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Mutual Learning Exercise: Open Science- Altmetrics and Rewards

Different types of Altmetrics

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MLE on Open Science: Altmetrics and Rewards — Different types of Altmetrics

European Commission
Directorate-General for Research and Innovation
Directorate A — Policy Development and Coordination
Unit A4 — Analysis and monitoring of national research and innovation policies
Contact (H2020 PSF MLE OPEN SCIENCE):
Ana CORREIA, Coordinator of the MLE on Open Science, Unit A.4- Ana.CORREIA@ec.europa.eu
Román ARJONA, Chief Economist and Head of Unit A4 - Roman.ARJONA-GRACIA@ec.europa.eu
Contact (H2020 PSF coordination team):
Román ARJONA, Chief Economist and Head of Unit A4 - Roman.ARJONA-GRACIA@ec.europa.eu
Stéphane VANKALCK, PSF Head of Sector, Unit A4 - Stéphane.VANKALCK@ec.europa.eu
Diana SENCZYSZYN, PSF Team Leader, Unit A4 - Diana.SENCZYSZYN@ec.europa.eu

European Commission
B-1049 Brussels

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Prepared by the independent expert: Kim Holmberg

Directorate-General for Research and Innovation

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1 INTRODUCTION

This report on **Different types of altmetrics** has been developed to give the participants in this mutual learning exercise (MLE) an overview of the different types of altmetrics currently being used and/or investigated for the purpose of research assessment, and discusses the benefits and challenges associated with them. Altmetrics can reflect the impact that different types of research outputs (including scientific publications, dataset, code, etc.) have had. Altmetrics data are mainly gathered from readily available online sources, making altmetrics highly relevant in the context of Open Science. This document summarises experiences (both 'good' and 'bad') concerning the use of altmetrics in the Member States (MS) and H2020 Associated Countries participating in the MLE. The report is based on a review of relevant background literature, discussions at the kick-off meeting on 27 February 2017 in Brussels, answers to a questionnaire sent to the MLE participants, and discussions during the 1st Working Meeting on 7 April 2017 in Brussels.

From the discussions with MS representatives and their response to the questionnaire it is clear that while certain MS have some Open Science initiatives either in place or in the planning, currently are no organised approaches available for the use of altmetrics in evaluating research. However, the representatives would like to learn about altmetrics and explore the possibilities they offer at the national level to support the evaluation and visibility of locally relevant research (often published in national languages and rarely included in international citation databases). They would like to see either the standardisation or harmonisation of altmetrics at the EU level (possibly building on the work of the National Information Standards Organization (NISO) on recommended practices for altmetrics: http://www.niso.org/topics/tl/altmetrics_initiative/).

The representatives want to see clear national policies and operational action plans that would include specific Open Science principles in research and education, and a road map towards Open Science at the national level. This would include establishing and developing a national current research information system (CRIS) as: 1) a reliable and sustainable base for evidence-based policymaking; 2) a source for country-relevant altmetrics; and 3) a provider of transparent, reliable and publicly available altmetrics data; sustainable support (finances and human resources) for infrastructures and platforms for data curation, data openness, dissemination and reuse; and implementation of principles laid out in the San Francisco Declaration on Research Assessment (DORA) and in the Leiden Manifesto for Research Metrics (Hicks, 2015). MS representatives would also like open access to research results and the availability of authored open educational results as a criteria for personal promotion and academic advancement for higher education teachers and researchers, as well as for research assessment in general. This would include the development of a much broader and more appropriate set of indicators and article-level metrics (ALMs) and reflections on adopting 'Open-Science-friendly' metrics that reflect the importance of different research outputs and activities. At a more general level, they want to see a cultural change with greater willingness among academic and research communities to share publications, research data, educational material and other types of scholarly work such as open access.

The representatives' expectations for this MLE are in line with their desire for change in their own countries. They would like to learn how altmetrics can or could be used for different purposes in different disciplines and how they should not be used. They also want to learn about how traditional metrics and altmetrics could be brought together to complement each other for research assessment purposes. Learning about altmetrics in general could then help shape the national debate in the MS about the use of altmetrics in policymaking. The representatives want to learn from each other about the good practices and failures of Open Science policies, regulations and practices to support and promote Open Science to be adopted by different stakeholders. Furthermore, they would like to learn about successful reward and evaluation systems; good practice in Open Science training and education programmes; and ways of ensuring open research data and exchanging and reusing it. To summarise, it can be said that the representatives want to learn how altmetrics can complement existing research metrics and promote Open Science.

2 BACKGROUND

Both citations and publication channels have been and are widely used in research evaluation (e.g. Garfield, 1972; Moed et al., 1985; Moed et al., 1995). As citations indicate use of earlier research it can be argued that they indicate something about the value (or quality) of the cited research, as assessed by other researchers. The assumption derived from this is that highly cited publications have made a more significant contribution to science when compared to publications with fewer citations or no citations at all. Citations are also part of the academic reward system (Merton, 1968), with highly cited authors tending to be recognised as having made a significant contribution to science. Similarly, publications in (so-called) high-impact journals tend to be considered as more valuable or as being of a higher quality, as it is assumed that the peer-review process in these journals is stricter and thus that only high-quality research would be allowed to be published in them. Consequently, citation counts and certain journals have become a proxy for quality. However, both approaches have some severe limitations (e.g. Smith, 2012; Vanclay, 2012; Zhang, Rousseau & Sivertsen, 2017). For example, because it can take a very long time before research results are published in a scientific article and recognised and cited by other researchers, citations can only reflect past scientific impact. On the other hand, assessing research based on the impact of the journal in which it was published can at best be an indication or estimation of future impact potential and does not necessarily say anything about the content or quality of the specific publication being assessed.

Focusing on citations and journals also misses out on all the other forms of research outputs, scholarly communications and engagements with the public that cannot be formally cited or published in a scientific journal (e.g. datasets, algorithms, code). In addition, both publishing and citation traditions vary considerably by discipline and they can be created for many different reasons, some of which do not reflect the scientific value of the cited work. This is the case for critiques or 'placeholder' citations that only mention a given work because it is the only one available on a given topic (MacRoberts & MacRoberts, 1989; Borgman & Furner, 2002). Carefully selected and responsibly used metrics can, however, complement research evaluation and support decision-making (Hicks, 2015; Wilsdon et al., 2015; Wilsdon et al., 2017).

Although citations and journals are still important for scholarly communication, they can no longer be considered as the sole venue for the communication and dissemination of scientific discoveries. Scholarly communication is changing as researchers increasingly use social media to discover new research opportunities, discuss research with colleagues, and disseminate research information (Rowlands et al., 2011). In addition, researchers are increasingly participating in public conversations and professional services, such as engaging with traditional media and journalists, public lectures and collaboration with schools. Although all these activities are evidence of scholarly activities and researchers' engagement with society, they are not taken into account with the traditional measures and methods for research assessment. As scholarly communication is breaking out from its closed ivory towers and as the Open Science movement is gaining more and more ground and funders' mandates for open access are growing, the public (those not professionally involved in scientific research) and relevant stakeholders can also be involved through citizen science, taking part in discussions about research and disseminating the research outputs in their own online networks. These online activities, either by researchers or by a wider public audience, leave traces on the web – traces that can be identified and collected as evidence of where and how research has been used, the kind of attention it has received, and by whom. In this context, it is important to emphasise that these traces do not necessarily reflect *quality* of research, but rather *reach*, *influence*, *engagement* or *impact*. Together, these online traces and the research area focused on investigating their meaning and applicability are called **altmetrics**.

In 2010, Jason Priem, Dario Taraborelli, Paul Groth and Cameron Neylon published the Altmetrics Manifesto (http://altmetrics.org/manifesto/), which begins by stating that: "*No one can read everything. We rely on filters to make sense of the scholarly literature, but the narrow, traditional filters are being swamped. However, the growth of new, online*

scholarly tools allows us to make new filters; these altmetrics reflect the broad, rapid impact of scholarship in this burgeoning ecosystem. We call for more tools and research based on altmetrics." The Altmetrics Manifesto emphasises the potential of altmetrics in filtering more valuable research outputs for researchers, practitioners and others trying to find relevant information from the rapidly growing volume of scholarly literature and other research outputs being published today. This filtering mechanism could, however, point to research with the greatest impact (or which has received most attention). The Manifesto continues: "*Altmetrics expand our view of what impact looks like, but also of what's making the impact*." By expanding the way we understand impact, altmetrics can go beyond the traditional citation-based indicators of impact and reflect the various types of impact the research has had beyond academia. Adie and Roe (2013) write that "*altmetrics presents an alternative to the current practice of relying only on citation counts and journal impact factors for the quantitative analysis of impact by introducing new complementary approaches and sources of data*." Adie and Roe (2013) also emphasise that altmetrics bring a new perspective to relying solely on citation counts and as such, rather than replacing citation-based assessment, are seen as complementing them by demonstrating other aspects of the impact a research has had.

Priem (2014) defines altmetrics as "*the study and use of scholarly impact measures based on activity in online tools and environments*", thereby focusing on the activity of using online data. Shema, Bar-Ilan and Thelwall (2014) present a similar definition and state that altmetrics are "*web-based metrics for the impact of scholarly material, with an emphasis on social media outlets as sources of data*", emphasising the actual data in their definition. Thus, altmetrics, or alternative metrics, refers to both: 1) the new research area that investigates the potential of new online data sources as indicators of impact or measures of attention that research has received from different audiences; and 2) the actual data identified and collected from different online data providers (e.g. the number of times a research output has been mentioned on Twitter, blogs, Facebook, Reddit, news articles, Mendeley, policy documents from selected sources, Wikipedia, LinkedIn, F1000, and Pinterest) about interactions with and mentions of various research outputs. These interactions could be a mere mention of research articles, sharing links to them, commenting, rating, bookmarking, saving, or in some other way indicating awareness or use of the research output. Tracking and analysing these interactions or events can expose when, where, why and how the research has influenced people and had some impact, potentially pointing to research that has had more influence on a wider audience or different audiences beyond academia. For instance, scholarly blogs have been found to play an important role in disseminating research (Kjellberg, 2010) and so-called blog citations have been suggested as a measure to predict future citations (Shema et al., 2014). Earlier research has shown a connection between usage statistics on Mendeley (Mohammadi & Thelwall, 2013), Wikipedia references (Evans & Krauthammer, 2011), and tweets mentioning scientific articles (e.g. Shuai et al., 2012; Thelwall et al., 2013), and the numbers of citations those articles receive later. Social reference manager applications, such as Mendeley and CiteULike, or recommendation systems like Reddit and Digg have also been suggested as fruitful data sources for altmetrics (Priem & Hemminger, 2010). Nevertheless, there is not yet a clear understanding of what the online attention some research receives actually signifies, what aspects of engagement or impact it reflects and by whom, or how and why some research receives more attention than others in social media and other online platforms. It is not even clear whether some altmetrics could reflect impact or quality. Therefore, altmetrics should not be used for research evaluation before these questions are answered.

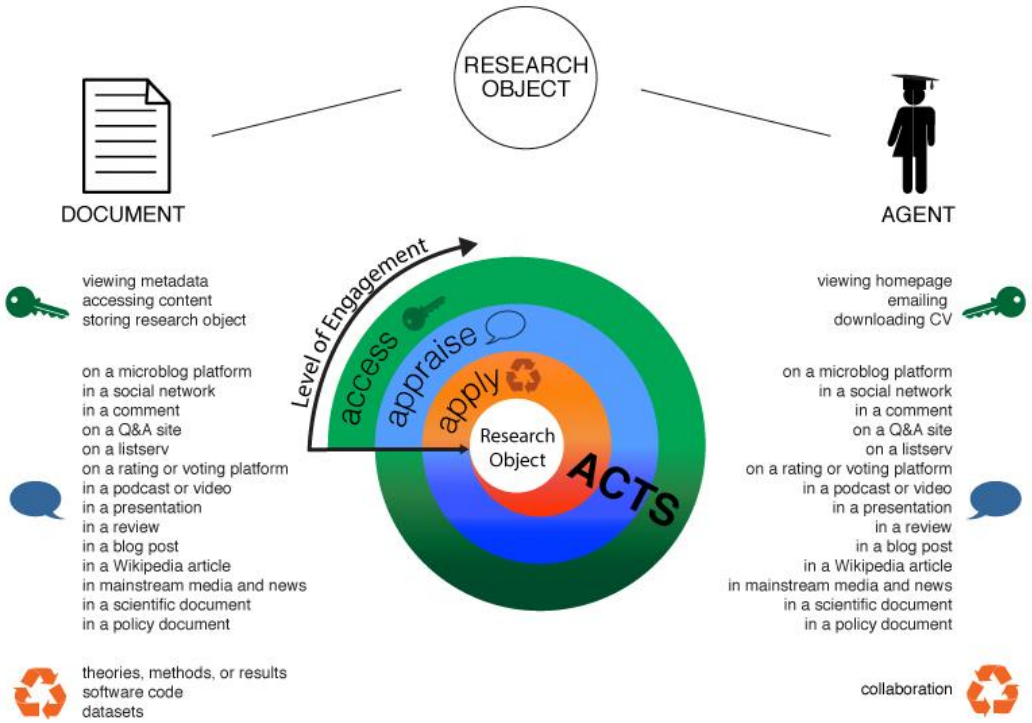
3 WHAT IS IMPACT?

During the first meetings, questions were raised about the meaning of impact and what it means for different stakeholders. Impact per se can be a difficult term to grasp, with its meanings and impact being interpreted differently by different stakeholders. Impact has been defined as "*an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia*" (Research Excellence Framework 2014, 2011, p. 26). It can also be seen as all the diverse ways that research-related skills benefit individuals, organisations and nations (Economic and Social Research Council 2016). The Research Councils UK (RCUK) defines impact as "*the demonstrable contribution that excellent research makes to society and the economy*" (Research Councils UK [RCUK], 2014) meaning that a simple indication of awareness or attention is not enough to demonstrate impact. The phrase "demonstrable contribution" requires evidence of how the results have been used by policymakers or practitioners, or how they have led to improvements or changes in society. In a similar way, the National Science Foundation (NSF) in the US evaluates two aspects of research funding proposals: intellectual merit and broader impacts, where intellectual merit refers to the potential with which the proposed research can be expected to advance scientific knowledge (scientific impact) specifically as well as its broader impacts "*encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes*" (National Science Foundation [NSF], 2016). As different stakeholders may have different expectations of "*specific, desired societal outcomes*", it is important to acknowledge that measuring or evaluating different types of impact may require different assessment methods and/or different types of metrics – or, as stated in the Leiden Manifesto: "*No single evaluation model applies to all contexts*" (Hicks et al., 2015).

Science can impact on various aspects of the society, such as education, the economy, culture, the environment, and on science itself. Traditionally, the scientific impact of science has been identified, mapped and measured through citations, reflecting how other researchers have used earlier scientific outputs. However, this seems to be changing as funders are increasingly demanding more evidence of societal impacts, or wider impacts, from research. Currently, there is no commonly accepted method of identifying and measuring the wider societal impact of research, although some approaches have been developed and discussed (e.g. Walter, Helgeberger, Wiek & Scholz, 2007; Wolf, Lindenthal, Szerencsits, Holbrook & Heß, 2013). Projects such as ERiC (Van der Meulen, 2010), SIAMPI (SIAMPI, 2012), ASIRPA (Joly, Gaunand, Colinet, Larédo, Lemarié & Matt, 2015) and UNICO (Holi, Wickramasinghe & van Leeuwen, 2008) have identified and evaluated a great number of both quantitative and qualitative measures that can demonstrate some aspects of research impact on different areas of society. For instance, ERiC and ASIRPA list dissemination of knowledge indicators (e.g. publications, advisory activities, number of PhDs, conference presentations), stakeholder interest (e.g. funding, collaboration, staff exchanges, consortium partnerships), and the impact and use of results (e.g. public debates and media appearance, and patents). UNICO, on the other hand, focuses on knowledge transfer and lists indicators related to networks, continuing professional development, consultancy, collaborative research, contract research, licensing, teaching and other measures. However, none of the various types of impact that go beyond academia are generally considered in research assessment, nor do they contribute to the academic reward system. It is also important to acknowledge that the various meanings and expectations different stakeholders attribute to impact also implies that the methods to identify and measure impact will differ.

In altmetrics, the concept of impact may be even more complicated: in some cases, evidence of impact may not be clear or it may be difficult or even impossible to identify who has been affected by specific research or who has been made aware of it. Haustein, Bowman and Costas (2016) discuss how research impact could be viewed as a spectrum of different levels of engagement between scholarly documents or outputs and the agent (person viewing or interacting with the document), ranging from *access* to *appraisal* and finally reaching *application* (Figure 1). `

Figure 1: Framework of categories and types of acts referring to research objects (scholarly documents and agents)



Source: Haustein, Bowman & Costas, 2016

Accessing a scholarly document or a research output indicates that a person has at least become aware of the research and thus this activity could be captured as a page view or by download counts. *Appraising* research output involves more engagement with it and could be evidenced by mentioning or commenting on the research in blogs, microblogs or social networking sites, to name a few possibilities. *Applying* requires the highest level of engagement with the research output, which occurs when a person is actively using, adapting or transforming significant parts of the original research output. Thus, applying would be evidenced by citations, use and adaptation of earlier code or datasets, designing presentations or lectures around the original research or even using it for commercial purposes. While it is assumed that citations always reflect use of earlier research, altmetrics may be able to reflect these various levels of engagement with research outputs.

During the first MLE working meeting, discussions on what impact actually means revealed significant differences among the Member States, highlighting the need for a common understanding of its meaning. The discussion revealed that there is no German word that equates to impact, Slovenia prefers *benefits*, and Sweden uses *value*. The Netherlands and Portugal use *making value* or *societal value*, as the previously used term *valorisation* is now considered to be related to economy or that it is too limited in its meaning. In Austria, the term *return on investment* is used, while Latvia uses a two-fold definition with *scientific impact* and *socio-economic impact*. Other terms or views mentioned that impact refers to *contribution to progress* and *making a change in society,* and that as a concept impact should include domains like teaching and other non-obvious interactions, such as influencing policy and public discourse. Some funders let the researchers themselves define what they regard as scientific and social impact. Other views exist, too; for Belgian funders, societal impact is not the main criterion as scientific impact is seen as the most important. But the meeting also suggested that should we not regard scientific impact as part of societal impact. Although it is clear that the meanings attached to the word impact vary greatly among Member States, and their terms and views may vary widely, there is less differentiation between how the research evaluations are carried out and the type of data used for them.

4 ALTMETRICS: DATA TYPES AND DATA AGGREGATORS

In general, we could say that altmetrics can be any identifiable (online) trace of an event where research outputs have received some form of attention or where the event reflects a certain level of engagement between a person and a research output. This could be a mention of a research output on Twitter or Reddit, a citation referring to a scientific article on a blog, Wikipedia, a policy document, or a discussion about the research output on a forum or social networking site. The term altmetrics covers a wide range of different online platforms that can be mined for data about these occurrences. Although a complete list of all potential sources of altmetrics could potentially include a vast number of different social media sites and other websites, many of the sources have a very low coverage of altmetrics and "*may only be useful to identify the occasional exceptional or above average article rather than as universal sources of evidence*" (Thelwall et al., 2013). Furthermore, altmetrics come in many forms and it is crucial to avoid thinking that all altmetrics are equal or reflect the same level of engagement. A simple retweet on Twitter with a link to a research output may not reflect as much engagement as a lengthy review of the same research output in a blog entry or a news article.

4.1 Different types of altmetrics

The vast number of different potential sources is reflected in the multitude of sources and platforms currently being tracked and mined for altmetrics. One altmetrics data aggregator, Altmetric LLP[1] (https://www.altmetric.com/) for example, can track a vast range of different online platforms, including public policy documents, mainstream media websites, online reference managers, post-publication and peer-review platforms, Wikipedia, Open Syllabus Project, a manually curated list of over 9000 blogs, citations from Scopus, recommendations from F1000, social media sites, including Facebook, Twitter, and Google+, and other online platforms such as YouTube, Reddit and Stack Overflow. Sometimes, different altmetrics are categorised according to the perceived activity they reflect or based on the similarity of the platforms. Another altmetrics data aggregator, Plum Analytics (http://plumanalytics.com/), categorises metrics into five different categories: *usage* (e.g. clicks, downloads, views, library holdings, video plays), *captures* (e.g. bookmarks, code forks, favourites, readers, watchers), *mentions* (e.g. blog posts, comments, reviews, Wikipedia links), *social media* (e.g. likes, shares, tweets), and *citations* (e.g. citation indexes, patent citations, clinical citations). Mega journal Public Library of Science, or PLOS (http://alm.plos.org/), has another approach and categorises the sources used to identify the *article-level metrics* they provide for each of their articles into five categories: *viewed* (page views and downloads), *saved* (CiteULike and Mendeley), *cited* (citation counts retrieved from different citation databases), *recommended* (F1000 Prime), and *discussed* (social media sites, including Facebook, Twitter, Reddit, Research Blogging and Wikipedia). Another categorisation is used by Snowball Metrics (https://www.snowballmetrics.com/) which refers to a set of tested methodologies to assess research outputs in order to support strategic planning and benchmarking of research-focused universities and other institutions. Snowball Metrics places various platforms and data sources of altmetrics in four categories: *scholarly activity* (scholarly platforms such as Mendeley, CiteULike, Google Scholar Library and ResearchGate), *scholarly commentary* (scholarly comments on, for instance, science blogs, YouTube, reviews on Publons and F1000, Wikipedia posts and citations), *social activity* (e.g. Facebook, Twitter, Reddit, Google+ and LinkedIn) and *mass media* (news websites). The various ways of categorising different altmetrics clearly emphasise the uncertainty of the underlying meaning of what different altmetrics reflect and the lack of standards that are still very problematic for altmetrics.

[1] In this document, the word *Altmetric*, with a capital A, will be used to refer to the company with the same name, while the word *altmetrics* refers to either the research area or the alternative metrics aggregated from different online sources.

Table 1: Altmetrics sources

Categories	Data sources
Social bookmarking	CiteULike, Mendeley, Delicious
Video, photo and slide sharing	YouTube, Vimeo, SlideShare, Flickr, Daily Motion
Social networks	Facebook, Google+, LinkedIn, Academia.edu, ResearchGate
Blogging	Nature blogs, PLOS blogs, Scientific American blogs, Research Blogging
Microblogging	Twitter, Sina Weibo, Tumblr
Recommendation and review systems	F1000, F1000 Prime, Reddit, Publons, Amazon reviews, Goodreads
Q&A	Stack exchange and others
Online digital libraries and repositories	PMC, Europe PMC, Biomed Central, PubMed, Scopus, Web of Science, CrossRef, Figshare, arXiv, SSRN, WorldCat, institutional repositories, RepEc, EBSCO, EPrints, dSpace, USPTO Patens, Lexis, CRIS
Dataset repositories	Dryad, Datacite, ADS
Source code repositories	Github, SourceForge, ADS
Online publishers	PLOS, Open Edition, Copernicus
Search engines, blog aggregators	Science seeker
Other	ORCID, Google code, Google patens, WIPO, bit.ly, COUNTER, policy documents

Source: Adopted from Priem and Hemminger (2010), Erdt et al. (2016), Haustein et al. (2016), and OpenUP (2016)

4.2. Altmetrics data aggregators

With the advent of altmetrics and the increasing use of the web in general and social media in particular in scholarly communication and disseminating research outputs, some start-ups have identified a business opportunity in tracking and aggregating altmetrics events and creating services and tools around the data.

4.2.1 Altmetric LPP

Altmetric LLP tracks and analyses online activity on scholarly research outputs and builds tools and services around the data it collects and analyses. Altmetric offers services for publishers, institutions, researchers and funders. Publishers can use its tools and data to monitor, measure and display the attention being given to the scientific articles they have published. Institutions can use the 'Explorer for Institutions' to monitor attention to research outputs from a specific institution, department, research project or team, researchers or papers, which will give them with a richer picture of the reach and influence of the research. Researchers can use Altmetric's tools to monitor how and by whom their work is being discussed and to showcase the attention it has received. In this way, these new or "alternative" metrics can help researchers to build, showcase and manage their online professional reputation and develop their promotion and tenure dossiers. Altmetric can give funders the tools to monitor how the research they have funded has been disseminated and discussed and where it has influenced public policy, for example. Altmetric has also been an active partner in several research projects around the world investigating altmetrics, and sharing their data and expertise. For instance, the Open

Science Monitor[2], developed by RAND Europe and commissioned by the European Commission, was supported by Altmetric LLP.

4.2.2 Plum Analytics

Plum Analytics (acquired in 2017 by Elsevier) is another company tracking and analysing online activity around research outputs. In March 2017, PlumX covered 52.6 million individual research outputs for which they collected 9.4 billion individual interactions or altmetrics events. Plum Analytics' main product, the PlumX Dashboard, provides research institutions with the means to track the attention and impact the research has had. PlumX pulls the publication data from an institution's current research information system (CRIS) and merges it with the altmetrics it collects from several online sources. Users of the PlumX Dashboard can then group the research outputs from their own organisation according to various organisational levels, such as faculties, departments, research groups or labs, or by subject, by journal, or any other group the user might be interested in investigating more closely. Thus, the Dashboard is a tool primarily for research administrators to identify those units needing more support or those that are doing particularly well. In addition, researchers can also use the Dashboard to monitor the attention their various research outputs have received and get credit for their work.

4.2.3 Impactstory

Impactstory (https://impactstory.org/) is a non-profit corporation that has developed an open-source website that helps researchers monitor, track and showcase the online attention their research receives. Most of the data is supplied by Altmetric, although other sources are used too, such as CrossRef[3] for article metadata and Orcid[4] for researcher identity management. Impactstory effectively promotes Open Science and open access publishing by, for instance, showcasing the degree of open access publications a researcher may have. The founders of Impactstory, Jason Priem and Heather Piwowar, are also the creators of Depsy (http://depsy.org/), a website that aims to "*value the software that powers science*" by showcasing how the code researchers publish on GitHub is being reused.

[2] Open Science Monitor: http://ec.europa.eu/research/openscience/index.cfm?pg=home&section=monitor
[3] Crossref (https://www.crossref.org/) is a non-profit association of scientific publishers and a Digital Object Identifier (DOI) registration agency of the International DOI Foundation.
[4] Orcid (https://orcid.org/) provides researchers with digital identifiers to reliably and persistently distinguish researchers and their work from each other.

5 POTENTIAL AND CURRENT USE OF ALTMETRICS IN THE MEMBER STATES

5.1 Benefits of altmetrics

There are some clear benefits of using altmetrics over traditional citation-based research evaluation. Altmetrics are generally quickly accumulated following publication of a research output, whereas citations can take a long time to acquire. Especially in disciplines where accumulation of citations has traditionally been slow, altmetrics can provide timely evidence of those outputs that are rapidly gaining attention online. They can capture a much more diverse set of impact types than citation-based metrics can. While citations can only reflect scientific impact, altmetrics are able to show different types of societal impacts, such as impact on culture, education, policy, environment, economy and health. Thus, they can help researchers, research administrators and funders to better understand how their research (or the research they have funded) is being shared and mentioned in different contexts that reflect various types of impact or engagement.

Altmetrics are not limited to scientific publications and formal citations, as a wide range of different research outputs can be mentioned, shared and discussed online and their traces captured. Altmetrics data is thus highly nuanced and in best cases it can provide great detail about the context of the online event that generated the altmetrics counts. Altmetrics can thus function as a more detailed or more qualitative (in terms of showing context and surrounding content) complement to citations. A combination of both citation-based metrics and altmetrics (allmetrics) can thus give a more comprehensive picture of the influence or impact the research has had, including information about the audiences it has influenced. Altmetrics also has an open access advantage. A great deal of altmetrics data is being traced and collected through open Application Programming Interfaces (APIs) in various social media sites or open RSS feeds (although some of the altmetrics data do come from proprietary sources), thus making the data (and altmetrics research) easier to replicate than when using data from purely proprietary databases. This allows for the creation and use of what could be called *open metrics*. Some studies have also shown that research published in open access journals attract more online attention (Adie, 2014).

A future potential of altmetrics is that it could be possible to track online events surrounding the research processes. However, these cannot yet be automatically identified or tracked as capturing the altmetrics events requires a specific identifier (e.g. DOI, PubMed ID, arXiv ID) attached to the online events. It would be possible on a small scale, however, to manually collect textual conversations surrounding, for instance, open research notebooks or conversations about research processes, map the users taking part in the conversations and analyse the influences those conversations may have had.

Benefits of altmetrics

- Altmetrics are quickly accumulated after the publication of a research output
- Altmetrics can capture a more diverse set of various types of impacts than citations
- Altmetrics are not limited to scientific publications and formal citations as forms of research outputs
- Altmetrics can demonstrate the context in which a research has had some influence or impact on different audiences
- Altmetrics use open data and are thus easier to replicate than data from proprietary databases

5.2 Challenges with altmetrics

There are still many challenges and unknowns associated with altmetrics, which means more research is needed. It is still unclear what different altmetrics can reflect and, in some cases, what they actually mean. More research is required to understand what aspects of engagement, influence, or impact altmetrics reflect and by whom, or how and why some research receives more attention than others. Altmetrics are also often mistaken to mean social media metrics. However, many of the platforms being tracked and used as data sources of altmetrics are not what is typically implied by social media (e.g. news websites and policy documents). Although the National Information Standards Organization (NISO) has recently completed a "recommended practice" for the use of altmetrics and a Code of Conduct that aims to improve data quality, how these will be integrated and followed in the future remains unclear. NISO's (2016) Code of Conduct aims at "*increasing the transparency of data provision and aggregation as well as ensuring replicability and accuracy of online events used to generate altmetrics*". Before this is implemented and achieved, it is not possible to compare altmetrics data from different altmetric-data aggregators as they may collect different data (e.g. because of API or contract restrictions, due to the use of different identifiers in the data collection, and simply differences in the platforms they chose to cover).

Comparisons of altmetrics from different platforms or data providers should also be avoided as the reasons behind the events leading to altmetrics (i.e. motivations to engage with research outputs) may vary between different platforms and their users. The reason for saving a scientific article on Mendeley, for instance, is probably different from the reason the same article is shared on Twitter or Facebook. Altmetrics are time-dependent in that they are usually generated soon after the publication of a research output. Although this can be seen as an advantage over citations, it also means that for older research outputs there may not be any altmetrics activity (with the possible exception of some 'sleeping beauties'). On the other hand, as the use of social media is constantly growing, more recent research outputs may end up having more altmetrics activity just because of the natural growth in the use of the platforms. Thus, it is not advisable to compare the altmetrics of older research outputs with newer ones – more research is needed to establish what the time-window for a reliable comparison might be. Altmetrics are typically identified and tracked on items that have a digital object identifier (DOI). While other identifiers are also used by some data aggregators (e.g. URN, arXiv ID, Handle, PubMed ID, URLs), DOIs remain the prominent tracking method. However, since not all research outputs have DOIs and as the DOIs are not always mentioned when a research output is discussed or shared, a lot of the activity surrounding various research outputs (and research processes) is being missed. Another cause of skewing in altmetrics is that although, with some exceptions, a lot of altmetrics are aggregated from social media, not everybody uses social media. It is important to remember that altmetrics (that are tracked from social media) only reflect the activities and engagement of the researchers and citizens who are using social media or are using social media to engage with research. In addition, social media data is highly dynamic as new content is constantly being created and old content may be deleted or disappear for other reasons. Whole platforms that have been used as altmetrics data sources may be discontinued, while new potential data sources are launched. Altmetrics aggregated from social media sites should thus be treated with extra caution. There is also some evidence that humorous or curious titles draw more online attention on social media which means that altmetrics (in some cases) do not necessarily reflect "*intellectual contribution or scientific quality*" (Haustein et al., 2013).

Perhaps one of the greatest concerns with altmetrics is how easily they can manipulated, i.e. how researchers, institutions or publishers could easily set up automated bots or fake accounts on various social media sites that would automatically engage with and share their research outputs, thereby inflating the altmetrics (Haustein et al., 2015). Although no evidence of systematic manipulation of altmetrics has yet to be detected, on Twitter, for example, there are many bots which tweet links to scientific articles that contain certain keywords or cover specific topics. These appear to have been mainly created for aggregation and dissemination purposes, although they are still influencing the altmetrics

of the articles they are tweeting about. Furthermore, we can probably assume that should altmetrics be used in future research assessment and in hiring and funding decisions, some researchers and/or publishers would begin to manipulate their numbers. Therefore, reliable procedures and systems to identify fraud and manipulation of altmetrics need to be in place before they can be considered for research assessment.

Challenges with altmetrics

- The meaning and applicability of altmetrics generated on different platforms is still unclear and thus it is uncertain whether (some) altmetrics could reflect the impact or quality of research
- Lack of data standards leads to issues with transparency, replicability and accuracy
- Altmetrics are time-dependent and thus comparing altmetrics of documents from different time periods should be avoided
- Commonly known tracking issues: DOIs are most often used to identify altmetrics activity, but are not always used when engaging with a research output; and not all research outputs have DOIs attached to them
- (Some) Altmetrics only reflect the actions of those who actively use social media
- Altmetrics may be skewed towards humorous and curious titles
- Altmetrics are easily manipulated; i.e. researchers, institutions or publishers could easily inflate the numbers if they so wish

5.3 Current use of altmetrics in the Member States

From the discussions during the kick-off meeting, it is clear that there is great diversity in the approaches and the degree of adoption of Open Science among the Member States. It is also clear that although some discussions are ongoing and there is a desire to learn more about altmetrics, none of the Member States are using altmetrics for research evaluation, and only a few examples of other types of use were mentioned. This was also confirmed by the responses to the questionnaire. With the possible exception of Moldova, altmetrics are not used for research evaluation at any level in the Member States (Question 1 in the questionnaire). However, they are aware of altmetrics and some examples of their use do exist. For example, some institutional repositories have integrated altmetrics, and in Slovenia they are displayed in researchers' bibliographies and in the COBISS/SCIMET portal which aggregates data about scientific outputs in the country for research assessment purposes (http://scimet.izum.si/). The portal aggregates data from Web of Science, Scopus, Altmetric and Plum Analytics.

Apart from some national journals and national or institutional repositories, altmetrics are not widely used in the Member States for other purposes either (Question 2 in the questionnaire). In France, they are being experimented with in the SJS (e.g. http://www.sjscience.org/article?id=580), they are in production in the French national repository HAL (https://halshs.archives-ouvertes.fr/) and altmetrics for books will be adopted by the OpenEdition Books platform (http://books.openedition.org, which is part of the HIRMEOS project (http://cordis.europa.eu/project/rcn/206340_en.html). In addition, there are some examples from Croatia: the Ruđjer Bošković Institute use altmetrics in its CRIS (CROSBI, http://bib.irb.hr/?lang=EN and FULIR, http://fulir.irb.hr/), and the repository of the Croatian Open Access journals HRČAK (http://hrcak.srce.hr/?lang=en) displays usage statistics (views and downloads). In some Member States, the researchers themselves add altmetrics to their CVs and homepages.

In addition, some EU countries provided examples of success stories and failures regarding Open Science initiatives and/or altmetrics (Question 5 in the questionnaire):

- **France**: HIRMEOS project (http://cordis.europa.eu/project/rcn/206340_en.html), which has yet to be implemented, was mentioned as a good example of a mutualised approach to implementing altmetrics within a community (specifically Social Sciences and Humanities).

- **Belgium**: Another example is the University of Liège's Green open access repository in which the evaluation is only based on what has been submitted to the repository by the researcher him- or herself.

- **Croatia**: The Ruđjer Bošković Institute has declared the first Croatian institutional self-archiving mandate, which requires open access for all publications, with respect to publishers' embargo times. The Croatian Declaration on Open Access (http://www.fer.unizg.hr/oa2012/deklaracija) has been supported by around 20-30 institutions since 2012. However, more work is needed before it is fully accepted within the academic, research and business communities. Croatia's national portal of scientific journals of Croatia (Hrčak), currently providing open access to 386 Croatian scholarly journals (http://hrcak.srce.hr), was also mentioned as a success story, along with the Croatian scientific bibliography CRSOSBI (https://bib.irb.hr/) which contains more than 450 000 bibliographic records, allowing scientists to archive full-text articles in open access.

- **Slovenia**: The COBISS/SciMet (http://scimet.izum.si/) and researchers' personal bibliographies in the same service were seen as positive examples. Through this service, researchers can monitor the performance of their publications by using different altmetrics and more traditional metrics.

- **Portugal**: The full implementation of the Liège model by two higher education institutions was seen as a good example of adopting open science. Within this, the deposit and availability of research outputs in the institutions' repositories are inextricably linked (conditionally) to research assessment procedures for career progression purposes.

As an example of a failure of change, the constraining conservatism of the academic community was mentioned. In the post-Soviet space, in particular, there is a strong authoritative perception of who should do science and how, often leaving young researchers in a more disadvantaged position. However, metrics and Open Science are seen as a way of escaping previous generations' authority and moving the science more towards the people and to being able to engage more with the society.

6 CONCLUSIONS

Based on the above review of the situation in the Member States, it is clear that altmetrics are not being used yet for research evaluation purposes at any level. As the meaning of altmetrics is still unclear, it would indeed have been premature to use altmetrics for research evaluations. Based on our current knowledge of altmetrics, we can say that: 1) some altmetrics can be a measure of attention and/or engagement, although data quality remains an issue; 2) some altmetrics can be a measure of societal impact or influence on different audiences, but more research and development work is needed to identify who these online audiences are (Holmberg, 2014); 3) altmetrics can be used to map interactions, contexts and networks to tell us something about the societal impact of research, although there are certain platform-dependent limitations that may result in data-access problems (Robinson-Garcia, van Leeuwen & Ràfols, 2017; Holmberg et al., 2014); and 4) altmetrics can be used to tell the narratives behind the numbers (Vainio & Holmberg, 2017). Based on present knowledge, the final option of using altmetrics to identify cases that have received exceptional attention online and to showcase that attention by means of narratives, is currently the best way to use altmetrics. However, more research is needed before the other possibilities can be fully realised. We can also conclude that altmetrics are not a measure of quality, nor should they be used (yet) as an indicator in any type of research evaluation. As altmetrics can be identified and aggregated from a vast number of different data sources with different users with different motivations to interact with research products (thereby creating altmetrics), different altmetrics should not be aggregated into a single number.

Altmetrics can be:

1. a measure of attention, engagement, and/or influence
2. a measure of societal impact of research on different audiences
3. used to map interactions, contexts and networks
4. used to tell narratives behind the numbers and to showcase exceptional research

Altmetrics cannot be (at least not yet):

1. a measure of quality
2. used as an indicator in research evaluation
3. aggregated into a single number

From the start, altmetrics research has been very much data driven, meaning that the abundance of available data has steered the research into investigating what we could do with all the data. The original idea for altmetrics was not to use the data for research evaluation, but rather to build filters so that researchers could find relevant and interesting research articles more easily. Similarly, the original idea for ISI Web of Science was to map patterns in scholarly communication and point researchers to relevant research. The goal of using altmetrics to evaluate research, measure impact, productivity and attention came later. It is vital that we now step back from this situation and ask ourselves: What kind of impact do we want research to have? What kind of data do we need to evaluate that impact? How can we measure and map that impact? What direct relations between scientific quality, integrity and impact do we want to create in the process? Altmetrics holds a lot of promise, but it is clearly too early to use them for research evaluation where funding decisions or hiring or promotion processes are concerned. More research is needed to understand how the online attention some research receives is created and by whom, and why some research receives more attention than others.

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The current report has been developed to give the participants in the Mutual Learning Exercise on open science an overview of the different types of altmetrics currently being used and/or investigated for the purpose of research assessment, and discusses the benefits and challenges associated with them. Altmetrics data are mainly gathered from readily available online sources, making altmetrics highly relevant in the context of Open Science.

Based on a review of the situation in the Member States, it is clear that altmetrics are not being used yet for research evaluation purposes at any level. As the meaning of altmetrics is still unclear, it would indeed have been premature to use altmetrics for research evaluations. Based on present knowledge, altmetrics could contribute to identify cases that have received exceptional attention online and to showcase that attention by means of narratives. However, more research is needed before other possibilities can be fully realised. We can also conclude that altmetrics are not a measure of quality, nor should they be used (yet) as an indicator in any type of research evaluation. As altmetrics can be identified and aggregated from a vast number of different data sources with different users with different motivations to interact with research products (thereby creating altmetrics), different altmetrics should not be aggregated into a single number.

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