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What Have We Learned Today? A Synthesis of Cases Presented

The organizations profiled in this work are of diverse origins, structure and purpose. There are both similarities and differences in their approaches to providing impact metrics services. The cases described also highlight benefits to the library or information center providing services and the parent organization. These cases underscore the best practices that are emerging from various areas of the scientometric, information science, and library communities.

Divergence across cases

Range of mission and purpose: Disciplines and missions extending from the advancement of hard science, technology and engineering, education and learning, regulatory enforcement, economic savings, community supported publishing and open access scholarship are all represented.

Funding sources of parent organization: A range of revenue sources fund these organizations, including government (both state and Federal, from legislative and agency sources), public and corporate donations, grants, organizational memberships, tuition, publication sales and subscriptions.

Parent organization activities: While a number of the cases have policymaking or regulatory implications to their mission, public education/programming, communications, and staff development are other activities that may be influenced by impact measurements.

Subjects/objects being evaluated: Subjects of evaluation not only include the usual PRJAs, staff researchers/scientists, institutional benchmarks, and other scholarly output; but also equipment use, a cyberinfrastructure, whole projects, non-scholarly publications.

Impact data output formats: The actual vehicle for which value of research was being demonstrated differed from organization to organization. The final outputs containing the indicators include organizational annual reports, award nominations, specialized “impact statements,” spreadsheets, web pages.

Technical resources and staff skill sets: Resources available to gather impact metrics vary greatly as well as staff strengths and skills. ITS has a skilled staff using low cost or free resources, University of Michigan Press has both highly skilled staff and an abundance of resources at its disposal. NCAR has staff with the ability to build an API, whereas the EPA hopes to recruit intern staff to fill a technical skills role. Given the nature of the research output being studied at the museum, librarians had data entry processes performed by the metrics provider.

Maturity/level of services provided: ITS describes a setup process that will facilitate the tracking of grey literature in transportation research going forward. UMP has a well-developed suite of metrics for their journal editors and has experimented with many resources to get the best data for their authors and editors. The EPA and NCAR have well-developed programs with plans for growth, and the museum model served more as a proof-of-concept.

Challenges across cases

Despite differing characteristics in many regards, these cases share similar challenges in undertaking projects relating to research impact metrics.

Labor intensive processes: Despite new tools, gathering metadata on a workable set of scholarly outputs from which to generate indicators was a particular challenge in each case. Much human “massaging” of the retrieved data and resultant analysis was needed to make the

content fit for stakeholder consumption. Despite improved analytics in many tools such as Web of Science, Altmetric, and Google products data cleaning, transformation, display and interpretation by the libraries and information centers made material relevant and useful to requestors and stakeholders.

Lack of standardized identifiers across output type: Every case presented indicated the loss of some information as a result of a lack of DOIs, author identifiers such as ORCID, and other identifiers that would have made it possible to more easily track the dissemination of the research output in question. To some cases, this lack is a greater problem than others. Even in traditional bibliometrics, it is essentially impossible to get to a citation count of “n=all,” but improving the trackability of formats such as conference proceedings, grey lit, data and other non PRJA scholarly output will benefit the entire research community, regardless of discipline.

“Out of the box” resources not a complete solution: Whether Web of Science/InCites, Altmetric, Google Scholar, or another tool was used, no single tool proved adequate to fully describe research impact beyond providing data for included traditional PRJAs. Web searches, news monitoring and other creative ways of finding impact help to supplement the data provided by metrics sources. It is challenging to describe the full impact of research topics from sources where the specific output is not attributed. Likewise, demonstrating the reach of a new scientist/researcher’s activities can mean going beyond the h-index or other indicators. Certainly the major citation index services have made inroads in regard to adding content for books, data, conference proceedings, emerging fields, and so forth, and perhaps we will see increasingly more robust and nuanced data from the citation index providers.

The metrics likewise have limitations: As noted elsewhere in this book, just because a metric is capturable doesn't mean it provides meaningful insights or clarifies understanding of a topic or problem. News hits, human narratives, anecdotes and context can help, along with human interpretation to complete the picture. Furthermore, some of the issues presented with indicators of research impact are discipline specific; several of the case studies presented here point to the increased need for data to support/describe social science and humanities research impact. Hargens states that there is a propensity to cite older works in addition to a longer turnaround time in citation count in the social sciences and humanities. He attributes this to a greater need for social scientists to convince others of the validity of their research, given the "weak evidence" in most social science methodologies. Thus a researcher traces the lineage of one's line of inquiry through to the great thinkers of yore within the field (Cronin & Atkins, 2000, p. 511).

Requestors of impact metrics don't always understand the metrics. Within and outside the research domain, the organizations for which metrics are provided often need information and education on the purpose, prevalence, strengths and limitations of the supplied information.

Demonstrating research impact outside the field: All organizations described an interest in showing impact outside the disciplinary or research domain. This may at times run contrary to attitudes in academia, namely the researcher who feels so long as his or her research is indexed in the "right" places, peers or others with the same specialization will be able to locate the work, thus the researcher need not make efforts to extend discoverability beyond key journals (usually paywalled). While this sentiment is slowly eroding in academia, specialized research entities are

perhaps at this time under greater need to demonstrate the value of their work as it is integrated into the fabric of society, and not simply that it has been read or accessed by ivory tower cronies.

User education/metric literacy: A vital role for the library or information center is instruction on research impact metrics, whether one-on-one as for the journal editors working with UMP, or through workshops at the EPA. Internal constituencies such as organizational administrators and the researchers themselves often benefit from instruction as well, as with the museum and NCAR. This lack of understanding provides both a challenge and an opportunity to the library or information center providing this information.

Other examples of specialized research impact services

It is worth noting other interesting case studies in the published literature that are not included in this work. For example, the National Institute of Standards and Technology (NIST) is performing topical network analysis, text mining, cluster analysis and other sophisticated methodologies with their impact data. They are able to map emerging research areas, collaborations, and assess disciplinary landscapes (Makar & Trost, 2018). The National Institutes of Health's library, long on the cutting edge of providing services related to bibliometrics and research impact has two informationist staff members who are experts in bibliometrics and research impact. The NIH Library has a user-friendly website and shares knowledge through the Bibliometrics and Research Symposium which they have held twice, bringing together librarians and others who practice these services across disciplinary domains ("Bibliometric Services | NIH Library," n.d.). Librarians at NIH also studied the provision of research evaluation services in seven biomedical libraries (Gutzman et al., 2018). One NIH informationist was embedded in a

project analyzing three decades of publications related to obesity under a given grant (Nicastro et al., 2016).

Demonstrating impact beyond the PRJA

There are many formats of output that have influence, reach and impact on scholarly thought than the PRJA. As a result, there are new standards and practices evolving to facilitate the measurement of their impact. Citation of datasets is being studied by a number of scholars. This is a key issue with new public data requirements from funders and publishers (Borghi, Abrams, Lowenberg, Simms, & Chodacki, 2018; Fenner et al., n.d.; Konkiel, 2013; Piwowar, 2011; Robinson-García, Jiménez-Contreras, & Torres-Salinas, 2016; Tenopir et al., 2011) Force 11 has issued a *Joint Declaration of Data Citation Principles* which recommends best practices for documenting the reuse of datasets. These include: giving data the same weight as PRJA and other scholarly output in terms of legitimacy, facilitating a standard attribution style for datasets, citation of data to back up claims, creation or adoption of persistent identifiers, persistent metadata for discovery and specific description, and interoperability amongst fields (Data Citation Synthesis Group, 2013). Likewise, FORCE 11 has proposed similar best practices for citation of software (Smith, Katz, Niemeyer, & FORCE11 Software Citation Working Group, 2016).

Patents represent another set of challenges in attribution and tracing citations. Such challenges include the differences in citation patterns in international patent offices as well as disciplinary fields, tracking examiner-added citations, and the effects of technology transfer (Alcácer & Gittelman, 2006; Jaffe & de Rassenfosse, 2017; Sorensen & Chambers, 2008).

The reach of non-PRJA research output can sometimes be captured by altmetrics or even Google Scholar, but there are gaps in coverage of many output formats, including but not limited to posters, computational algorithms and modeling, presentation slide decks, recordings, visual arts, and performances. Establishing best practices to measure and determine the true significance or level of influence and impact these outputs garner is a field of emerging study.

Naysayers and chicken littles

An increased reliance on metrics of various ilk has led to a proliferation of metrics critics. Is assessment and evaluation through metrics a form of surveillance like Muller posits? Is this a “tyrannical” means of research evaluation (Muller, 2018)? The reality is that “new” metrics such as altmetrics, usage metrics, web analytics and the like, when combined with traditional citation-based approaches such as the JIF can be paired with expert evaluation and peer review to provide a nuanced and effective profile for organizations to be able to demonstrate value, allocate resources, and answer questions of direction and focus. Does this result in a loss of autonomy for researchers? Does it engender and encourage the gaming of research metric system, leaving us with “bad apples” that spoil the validity and integrity of scholarly metrics as a whole? Does this reliance on the data and benchmarking reward mediocrity over innovation? To what extent have the pressures of the academy bled into other types of research organizations? There are myriad complaints, but minimal research or data to back up the concerns expressed by many of the naysayers and chicken littles.

That does not mean that all criticism is without merit. As with any data problem, we need to make certain the data collected and the metrics utilized answer a legitimate and useful question that provides insight and information to the stakeholders to whom the information is presented. Easy to collect and analyze data may not always be the most informative. This is perhaps a significant issue with any sort of data, assessment rubric, or protocol in any field or sector, yet efficient-to-collect data and metrics are all too often used as an expedient proxy for indicators that have real value or worth.

Likewise, it would be foolhardy given the nuanced, multidimensional, and complex nature of the research process to boil down a research unit's effectiveness to a single indicator or score. Take for example, the h-index. Hirsch may have felt that the panel of citation data provided in an academic dossier may be too complex and confusing for reviewers (Hirsch, 2005). Perhaps however, the answer to that criticism is not the creation of a simplistic integer-based indicator, but rather education of evaluators and those who are evaluated, assuring to the best of our ability that there is "metric literacy."

Efforts at regulation

Myriad concerns exist regarding the limitations of research impact metric use, misuse based on lack of understanding, and outright fraud or gamesmanship. Concerns regarding their limitations generally center around the insufficient coverage of relevant literature, a lack transparency in publication and research sets used to derive the analysis, issues with the statistical methodologies used to calculate a given metric, and so forth. Efforts at raising awareness of misuse issues abound. For example, the San Francisco Declaration on Research

Assessment is a group of authors and organizations who oppose the use of journal based metrics (particularly the JIF) for evaluating individual researchers (“San Francisco Declaration on Research Assessment (DORA),” 2019).

In the UK, the Responsible Use of Metrics movement from which a report called *The Metric Tide* provided recommendations for responsible use. Many of their recommendations apply specifically to the UK Research Evaluation Framework (REF) and/or to academic institutions, but others are generally applicable, for example: using the term “indicator” over “metric,” calling upon institutions to establish policies and statements in favor of responsible use, educating researchers in the limitations of indicators, making the data and methodologies used transparent to the community, reducing reliance on journal based measures, promoting identifiers such as ORCID, INSI, and DOIs, and creating community supports (including the website www.ResponsibleMetrics.org) (Wilsdon et al., 2015).

Similarly, the Leiden Manifesto provides ten criteria for using research metrics in evaluation. These criteria center around openness, alignment with research mission, including local scope mission; disciplinary contextualization; use of multiple metrics, understanding the limitations of the metrics, transparency of methodology and allowing researcher verification of data, and regular evaluation and of the suite of metrics used for assessment and review (Hicks, Wouters, Waltman, Rijke, & Rafols, 2015).

In the United States, some attention has been paid to the question of best practices related to the use of altmetrics. The National Information Standards Organization (NISO) developed recommendations to standardize altmetrics and identify situations where altmetrics might be effectively utilized. These use cases are framed in terms of eight “personas” of stakeholders and

three overarching themes of use. The personas include: librarians, research administrators, hiring committee members, funding agency staff, academics/researchers, publishers/editors, media/journalists, public information officers, and content platform providers. The overarching themes where altmetrics might be deemed applicable are: the demonstration of scholarly achievement, the assessment of “impact or reach” of research, and increasing the discoverability/findability of scholarship and researchers (National Information Standards Organization, 2016, pp. 1–3).

Best practices

To generate an appropriate dashboard or “impact statement” for a given research entity, we need to ask first and foremost, what is the mission of that entity? In this book we have seen five considerably different goals and missions of the organizations presented. How does the use of research impact metrics further an organization’s mission? What is the organization trying to demonstrate and how is it best described? It is imperative for the compiler to have a clear understanding of the mission, vision, goals and objectives of their organization. This will ensure the service is of the most possible value to the parent organization. Specialized organizations can be an example for the slower-moving higher educational institutions which rely heavily on traditional bibliometric indicators related to PRJAs. A research entity not focused on promotion and tenure dossiers may have the ability to be more flexible in choosing what to measure, how to analyze and visualise it. There is no one right or wrong way to accomplish this, but as we have seen the need to take care to carry out this undertaking responsibly as has been demonstrated by

the cases contained herein. Specialized information centers and libraries have the ability to be role models in the responsible use of metrics movement.

Benefits for the information center

There are many benefits to the specialized library or information center which provides research impact metrics services to its parent organization. These are not really any different than the benefits gleaned by academic libraries for providing the same services, however because their expenses are often perceived as overhead (read: source for cutting), specialized libraries can be under a measurably greater need to demonstrate their value and relevance to their parent organization. Collaboration with researchers, administrators and other internal stakeholders and constituencies is a valuable byproduct from meeting research impact data needs that engenders greater visibility for the library. As the expertise of librarians and information professionals is recognized, they may be asked to partner on other projects, even becoming “embedded” in a given team or organization undertaking (Shumaker & Talley, 2009). Providing needed support for mission-critical activities of the parent organization can only broaden the portfolios of valuable and relevant services recognized by leaders and administrators and may engender new library/information center champions. Finally, the improved educational prospect of “metric literacy” in organizations bolsters the research ecosystem as a whole: “a rising tide raises all ships.”

Benefits for greater organization

Improved confidence in the numbers: Research impact indicators do not have to exist in a vacuum. Strengths and limitations are contextualized by librarians/information professionals. The parent organization can go forward with greater confidence and understanding of its reach and impact.

The law of comparative advantage: Let each party focus on what they do best: scientists as scientists, administrators as administrators; letting the impact metrics experts lead the way in understanding how indicators are best utilized. To maximize the law of comparative advantage, however each party must communicate and exchange the benefit of their own expertise. The domain expert and the metrics expert work together to create a better-informed and contextualized picture of the research landscape of the parent organization.

Better communication: Researchers and organizations are likewise better able to communicate their reach and from that make decisions, allocate resources, receive awards, goals and objectives.

Own the story: Armed with a new understanding and ability to communicate influence and impact, these services give the parent organization an opportunity to change the narrative, to “own” the metrics, decide how to tell its own story.

So what are the “new” metrics?

The case studies presented in this volume utilize a variety of bibliometric, altmetric, and other indicators from which to create an understanding of research impact for various types of research units and their requisite research outputs. Judging by these five examples, there is still heavy reliance on traditional bibliometric indicators as a measure of scholarly research output.

Particularly beyond simple citation counts, Web of Science's JIF remains nearly ubiquitous in the analyses presented, albeit for divergent purposes. While there are many newer bibliometric indicators, those provided by Web of Science still hold their place as the gold standard for measurement. Many newer indicators, Eigenfactor, SNIP, SJR, CiteScore, i10, and others are understood by information scientists, scientometricans, librarians, and other bibliometrics experts, but it is likely they are not well understood by non-specialists. The one newer metric that seems to have permeated the non-specialist mentality is the h-index, which is of questionable merit as an evaluative tool, as has been noted earlier in this work.

Many of the cases presented here use metrics other than bibliometric or altmetric indicators as a barometer for the impact of the scholarly output they are tracking. Usage metrics, costs, and components of altmetric indicators such as news hits or social media mentions may be the "new" metrics. Really though, the term "new metrics" could be considered a misnomer. In this rapidly evolving field, what one might consider "new" metrics are not yet widely adopted. Is this changing? The rate at which they are adopted is following newer analytics development. Bigger, cheaper, faster data and analytics could bring further changes in demonstrating future research impact. It is highly doubtful given the current science policy climate that there will be an increase in the proportion of Federal government funds spent on R&D projects, and a plateau or decrease will likely be reflected in other funding sources. Increase in scholarly output, both in terms of content and format, combined with fewer funds will only lead to escalating demand for accountability on the part of the research unit. Demonstrating the value of research has moved beyond the scholarly peer-reviewed journal article and the academy.

The landscape of research impact metrics, with its many manifestos, declarations, and report recommendations has a solid grounding from which to continue to improve. There is ample signage pointing the way down the path to a more informative and useful suite of indicators, data tools and analysis methodologies to show new relations between researchers, research fields, and research output. Linked data sources such as Dimensions may give us the power to see more nuanced levels of reach and impact at various stages of the research cycle. To those who say this is surveillance and by subtext oppressive, data collection and tracking is a juggernaut in all fields these days. Trying to undo all of the data collection that is being undertaken with regard to research and other sections would be like trying to put toothpaste back in the tube. Clearly, in fields far beyond research evaluation the many benefits of having more data available has transcended concerns of surveillance, privacy intrusion, and so forth. What we must strive for is implementation of best practices akin to those discussed here and elsewhere. An important practice to make ubiquitous is transparency of data collection and methodology. Self-ownership and/or access to data about a subject and how it is being used, likewise is powerful in its own right. Those who have concerns about misuse, fraud or other aspects of data-driven decision making as regards research evaluation should be encouraged to continue to bring critiques before the arena of public and scientific discourse where there can be an iterative process of continuous research evaluation improvement and refinement.

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