Dutch universities, followed by the SURFshare programme (2007–2011), which built on the existing knowledge infrastructure. All Dutch research universities have one or more repositories.

In the EU, the move towards open European e-Infrastructure is also evidenced by large-scale initiatives like DRIVER (Digital Repository Infrastructure Vision for European Research) which evolved into OpenAIRE; DILIGENT (Digital Library Infrastructure on Grid Enabled Technology); the Content Enrichment Projects funded by the EU programme eContentplus, which demonstrates the advantages of enrichment with well-defined and structured metadata; and e-SciDR (Towards a European Infrastructure for e-Science Digital Repositories), a study to drive forward the development and use of digital repositories in the EU in all areas of science.

A limited number of institutional repositories are dedicated to research data; many data repositories are central repositories that address specific scientific data needs. Prominent examples include NIH's GenBank, the DNA DataBank of Japan (DDBJ), the European Molecular Biology Laboratory (EMBL) Nucleotide Sequence Database, and the ClinicalTrials.gov database. Most data repositories, however, are run by smaller governmental entities, such as states, provinces, and municipalities. However, the US portal data.gov, which became operational in 2009, was the first open data portal established by a country; it offers OA to staggering amounts of data. Other national OD portals within the ERA and selected countries, including Austria, Belgium, Brazil, Canada, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, and the UK. A number of other governments are in the process of developing the infrastructure required to collect, manage, and disseminate scientific data, as well as disciplinary standards to index specific types of records in the face of an ever-rising tide of data.

8 Success Factors and Barriers Impacting the Growth of Open Access at the National Level

An analysis of the data collected for this study, as well as the detailed country profiles collected as part of the OpenAIRE² and the Global Open Access Portal (GOAP)³ initiatives, reveals the major critical success factors and barriers that characterise the development of OA in the examined countries.

The claimed success factors associated with approaches to OA are listed here. Please note that several of these factors could be self-serving to OA stakeholders and that more research is required to determine more rigorously how important each of these determinants are.

- the fact of being a signatory to the Berlin Declaration on Open Access;
- legislation requiring that the results of funded scientific activity be made publicly available;
- a coordinated, national platform (e.g., initiative, programme) or body (e.g., working group, council, network, advisory board, consortia, committee, etc.) with an objective to increase awareness of OA;
- a common national OA research database or portal and/or a centralised source of information on OA;
- national funding mandates related to OA, including those implemented by major public research funding bodies;
- institutional mandates to green self-archive in an OA repository;
- central funds or grant support to cover some or all of the indirect costs of publishing in OA journals;
- sustained public funding of OA programmes or infrastructure;
- high levels of awareness among and balanced involvement of stakeholders across sectors and disciplines in OA debate and advocacy;
- participation in regional and international initiatives (e.g., OpenAIRE and COAR [the Confederation of Open Access Repositories]);
- a high prevalence of OA repositories at universities; and
- a vibrant and well-funded OA journal publishing environment, where publishers are further encouraged to develop OA models.

The claimed barriers hindering the progress of OA in some countries are the following:

- the lack of a national OA mandate;
- no coordinating national body, platform or strategy for OA;
- limited public funding for OA projects and programmes;
- little interest in or budgeting for OA in relevant institutions;
- voluntary (not mandated) deposit of research articles or data in OA repositories;
- a lack of awareness and persistent misperceptions surrounding OA in the research community, particularly with respect to
 - cost to researchers of OA in pay-to-publish models,
 - the lack of awareness of free OA solutions,
 - the time and effort needed to deposit,

² <https://www.openaire.eu/en/open-access/country-information>.

³ <http://www.unesco.org/new/en/communication-and-information/portals-and-platforms/goap>.

- copyright and digital rights,
- long term digital preservation, and
- quality assurance.
- the lack of a national infrastructure for OA and limited funding for the development of digital infrastructures;
- a lack of OA journals of sufficient quality in specific fields;
- self-archived material that is not Open Access Initiative (OAI) compliant or retrievable;
- active publishing lobbies;
- concerns surrounding the viability of national scholarly publishing alongside OA; and
- a lack of financial support and business models for OA publishing.

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