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Mutual Learning Exercise: Open Science- Altmetrics and Rewards

How to use altmetrics in the context of Open Science

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MLE on Open Science: Altmetrics and Rewards – How to use altmetrics in the context of Open Science

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Mutual Learning Exercise Open Science- Altmetrics and Rewards

How to use altmetrics in the context of Open Science

Thematic Report No 2

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Directorate-General for Research and Innovation

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1 INTRODUCTION

According to the Mutual Learning Exercise's (MLE) *modus operandi*, the overall goal for this second topic in the series, **How to use altmetrics in the context of Open Science,** is to: "Identify and discuss practical examples/best practices of how altmetrics (short for 'alternative metrics') are being used for evaluating research and rewarding researchers for engagement with open science."

In addition to reviewing the current uses of altmetrics in EU Member States (MS), this report will therefore discuss: how altmetrics could contribute to the academic reward system, and how altmetrics could promote wider adoption of Open Science.

This report starts by giving a brief overview of Open Science and the academic reward system in general, then moving deeper into the connection between altmetrics and open science, followed by (possible) practical examples of how altmetrics are currently being used for research assessment and as part of the academic reward system in Member States. It concludes with recommendations for how altmetrics could be used for these purposes. This report is based on a review of relevant background literature, discussions at working meetings in Brussels (7 April 2017) and in Helsinki (31 May 2017) and on the answers to open-ended questions sent to the participants of the MLE.

2 BACKGROUND

2.1 Open Science

The most cited definition of Open Science probably comes from Nielsen (2011) who defined it as "the idea that scientific knowledge of all kinds should be openly shared as early as is practical in the discovery process". Opening up the research process and research outputs (e.g. scientific articles and datasets) has many potential benefits. According to Friesike and Schildhauer (2015) Open Science aims at "increasing research quality, boosting collaboration, speeding up the research process, making the assessment of research more transparent, promoting public access to scientific results, as well as introducing more people to academic research". However, while Open Science has been fostered and welcomed in some fields, the move towards it has been slow among research institutions and researchers in most disciplines.

Science and research can be made open in different ways. Friesike and Schildhauer summarise earlier research about Open Science and list five different forms or aspects of it by interpreting the meaning of "open". First, open means **increased transparency** in the research process, as in opening the data and methods up for reuse, and thus ensuring replicability of research. Second, open means **collaborative**, as in making the research process public and allowing for others to join in and contribute to it. Third, open means a **broader understanding of impact**, reflecting the need to update standards and motivate researchers to focus on quality not quantity. Friesike and Schildhauer discuss the role of diverse quantitative indicators and research 'impact' in motivating researchers to adopt Open Science ideology by making their work more accessible. Fourth, open means writing in **understandable language** and including the public in the research process through citizen science. Fifth, open means research publications are **accessible to anyone (Open Access, OA).**

Open Science means…-

- increased **transparency** of the research process
- increased **collaboration** that makes the research process public
- broader understanding of **impact**, leading to new research incentives
- **understandable** or non-academic writing styles and promoting citizen science
- **accessible** to anyone through open access publications

Fecher and Friesike (2014) review literature on Open Science research and distinguish **five** "Open Science schools of thought". The first is called the **public school**, which incorporates ideas of making the research process accessible and making the research results understandable (i.e. writing that anyone can comprehend). The second is called the **democratic school**, which focuses on the accessibility of research outputs, i.e. open access publications and open research data which has been described elsewhere as a "human right", a "necessity for human development", and as a "catalyst for development". Research funded by tax-payers should be free of charge to tax-payers, is the logic behind the democratic school. The third is the **pragmatic school**, which argues that open research processes encourage wider collaboration and information-sharing. The fourth is called the **infrastructure school**, which sees Open Science as a technological challenge that can be tackled by unlocking software, applications and computing networks to facilitate more open and inclusive science. The fifth and final school is known as the **measurement school**, where existing measures of scientific impact are complemented by novel measures developed from new types of data and indicators that better reflect the modern digital age – information is shared more rapidly and efficiently online.

Open Science schools of thought…

1. Public school: Making the research process accessible and the results understandable
2. Democratic school: Open access to scientific publications and data
3. Pragmatic school: Collaboration and information-sharing
4. Infrastructure school: Accessible software, applications and computing networks
5. Measurement school: Updating traditional metrics to better fit the modern digital age

The Open Science movement has been slow to win ground among researchers in some disciplines, mainly because of a disconnect between the 'schools of thought' and the academic reward system. While the academic reward system can be defined as "the many ways in which an institution and field regards faculty – including, but not limited to, how it recruits, sustains, assesses, and advances faculty throughout their careers" (O'Meara et al., 2008, p. 161-162), most incentives in the academic system can be traced back to scientific publications, high-impact scientific journals and the attention publications receive – formal citations from other scientific publications. The criticism against these have, however, intensified in recent years.

In order to promote Open Science at national level some, Member States are in the process of creating a roadmap for Open Science/Access and some already have such plans in place. The national strategy of Open Access to scientific publications and research data in Slovenia

(2015-2020), for instance, states that "evaluation of researchers, research organisations, research programmes and projects should encourage open accessibility of scientific information in the form of publications and research data". The criteria, it continues for evaluating science should also include relevant new methods. Another example comes from Lithuania where the main outline for the policy concerning Open Access (Article 51 of the Law on Higher Education and Research) states that "results of all research works carried out in state higher education and research institutions must be communicated to the public" providing it respects data, secrecy and privacy laws. Another example is Finland's Open Science framework (www.doria.fi/handle/10024/130363), which sets national principles that govern data and services used in science and research, the exchange of information, and the development of e-services in the country.

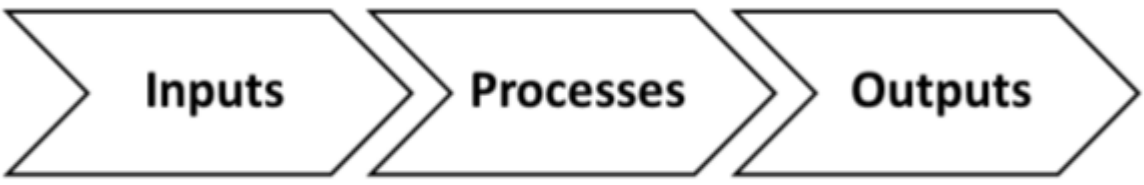
The adoption of Open Science has been slow in many Member States. Universities are not always receptive, as they fail to see a strategic advantage in Open Science and the researchers who do well with the traditional system (often senior) are reluctant to change it. To reverse this trend, it was suggested during discussions that Open Access (OA) publishing should be mandatory: "The only way to get people to publish OA is to make it part of the academic reward system." Changing the funding criteria to include or require Open Science strategies was seen as the best motivator for rapid change.

2.2 The academic reward system

The academic reward system is an "ever-present, ongoing system of participation, action, and consequences that influence faculty priorities and careers" (O'Meara, 2011), or simply the actions connected to "the valuing of people's professional lives" (O'Meara, 2002, p. 77). Although faculty roles span from teaching to supervision and from research to engagement with the public, research activities – and especially research outputs in the form of peer-reviewed scientific articles and citations – are still the most highly valued in terms of promotion, tenure and recognition (O'Meara, 2011).

The academic reward system is a complex interplay of demographics, personal characteristics, and work performance which O'Meara (2011, citing earlier work) divides into three groups: inputs, processes and outcomes. **Inputs** include, for instance, individual characteristics (e.g. gender, race, age, background) and experiences, appointment type and associated reward structures, and external influences, such as university rankings and conditions on the academic labour market. **Processes** include performance and productivity in teaching, research and service, and assessments and reviews of these, among other things. **Outcomes** include promotion, tenure and contract renewal, pay, recognition by peers, organisational commitments, and opportunities for professional growth. The academic reward system thus contains elements that are beyond the control of an individual researcher and incentives that are the source of motivation for faculty members.

Figure 1: Elements of the academic reward system; Inputs, Processes, and Outputs



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3 ACADEMIC REWARD SYSTEM

3.1 Use cases for altmetrics

As scholarly communication is increasingly moving away from the traditional formats of publishing research in specific journals and as citation-based research evaluation is increasingly criticised (e.g. the San Francisco Declaration on Research Assessment, DORA, at http://am.ascb.org/dora), some alternative or complementary sources of data about research impact or attention are being investigated under the umbrella term *altmetrics*. Although altmetrics does not yet have a widely accepted definition, the idea and potential of altmetrics is that the mentions and other indicators of visibility and awareness (e.g. number of tweets, comments, blog entries, news stories, Wikipedia references, and social bookmarks) a scientific article and other research outputs receive on the web, in general, and in social media, in particular, could tell something about the impact or influence of that research or of the engagement people have had with it. Shema, Bar-Ilan & Thelwall (2014) try to capture this as they define altmetrics as "web-based metrics for the impact of scholarly material, with an emphasis on social media outlets as sources of data". We know that research has impact far beyond citations, in fact, less than 1 % of the article views in the Open Access journals of the Public Library of Science (PLoS) result in later citations, leaving 99 % of the engagement "uncaptured" (Lin & Fenner, 2013). Thus most of the impact or influence of research articles is never captured when using citations alone as an indicator. In addition, citations can only tell something about scientific impact of research, as acknowledged by other researchers, while funders and policymakers are increasingly demanding evidence of a wider, societal impact of research (e.g. REF2014 in the UK, www.ref.ac.uk).

Research in general has multiple audiences and research impact and attention received can be identified, collected and measured from a wide range of different sources on the web and in social media. For instance, earlier research suggest that Mendeley, the online reference manager used by many researchers, can reflect scientific impact (Li, Thelwall & Giustini, 2012), while attention on Facebook and Twitter probably comes from a wider audience not limited to researchers alone (Bornmann, 2014). In a similar way, mentions in policy documents could reflect the societal impact of how research is being used in policymaking. By investigating novel data sources, such as those mentioned above, for mentions of research products we are able to give a more nuanced understanding of where, how and on whom research has had an impact, thus tying back to what Friesike and Schildhauer (2015) describe as the motivating or "incentivising" function emanating from a broader understanding of impact and what Fecher and Friesike (2014) called the "measurement" school of thought of Open Science. While certain citation-based indicators are still regarded as important and efficient when used responsibly, many Member States prefer not to rely on a single measure, but apply various indicators in research evaluation. This would allow for a broader and more nuanced picture of 'impact' and help mitigate the shortcomings of individual metrics.

While the meaning of altmetrics – and in particular the link between altmetrics and open science – is still somewhat unclear, Member States are thinking about alternative or complementary metrics and methods of assessment to make better decisions. Another potential of altmetrics is for it to showcase different types of impact on society, such as on health, economy, environment, and culture, by mapping the people and organisations affected by, exposed to and engaging with research outputs. Methods to evaluate the impact of all types of research outputs and different types of impact should be developed, and existing methods and metrics should be reviewed regularly.

Of interest is also the possibility of focusing on the research process instead of research outputs. Opening up the process could allow for the undervalued parts of research to be identified. However, this could prove to be difficult unless a unique identifier is attached to research output to capture the altmetric events surrounding it. Currently, most altmetric events are identified by the use of DOIs (Digital Object Identifiers), which is problematic as not all scientific journals use DOIs (for instance, many national journals in national

languages do not use them) and, when they are used, they are not attached to all research outputs. This puts into question whether it is only high-impact international science that is being tracked with altmetrics, while important and interesting national research published in national languages remains undetected. A better understanding of the meaning and reliability of altmetrics is needed. Because of the many uncertainties with altmetrics, many EU countries are still waiting to see what other Member States are doing before implementing any changes to their own systems.

- The NISO Alternative Assessment Metrics Project (NISO, 2016) set out to specify definitions and terminology connected to altmetrics, and to identify the main use cases relevant to altmetrics and the stakeholder groups. The project defines altmetrics as "the collection of multiple digital indicators related to scholarly work". These indicators are obtained from various online engagements between diverse stakeholders and scholarly outputs. The stakeholders of altmetrics (in no particular order) listed in the report by NISO are: librarians, research administrators, members of hiring committee, members of funding agency, academics/researchers, publishers/editors, press officers/public information officers/journalists, and content platform providers.

The NISO report lists three main use cases for altmetrics:

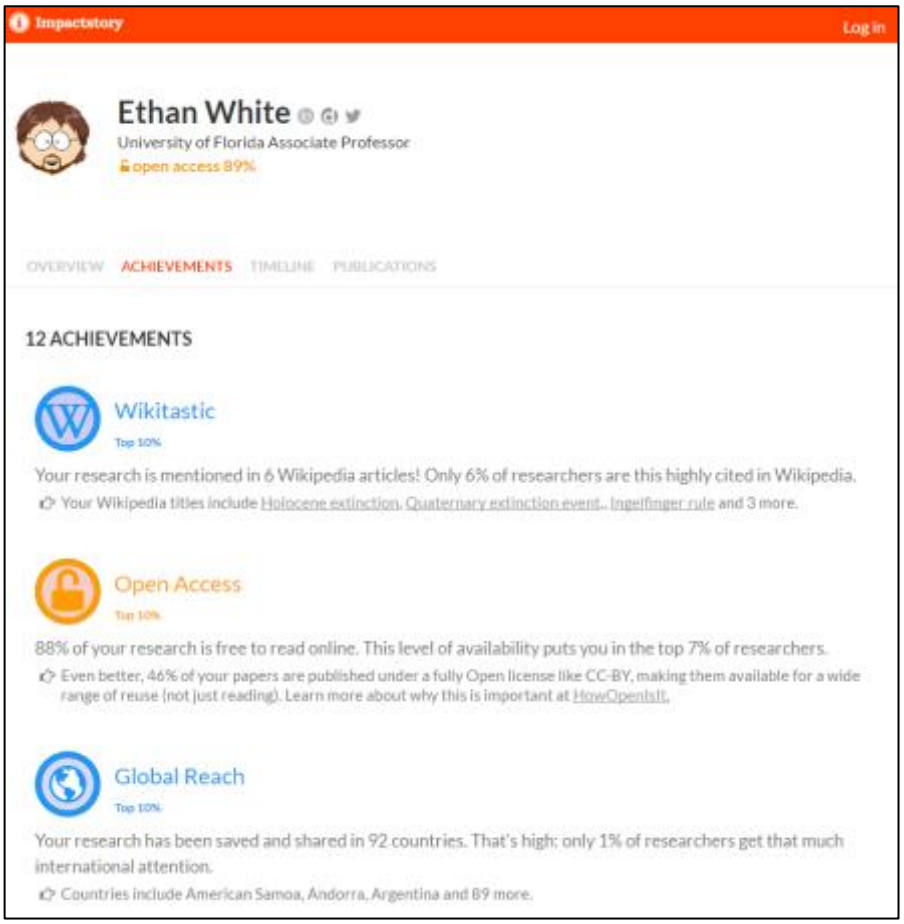
1. Showcase achievements: Indicates stakeholder interest in highlighting the positive achievements garnered by one or more scholarly outputs.

2. Research evaluation: Indicates stakeholder interest in assessing the impact or reach of research.

3. Discovery: Indicates stakeholder interest in discovering or increasing the discoverability of scholarly outputs and/or researchers.

Using altmetrics to showcase achievements could help motivate researchers to publish their research in Open Access journals and to share their research data openly. Impactstory (https://impactstory.org) is an example of an online service where researchers can create professional profiles not only to showcase their publications, but also their specific achievement attached to them as measured with altmetrics (Figure 3). Researchers are granted badges that showcase, for instance, how much of their work is published in Open Access journals, how their work has been referenced in Wikipedia, how the code they have written has been used by others, and many other achievements that demonstrate the quality of their academic work through the attention and take-up it received. As online academic social networks like ResearchGate are popular among some researchers, online professional profiles and badges such as those awarded by Impactstory may encourage researchers to adopt Open Science ideology because it showcases a more complete set of academic achievements.

Figure 2: Example profile at Impactstory



Source: https://impactstory.org/u/0000-0001-6728-7745

Besides using altmetrics to showcase specific achievements, they could be used to point researchers in the direction of interesting and valuable research, which has received significant attention from other researchers and from the general public. With the continuous growth of scientific literature (e.g. Jensen, Saric & Bork, 2006; Larsen & von Ins, 2010; Bornmann & Mutz, 2015) and an estimated doubling of scientific literature every nine years (Bornmann & Mutz, 2015), it is increasingly important to develop new filtering mechanisms in order to help researchers find the most valuable publications for their work. In addition, while the Open Science movement still lacks the incentives for individual researchers to adopt it, which in turn hinders its uptake, altmetrics could fill the gap by providing novel indicators for **attention, visibility and impact**. The same mechanisms and indicators could therefore help researchers find the most valuable publications and function as an academic reward mechanism. Similarly, altmetrics can inform funders, policymakers and other stakeholders of the wider impact of research and give a broader and more nuanced understanding of the impact research has made and the attention it has received from different audiences.

There are, nevertheless, some concerns about data quality that need to be resolved before altmetrics can be reliably used for assessing research in that way. The report of the NISO Alternative Assessment Metrics project addressed some of these concerns and called for altmetric data providers and aggregators to commit to the following:

1. Transparency by offering information about how and how often the data is generated, collected, aggregated, and how it can be accessed

2. Ensure replicability by documenting any changes in methods to collect and access the data

3. Maximise accuracy by identifying, correcting and communicating any errors, corrections or changes in data and in access to the data

How the altmetric data providers and aggregators will comply remains to be seen.

3.2 The importance of publication databases

We cannot study aspects of Open Access publishing (on international or national level) unless we have accurate data about which publications are published that way and which are not. The data available in the major citation databases is incomplete, at best, on matters of Open Access and about the existence of alternative sources. The Directory of Open Access Journals (DOAJ, https://doaj.org) could be used to check if a specific journal is listed as Open Access. CrossRef (https://www.crossref.org) could be queried to see if the publisher has reported an open license. The Bielefeld Academic Search Engine (BASE, https://www.base-search.net) could be used to search for a green OA version of a specific article. Yet these sources alone are limited in various ways and would not be that helpful analysing, for instance, developments in OA publishing at a national level. There are, however, some national efforts to collect metadata about research publications including information about OA publications, which would allow for national analysis. In Sweden, for instance, metadata about research publications is stored in the SwePub portal (http://swepub.kb.se/), which allows for the metadata (including information about OA publications) to be downloaded for bibliometric analysis. A similar system, called VIRTA, is being developed in Finland to collect information about research publications from Finnish universities and research institutions. VIRTA will offer access to the metadata through an application programme interface or API, which is a small program to gain access to data or certain features. NORA (Norwegian Open Research Archives) in Norway (http://www.cristin.no/english/open-access-eng/nora/) is a service that brings together data from institutional repositories and national Open Access journals, and makes them searchable. The Danish National Research Database (http://www.forskningsdatabasen.dk/en/open_access/overview) uses an Open Access indicator to monitor how the national goals for OA publishing are met. On an international level, the European OpenAIRE project (https://www.openaire.eu) and the platform developed in the project aims at collecting publication metadata on a European level and make it easily searchable. National and international databases, such as those mentioned above, serve as base from which the development of OA as well as metrics based on OA to be further analysed.

3.3 Opening research metrics

Another aspect connecting altmetrics closely to Open Science is the fact that these measurements generally rely on openly available data about online mentions of research products, such as scientific articles identified or mentioned (i.e. through DOIs). Data for altmetrics is often traced and collected through open APIs of various social media sites, making the data and research more easily replicable than when using data from purely proprietary databases. In addition, some altmetrics data aggregators such as Altmetric.com and ImpactStory provide API access to their data. This kind of openness allows for the development of what could be called *open metrics*, in contrast to metrics that are derived from (citation) data bought from commercial sources. However the degree of openness this affords is still limited. Some of the providers offer free access to their data through APIs, but not to the full data stream. Even if access to data was free and full, the work that goes into aggregating the data (in many cases from multiple sources) is not free, which makes it difficult to say with confidence that that altmetrics is equal to open metrics. However, they are helping to open up research metrics and thus contributing to Open Science.

4 ALTMETRICS AND THE ACADEMIC REWARD SYSTEM

4.1 Incentives in the academic reward system

In addition to incentives for the individual researcher to adopt Open Science, the incentive structures according to Friesike and Schildhauer (2015) include:

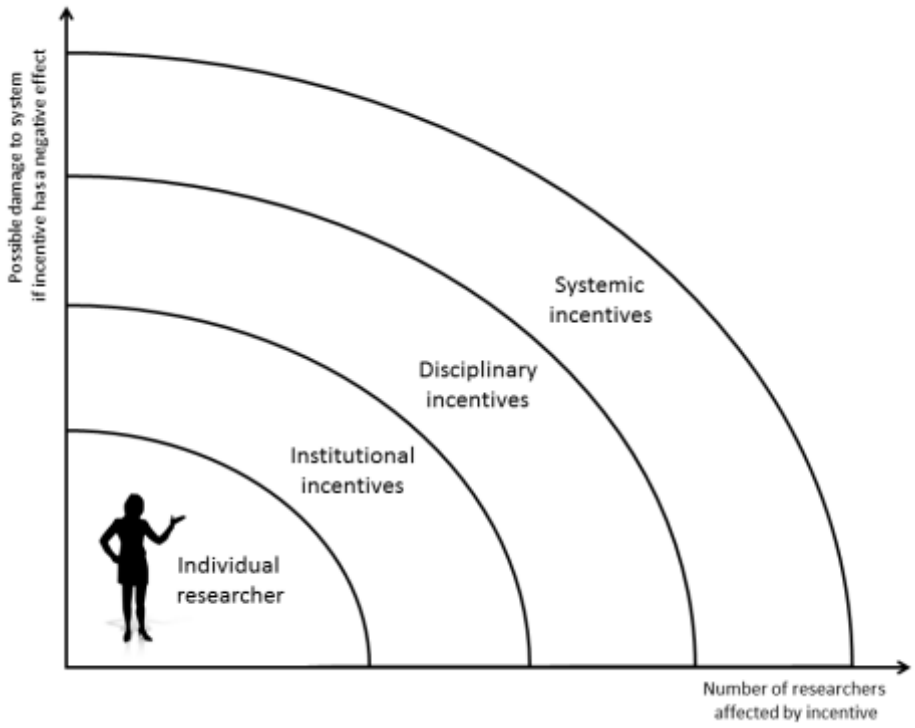
1. **Institutional incentives,** e.g. institutional blogs, data repositories, archiving services, OA appointees, funding options for OA publishing, and advisors that mentor and orient young researchers towards open science

2. **Disciplinary incentives, e.g.** disciplinary databases for research data and scientific journals with specific policies for open research data

3. **Systemic incentives,** which affect researchers regardless of their institution or discipline, such as requirements for Open Science in research funding

In addition to the incentives listed by Friesike and Schildhauer (2015), there are also **societal incentives,** such as influencing policymaking, engagement with the public, public demand for open science, which can stimulate Open Science at all these levels.

Figure 3: Forms of incentives to promote Open Science (adapted from Friesike and Schildhauer, 2015)



With growing competition for promotions, tenure and research funding, researchers are making increasingly strategic decisions about how to best use their time in order to further their careers. Here, however, lies a contradiction between what is best for the individual researcher and what is best for science as a whole. Friesike and Schildhauer call this the "social dilemma" of Open Science and write: "What is in the best interest of the scientific system is not what incentivizes the individual researcher." With this, the authors mean that the individual researcher is mainly motivated by actions that help them further their career, i.e. publishing scientific articles in specific high-impact journals. It is thus not reasonable to expect researchers to adopt the principles of Open Science just to improve the system at the expense of their own career development. The incentives to adopt Open Science strategies **must also benefit researchers' individual career development**. Researchers need clear incentives that are in line with their own career ambitions but which

also improve the system (Leonelli et al., 2015; Levin et al., 2016). Open Access Citation Advantage (OACA) could be such a thing.

4.2 Open Access Citation Advantage

There is plenty of evidence[1] that OA articles do receive more citations compared to articles that are not openly available (Lawrence, 2001; Antelman, 2004; Harnad & Brody, 2004; Houghton & Sheehan, 2009; Kousha & Abdoli, 2010). For instance, Wang et al. (2015) discovered that open access papers in *Nature Communications* received more citations compared to other non-Open Access papers in the same journal and that the attention the papers received (in the form of downloads) lasted much longer for the OA papers, as the number of downloads quickly fell for non-OA papers after an initial peak. The extent of the OA advantage seems, however, to vary between disciplines (Hajjem et al., 2005). In some cases it has been argued that the OACA is self-fulfilling; the authors elect to make their best work openly available online which then results in higher citation counts. However, Gargouri et al. (2010) came to the conclusion that the OA advantage is "real, independent and causal, but skewed". The authors conclude that the advantage of OA is greater for more citable articles not because of a "quality bias" resulting from authors selecting what to publish in open formats, but because of a "quality advantage" thanks to OA's ability to lift the constraints of selective accessibility to subscriber-only publications. In other words, OA makes it possible for users to choose the articles that best suit their needs.

4.3 Open Peer Review

Altmetrics is closely related to the Open Science movement, partly because it is mostly derived from openly available mentions (in contrast to the major proprietary citation databases) of scientific articles and to some degree other research products. One of the ideas with altmetrics, and Open Science, is that Open Peer Review could replace the current standard of double-blind Peer Review. With an open review process, reviewers would get credit for this otherwise hidden part of their work, while the openness of the process could lead to increased transparency. There are, nevertheless, some potential drawbacks with Open Peer Review, as some reviewers may feel reluctant to give negative reviews of renowned researchers' work, thus leading to self-censorship to avoid clashes.

This does not take away from Open Review's ultimate potential to measure impact and filter quality, simply tapping into existing online communications that mediate the "wisdom of crowds" and point to more valuable scientific work (Priem, 2011). As the current system of academic publishing still holds ground and forms the backbone of the academic reward system in the form of citations, it may take some time before it is changed or replaced. **Altmetrics may still be our best shot at changing the current system towards a broader understanding of research impact and openness.**

4.4 Open Access altmetrics advantage

There is indeed evidence that OA publishing and sharing of the articles openly in social media can help researchers and their research to get noticed (e.g., Adie, 2014; Shema et al., 2014; Alhoori et al., 2015; Wang et al., 2015, Niyazov et al., 2016). For example, Wang et al. found that OA articles in a specific hybrid journal received more social media attention compared to other articles in the same journal. Alhoori et al. discovered that OA articles received higher altmetrics than non-OA articles, but that the OA advantage was clearly less significant when the authors took other factors such as journal, publication year and citation counts into account. Shema et al. discovered that articles mentioned in blogs received more citations.

[1] For an extensive bibliography of research about Open Access citation advantage visit http://sparceurope.org/oaca.

Meanwhile, Niyazov et al. studied articles uploaded to the academic social networking site Academia.edu and compared their citation rates with papers published in similar journals but not available through Academia.edu. The results showed that articles uploaded to Academia.edu received 37 % more citations after one year compared to similar articles that were not openly available online. After five years the advantage had grown to 83 % more citations. The authors of this study noted some competing interests, as Academia.edu paid its employees, contractors and an external consultancy to perform this study.

Although some studies have shown that early altmetrics are associated with later citations. It is still unclear whether the papers receive more citations because they were shared online more or because they were of higher quality and thus received more attention both in the form of online mentions and later citations. Still, the fact alone that OA articles receive more citations and online attention may encourage researchers to publish their work openly online.

5 RESEARCH EVALUATION AND OPEN SCIENCE

5.1 Responsible use of metrics

Both citations and publication channels are widely used in research evaluation (e.g. Garfield, 1972; Moed et al., 1985; Moed et al., 1995) and they are also fundamental parts of the academic reward system (Merton, 1968). Indeed, highly cited authors are regarded as having made a significant contribution to science, and their work considered to be of higher quality, because getting a manuscript published in a respected journal is thought to be tougher. Thus, both citations and journals (to some degree) are considered as proxies of scientific quality. Neither citations nor publication channels can, however, reflect the true impact that the research may have had on an audience beyond academia, or measure the attention other forms of scientific output (e.g. datasets, code) or academic work (e.g. teaching, societal engagements) have received.

A broader understanding of the impact that research has on society is needed. Both Friesike and Schildhauer (2015) and Fecher and Friesike (2014) describe how incentives and the broader understanding of impact may lead to changes in the academic reward system, and to increased adoption of Open Science. Several earlier reports also point out the importance of using existing metrics (and new metrics) responsibly and transparently.

5.1.1 The Leiden Manifesto for research metrics

Research evaluations are increasingly led by data and metrics rather than Peer Reviews and judgement. The authors of the Leiden Manifesto call this "abuse of research metrics" and offer a list of best practices for metrics-based research evaluation (Hicks et al., 2015). The ten principles of the Leiden Manifesto are:

1. Quantitative evaluation should support qualitative, expert assessment
2. Measure performance against the research missions of the institution, group or researcher
3. Protect excellence in locally relevant research
4. Keep data collection and analytical processes open, transparent and simple
5. Allow those evaluated to verify data and analysis
6. Account for variation by field in publication and citation practices
7. Base assessment of individual researchers on a qualitative judgement of their portfolio
8. Avoid misplaced concreteness and false precision
9. Recognise the systemic effects of assessment and indicators
10. Scrutinise indicators regularly and update them

The authors of the Manifesto acknowledge that research metrics can (when used appropriately and correctly) provide valuable information that would be difficult to obtain through Peer Review, which relies on individual knowledge, but that quantitative methods should not be used alone. The authors conclude the Manifesto by stating that "the best decisions are taken by combining robust statistics with sensitivity to the aim and nature of the research that is evaluated". Metrics alone cannot inform decisions, but when high quality data is placed in context and carefully examined against the goals of the research being evaluated, quantitative evidence together with qualitative evidence can help in making informed decisions.

5.1.2 The Metric Tide

The Metric Tide report contains the findings and recommendations of the Independent Review of the Role of Metrics in Research Assessment and Management (Wilsdon et al., 2015). While the report is specifically intended to aid in future Research Excellence Frameworks (REF) in the UK, many of the recommendations apply to the international context. Building on the concept of "responsible research and innovation", the Metric Tide report puts forward the notion of **responsible metrics** that include the following dimensions:

1. **Robustness**: basing metrics on the best possible data in terms of accuracy and scope

2. **Humility**: recognising that quantitative evaluation should support – but not supplant – qualitative expert assessment

3. **Transparency**: keeping data collection and analytical processes open and transparent, so that those being evaluated can test and verify the results

4. **Diversity**: accounting for variation by field and using a variety of indicators to support diversity across the research system

5. **Reflexivity**: recognising systemic and potential effects of indicators and updating them in response

With these, the Metric Tide report highlights the importance of using the best possible data, combining quantitative and qualitative methods in research assessment, keeping data and methods open, taking diversity of science into account, and recognising unwanted side-effects in using indicators.

5.1.3 Next generations metrics: responsible metrics and evaluation for Open Science

The report of the European Commission Expert Group on Altmetrics reviews the state of the art in the field and summarises the results into five findings followed by a set of recommendations (Wilsdon et al., 2017). The five headline findings of the report are:

1. An Open Science system should be grounded on a mix of expert judgement, quantitative and qualitative measures

2. Transparency and accuracy are crucial

3. Make better use of existing metrics for Open Science

4. Next-generation metrics should be underpinned by an open, transparent and linked data infrastructure

5. Measure what matters

The report reiterates the recommendations from earlier high-profile reports on research metrics and highlights the importance of using both quantitative and qualitative methods for research evaluation, the importance of transparency by opening up both the data and the methods used, and the need to take the complexity and diversity of science as a whole into account by measuring what matters in each specific case. What differs from earlier reports is the recommendation to "make better use of existing metrics for Open Science". This refers to the use of appropriate metrics to measure the progress of Open Science specifically, as in usage, collaboration and societal impact.

5.1.4 San Francisco Declaration on Research Assessment

The San Francisco Declaration on Research Assessment (DORA, http://www.ascb.org/dora) from 2012 is a set of recommended practices in research assessment, with a specific focus on assessing research on its own merits instead of relying on journal-based metrics, such as Journal Impact Factors, in funding and appointment decisions.

While each stakeholder group (funding agencies, institutions, publishers, organisations that supply metrics, researchers) have a set of targeted recommendations, the general recommendation of DORA states the following: "Do not use journal-based metrics, such as Journal Impact Factors, as a surrogate measure of the quality of individual research articles, to assess an individual scientist's contributions, or in hiring, promotion, or funding decisions." The declaration has been signed by over 12 000 individuals and almost 1 000 organisations that support the adoption of the given recommendations (June 2017).

5.1.5 Amsterdam Call for Action on Open Science

The Amsterdam Call for Action on Open Science is the result of a conference on Open Science held in Amsterdam in April 2016. The Call formulates two pan-European goals leading up to 2020 and the steps that need to be taken in order to reach the goals. The two overall goals for 2020 are:

1. Full open access for all research publications

2. A fundamentally new approach towards optimal reuse of research data

The two major changes or developments that need to be completed in order to meet these goals are:

1. New assessment, reward and evaluation systems

2. Alignment of policies and exchange of best practices

In line with the San Francisco Declaration, the Amsterdam Call for Action acknowledges the problems with current research assessment methods that heavily emphasise quantity of scientific publications and the prestige of journals in which the research has been published (i.e. impact factors). This has severe negative side-effects as researchers make increasingly strategic decisions to meet the criteria with which they are being assessed, which again "inhibits the progress of science and innovation, and the optimal use of knowledge". The Call proposes the following steps as a solution to this problem (verbatim):

- Ensure that national and European assessment and evaluation systems encourage open science practices and timely dissemination of all research outputs in all phases of the research life cycle.

- Create incentives for an Open Science environment for individual researchers as well as funding agencies and research institutes.

- Acknowledge the different purposes of evaluation and what 'right' criteria are. Amend national and European assessment and evaluation systems in such a way that the complementary impact of scientific work on science as well as society at large is taken into account.

- Engage researchers and other key stakeholders, including communications platforms and publishers within the full spectrum of academic disciplines. Set up assessment criteria and practices, enabling researchers to exactly understand how they will be assessed and that open practices will be rewarded.

5.1.6 Summary of recent recommendations and declarations

The above recommendations highlight specific aspects of responsible use of metrics in research evaluation:

- Metrics should be used to support or complement qualitative expert assessment
- Research assessments should take goals and missions of the evaluated entities and variation by field into account.
- Research assessments should be based on best available data and keep both data collection and analytical processes open and transparent.
- Indicators and methods should be scrutinised regularly to recognise systemic effects or false precision and they should be updated accordingly in response.

Responsible and transparent use of research metrics is crucial, but that alone does not necessarily foster wider adoption of Open Science. According to the Next-generation Metrics report, research metrics can have two roles in supporting of open science: 1) "monitoring the development of the scientific system towards openness at all levels", and 2) "measuring performance in order to reward improved ways of working at group and individual level".

In addition to these, the reviewed recommendations and calls above show a clear desire to update the current research metrics so that they can better **reflect a broader understanding of the impact research has had and to create incentives for adopting Open Science** at all levels.

5.2 Research evaluation in the Member States

There are great differences in how research is being evaluated at governmental level among EU Member States (MS) and in some cases even inside a single MS. In many MS there are clear regulatory or legislative instruments in place that dictate procedures for research evaluation. In many cases the evaluations are performance-based, using mainly quantitative assessment of scientific publications and other research and teaching activities (such as collaboration with industry and business, amount of competitive external funding, number of students and degrees awarded).

Impact statistics as indicators of performance and international peer reviews are used too. In Austria, for instance, the statutory foundations provided by a series of laws stipulate how to include the purpose, objectives, and procedures, as well as deadlines for evaluating the achievement of the funding objectives, and how the appropriate indicators must be defined. This statutory basis in is used by nearly all research and technology programmes in Austria as they evaluate their programme planning (ex-ante evaluations), programme implementation (monitoring and interim evaluations) and programme conclusion (ex-post evaluation).

Relevant documents from the MS related to this question:

- Slovenia: http://www.mizs.gov.si/fileadmin/mizs.gov.si/pageuploads/Znanost/doc/Strategije/01.06._RISSdz_ENG.pdf
- Moldova: http://www.cnaa.md/en/
- Austria: http://www.fteval.at
- Switzerland: https://www.ressortforschung.admin.ch/html/index_de.html

- Latvia: Law of scientific activity, section 41, https://likumi.lv/doc.php?id=107337

In the research evaluations of project proposals submitted to the main research funders in the MS, external reviewers (international expert panels or individual reviewers) are used by almost all MS. The evaluation procedure is thus a more qualitative evaluation of the scientific quality of the proposal, as well as the merits of the researcher(s) submitting the proposal. However, it cannot be completely ruled out that external reviewers apply metrics when evaluating a person or proposal, thus in the evaluation of the scientific merits of the researchers publication lists and sometimes impact factors are used. Depending on the proposed project, other aspects such as cooperation with industry or potential for innovations may also be assessed.

Relevant documents related to this question:

- Slovenia: http://www.arrs.gov.si/en/progproj/
- Switzerland: http://www.snf.ch/en/theSNSF/evaluation-procedures/project-funding/
- Moldova: http://www.acd.asm.md/en
- Croatia: http://www.hrzz.hr/default.aspx?id=48
- Lithuania: http://www.lmt.lt/download/7073/2%20description%20of%20the%20procedure%20for%20the%20expert%20evaluation%202016-07-04.pdf
- Austria: https://www.fwf.ac.at/en/research-funding/decision-making-procedure/decision-making-procedure/
- Latvia: https://likumi.lv/doc.php?id=262508

Overall quantitative metrics are in many cases used together with informed Peer Review, even though there are disciplinary differences in how they are used. Connecting quantitative indicators with Peer Review is seen as a way to reduce (to a certain degree) some of the unintended and potentially undesirable effects that some quantitative indicators alone may have. In some MS, there are efforts to avoid unintended effects of quantitative indicators by, for instance, requiring a limited list of publications in applications for faculty positions or leaving some freedom to the researcher to mention metrics they find interesting or advantageous to mention in their applications. Overall, the use of Journal Impact Factors was seen among the MS as problematic and as a hindrance for the development of Open Science. To diminish what Lariviére, Haustein & Mongeon (2015) describe as an oligopoly of academic publishers , it was suggested that both OA repositories and collaborative OA publishing platforms should be established and that efforts to **replace journal impact with article impact** should be made.

While some MS had not heard of the recent reports and recommendations for research assessment (4.1-4.5), others had rather clear implementation of Open Access/Science principles at a legislative level, but only a few had implemented the recommendations officially. Three MS have officially committed to the Amsterdam Call for Action on Open Science, one has officially committed to the Leiden Manifesto and one has officially committed to the San Francisco Declaration on Research Assessment (Table 1). None of the MS have made any official commitment to follow the principles or recommendations stated in the Metric Tide report or the Next-generation Metrics report. The Leiden Manifesto was specifically mentioned "as a good source of inspiration for the future development and potential use of performance indicators". Even though most of the MS have not officially commited to the recommendations or calls presented here, it appears to be likely that they have still been inspired by them when planning for their national strategies and road maps for Open science.

Table 1: Commitments from the Member States to selected recommendations for use of research metrics

	Amsterdam Call for Action on Open Science	Leiden Manifesto	San Francisco Declaration on Research Assessment	Metric Tide report	Next-generation Metrics report
Austria	X[2]		X		
Armenia					
Belgium	X[3]	X			
Bulgaria					
Croatia					
France					
Latvia					
Lithuania					
Moldova	X				
Portugal					
Slovenia					
Spain					
Sweden					
Switzerland					

[2] The Austrian Science Fund (FWF) has officially adopted the San Francisco Declaration on Research Assessment.
[3] The Amsterdam Call for Action has officially been signed by Belgium but its implementation has been postponed for further evaluation.

6 CONCLUSIONS

While there are many open questions about the definition, meaning and practical applications of altmetrics, there remains potential in these tools to: 1) offer insights into new forms of scholarly communication (i.e. how researchers are communicating about their research), 2) broaden our understanding of the impact research has made on society (possibly by mapping the networks of interactions and people, and organisations involved in them), and 3) evaluate the impact or influence that scientific output and activities have had.

By bringing new methods to showcase scientific achievements and assess the broader impact of research, altmetrics breaks away from traditional citation-based indicators and, with that, promotes change in the academic reward system and in Open Science in general.

But as discussed in this report, Open Science strategies have to be tied to the academic reward system in the form of new incentives, and altmetrics may be an important part of that change, a move away from the culture of "publish or perish". One of the responses to the questionnaires conducted in the course of this report stated that "… to change this habit [publish or perish] and build on new experiences with a new system will require time".

While this may be true of many entrenched systems built on long traditions, change can also be rapid, especially if research funding is tied to the adoption of Open Science strategies. Organisations and governments funding research are therefore in a position to promote Open Science and wider impact of research by changing their reward systems.

This thematic report gave an overview of recent recommendations for responsible use of research metrics and mapped how these recommendations have been adopted in EU Member States. While the official adoption of these principles is presently low among MS, it would appear that recent recommendations have inspired action in several countries which are now planning their Open Science strategies.

The main recommendations for responsible use of research metrics highlighted in this report are as follows:

- Assess research on its quality against the set goals and missions, not on quantity
- Quantitative indicators should only be used together with qualitative assessment
- Research assessments should be open and transparent and guarantee replicability
- Existing indicators should be regularly scrutinised and evaluation of all types of research output developed and supported

And finally, altmetrics is not ready to be used alone for research assessment. More information is needed about the meaning of altmetrics and limitations of data sources before practical and reliable applications of altmetrics can be developed.

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Altmetrics has the potential to promote Open Science by broadening our understanding of research impact, thus reflecting the need to update standards and motivateresearchers to focus on quality rather than quantity.

This report starts by giving a brief overview of Open Science and academic reward systems in general. This is followed by a discussion of how altmetrics could contribute to academic reward systems, and how altmetrics could promote wider adoption of Open Science in EU Member States.

Altmetrics are, however, not yet ready to be solely relied on for research assessment. More information is needed about the significance of altmetrics and limitations of data sources before practical and reliable applications of altmetrics can be developed.