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Research Impact for Engineering: a National Survey of Engineering Librarians

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Abstract

In recent years, the demand on scholars and institutions worldwide to demonstrate their research impact has become an increasingly important part of funding applications, promotion dossiers and ranking analytics. The need for impact assessment has steered the development of metrics, altmetrics, and metrics services. Some research metric services have been in place at academic institutions around the world. Certain nations have even adopted nationwide assessment programs. However, in the United States this has not been the case. Recently, some United States academic libraries have established formal research metric services, but the extent of these services and the involvement of engineering librarians have not been explored. The authors are conducting a survey of engineering librarians at institutions in the United States with Very High (RU/VH) and High Research Activity (RU/H) Carnegie Classifications. The survey will explore engineering librarians' perceptions and understanding of research impact and metrics, including traditional bibliometrics and alternative metrics. The authors hope that the survey results will help identify the most useful metrics and tools to assess broader impact of different engineering disciplines. The survey will also establish a benchmark of formally established research metric services and the extent to which engineering librarians are directly involved. Engineering librarians can be inspired to help capture research dollars by assisting engineering researchers in gathering evidence of their research impact.

Introduction

The development of online resources and search tools brought many changes to librarianship. Easy access to information meant that the libraries' "gatekeeper" role was deemed unnecessary, which in turn, created opportunities for redefining and widening of library role within their institutions. As a result, libraries moved more toward offering services as needed on campuses, as well as becoming collaborators or partners with different units within their organizations. Consequently, libraries have become partners in teaching information literacy, became the scholarly communication specialists, took a leadership position in research data management, and offer support in research assessment activities through bibliometrics analyses.

As the evaluation of research outcomes became a highly selective element in research funds allocation process, the perceived need for competent and consistent tools to be used for research assessment has intensified. Bibliometrics, the statistical analysis of written publications, seemed to be able to provide some quantitative measure for academic productivity and, as a result, bibliometrics methods have been adopted by research evaluation process. However, there are many controversies around the topics of research assessment' need, its methodology, and ethics, and whether the bibliometric methods could indeed produce a valid measurement for research

evaluation. Since bibliometrics has been an important field of research in library and information science and part of libraries professional practice for a long time, it seemed a natural transition for libraries to start offering bibliometrics services.

Bibliometrics services as part of research evaluation process are more common in libraries from countries with national research assessment frameworks that are mostly specific to Europe. In U.S., these services are in incipient stage, and are more common for the libraries affiliated to medical schools or medical research centers. However, as the main funding agencies in U.S. have adopted new criteria for selection requiring the demonstration of research impact, there is a growing interest from universities to support research assessment activities, which in turn, created more demands on the libraries to contribute with bibliometric analyses.

Engineering is among the highly competitive disciplines requiring funding. Engineering research is characterized by interdisciplinarity, large quantity of research outcomes, and numerous applications to industry and society. These traits contribute to creating a more difficult methodology for demonstrating the impact and, as a result, an increased demand for adequate support services.

This study addresses the questions of how are engineering librarians roles impacted by and what is the extent of their involvement with the new research metrics practice.

Literature Review

Research assessment was done traditionally through peer-review with the intention of improving the quality of scientific research.[1] However, the exponential increase of scholarly outputs and increasing interdisciplinarity deemed peer-review activity as insufficient assessment practice and created the need for a more comprehensive assessment methodology. Additionally, as the understanding of the relation between research and social and economic benefits changed, research public policy also changed, which in turn, impacted how funds are allocated.[2] The increased competition for funding and decreasing availability of funds prompted finding ways to select the highest quality projects that will have the most socio-economic impact. The conjuncture of the two conditions precipitated the transformation of the research assessment into a complex process aiming to evaluate research quality and measure its impact.[3] As a result, research assessment process plays an important role in funding decisions and enables organizations to manage their research performance and to maximize their research output and impact.[4]

The growth in research assessment scope triggered an expansion of the stakeholders involved in the process to include university administrators, faculty, funding organizations, and policy makers.[3] University administrators have financial interests because institution’s ability to attract more external funding and students depends on the institution’s reputation and rankings.[5] Faculty

interest is fostered by tenure and promotion process and the allocation of research funding or bonuses. Funding organizations, both governmental and private, need impeccable means for selective distribution of available funds and increased accountability.[6]

Nowadays, research assessment consists of two components, academic impact and socio-economic impact.[4] Academic impact is the influence exercised on an academic field and is measured using metrics,[7] while socio-economic impact is considered to be "an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia"[8] with no clear system for measuring it. The ascertainment that research is greatly affected by assessment generated a strong interest in improving assessment methodology and resulted in the development of new methods or the adoption of new criteria, such as: bibliometrics, usage-based assessment via publishers' sites and social media (known as altmetrics), performance-based funding, research in a global market, internal research assessment systems,[3] number of patents and commercial income generated,[9] etc.

The development of research assessment systems began to proliferate starting in the 1990s in OECD countries as a result of increased government supported research.[2] A variety of frameworks have been designed to address specific requirements at national, organizational or stakeholders' levels. National frameworks are most common in European countries[10], Australia, and New Zeeland.[11] The United States has been slow in adopting a national framework, although steps toward the development of evaluation systems started at the same time with Europe,[12] with STAR Metrics[13] and NIH and NSF biosketches being the latest developments. Research evaluation systems continue to be controversial topics within the research community worldwide.[14-15] Due to their impact on research communities, it is important to consider how the assessment is done and by who, what was evaluated and in what scope.[4]

Bibliometrics, the statistical analysis of publications, was founded by LIS researchers.[16] The key concept in bibliometrics is citation and the assumption that citations represent a measure of influence.[17] Bibliometrics turned into an academic impact measuring tool at the advent of Science Citation Index that later transformed into Web of Science, and further development of other bibliometrics indices.[18] Although these metrics are relatively easy to calculate and use, there are wide controversies related to citations used as indicators of quality,[18] errors,[19] capacity to give a full picture of impact,[20] and the overall practice and interpretation of the metrics.[21]

Bibliometrics indicators have been applied by libraries for information retrieval systems and collection development.[18] Recently, libraries started adopting bibliometric methods and techniques for research evaluation purposes.[22–29] The development of such services has its roots in the perceived need for librarianship to redefine its role and expand its competencies[22] and it was possible due to availability of bibliometrics tools within the libraries, libraries position within the campus communities, scholarly communication environment awareness, professional knowledge in bibliometrics,[30] as well as libraries' scholarly neutrality.[31] Library involvement

with bibliometrics services could add additional responsibilities to library portfolio, increase visibility of the library,[32] and create more opportunities for "higher end researcher support."[33] However, adoption of bibliometrics services by the libraries may raise questions about service ethics, library competencies and capacities to carry such services, and library shift toward auditing function.[32]

Prompted by NIH requirements, medical schools and research centers libraries in the U.S. were the first to initiate these new types of services. In authors' opinion, engineering disciplines, ranked second in governmental funding after medicine[34] and fourth in number of publications,[35] are most likely to follow in adopting research assessment. This adoption may likely be rushed by the NSF requirements for demonstrating "broader impact." In turn, this would create opportunities for engineering librarians to offer support with assessment activities.

This study brings in discussion this new service opportunity and gauges U.S. engineering librarians interest in the topic. To the best of our knowledge, there have been published only three similar studies, one assessing Swedish academic librarians opinion on research metrics services in the libraries,[22] one study on bibliometrics data support activities in 140 libraries in Australia, New Zeeland, Ireland, and United Kingdom,[24] and recently, one in the U.S., analyzing availability of documentation on metrics and impact on the AAU libraries websites.[36]

Methodology

The study was meant to establish a baseline of research metrics services at major institutions of higher education in the United States and the involvement engineering librarians in those services. The study involved the engineering librarians at all United States Class 15 (Very High Research Activity (RU/VH)) and Class 16 (High Research Activity (RU/H)) institutions per the 2010 Basic Carnegie Classification of Institutions of Higher Education. The Classifications Data File can be obtained at http://carnegieclassifications.iu.edu/2010/resources/. IRB clearance for the survey was obtained from both [university A] and [university B]. The authors gathered the e-mail addresses of the engineering librarian(s) by inspection of the library website of each institution. The survey was meant to elicit responses from a population that include the engineering librarians at all doctoral degree granting institutions throughout the nation. Use of the Classifications Data File allowed for a well-defined list of target institutions.

All engineering librarians identified at these institutions were contacted via e-mail. An engineering librarian was defined as a librarian who had partial or total responsibility of subject liaison responsibilities for engineering per the library's website. Twenty-two of 99 (RU/H) and 12 of 108 (RU/VH) institutions did not have an engineering librarian – these institutions were not contacted.

A standard e-mail containing a link to the SurveyMonkey instrument was sent to each contact for an initial and a follow-up contact. The instrument and messages are provided as attachments A through C.

Questions on the survey dealt with the existence of specific research metrics services to provide some nuance to whether or not services existed, including tenure and promotion dossiers, impact statements for funders (such as the NIH Biosketch or NSF broader impact statements), benchmarking at the departmental or institutional level, identifying publication venues, collaboration network analysis, topical bibliometric analysis and one-on-one consultations. The next question delves into the identification of tools used for metrics services. Additional questions deal with whether or not job descriptions have changed to include metrics services, if websites have been built to support services, the extent of training provided to campus and the interest in research metrics of university stakeholders (including the engineering librarian). Demographics were limited to whether or not the institution was public or private and the institution's Research Activity Carnegie Classification. Open-ended comments are allowed when appropriate and as the wrap-up question.

Analysis of the data utilized the Analyze Results function of SurveyMonkey. This includes descriptive statistics and text analysis of open-ended comments.

Results

The survey was sent to 308 engineering librarian email addresses at RU/VH and RU/H institutions in the United States. Three of the messages were undeliverable leaving the population at 305 engineering librarians. The response rate was 37.38 percent (n=114 of 305), with 37.05 percent (n=113 of 305) answering the opening consent question. A review of the responses indicated that 26.89 percent (n=82 of 305) answered a usable portion of the survey.

The second question was "What research metrics services does your library offer?" The question is further nuanced by asking respondents to indicate if the service is formal, informal, planning a formal service, investigating or none. Detailed results are given in Figure 1 with 26.89 percent (n=82 of 305) answering parts of the question. With the exception of "One-on-one consultations" 56.10 percent (n=46 of 82), only a small number of engineering librarians indicated the existence of a formal service for the list of services posed. Other responses indicating formal services in existence ranged from low of 3.70 percent (n= 3 of 81) to 7.50 percent (n=6 of 80). Informal services were reported in larger numbers. Nearly all institutions provided one-on-one consultations with 40.24 percent (n=33 of 82) being informal (in addition to those that were reported as formal). Other responses for informal service ranged from identifying publication venues at 71.60 percent (n=58 of 81) down to collaboration network analysis at 19.75 percent (n=16 of 81). More than half of the responses indicated 'none' for tenure and promotion dossiers, impact statements for funders, benchmarking at departmental and institution level and collaboration network analysis. Responses indicating 'planning of a formal service' or 'investigating' were in single digits. Open-ended comments indicated that in one case the library wasn't the entity undertaking a research metrics service, one indicated that

perhaps their service should be a separate entity from their more general scholarly communications service, one indicated confusion about what the word metrics meant, one indicated presenting to faculty on citation metrics and raising the visibility of their research, one indicated providing training on the finding and use of metrics for tenure and promotion and one indicated creating a guide for faculty explaining citation metrics and how to compile them at the individual faculty level.

	Formal service	Informal service	Planning a formal service	Investigating	None	Total
Tenure and promotion dossiers	4.88% 4	41.46% 34	0.00% 0	2.44% 2	51.22% 42	82
Impact statements for funders (NIH Biosketch, NSF broader impact, etc.)	5.00% 4	28.75% 23	1.25% 1	5.00% 4	60.00% 48	80
Benchmarking at departmental and institution level	7.50% 6	33.75% 27	0.00% 0	8.75% 7	50.00% 40	80
Identifying publication venues	3.70% 3	71.60% 58	0.00% 0	4.94% 4	19.75% 16	81
Collaboration network analysis	3.70% 3	19.75% 16	2.47% 2	11.11% 9	62.96% 51	81
Topical bibliometric analysis	3.70% 3	50.62% 41	0.00% 0	6.17% 5	39.51% 32	81
One-on-one consultations	56.10% 46	40.24% 33	0.00% 0	1.22% 1	2.44% 2	82

Figure 1: Q2, What research metrics services does your library offer?

The third question was phrased "What tools are used at your library to gather metrics?" Full details on all tools are given in Figure 2. Respondents were asked to check all that applied. Three of the tools were familiar citation databases and out of 77 responses to the question 92.21 percent (n=71 of 77) were using *Web of Science*, 50.65 percent (n=39 of 77) were using *Scopus* and 81.82 percent (n=63 of 77) were using *Google Scholar*. For research impact measurement tools, respondents indicated both *InCites* and *SciVal* at 19.48 percent (n=15 of 77). For alternative metrics tools, respondents indicated use at 9.09 percent (n=7 of 77) for *Altmetrics for Institutions*, 1.30 percent (n=1 of 77) for *ImpactStory* and 3.90 percent (n=3 of 77) for *Plum Analytics*. For research information systems (RIS), respondents indicated 1.30 percent (n=1 of 77) for *Converis* and 2.60 percent (n=2 of 77) for *Pure*. Open-ended comments mentioned

altmetrics that are within databases or publisher platforms (e.g. *bepress/Selected Works* author pages), *Engineering Village*, and *IEEE Xplore*.

Answer Choices		Responses	
Web of Science		92.21%	71
Scopus		50.65%	39
Google Scholar		81.82%	63
Microsoft Academic Search		10.39%	8
Publish or Perish		14.29%	11
InCites		19.48%	15
Converis		1.30%	1
SciVal		19.48%	15
Pure		2.60%	2
Altmetrics for Institutions		9.09%	7
Impact Story		1.30%	1
Plum Analytics		3.90%	3
VIVO		9.09%	7
None		3.90%	3
Other (please specify)	Responses	11.69%	9
Total Respondents: 77			

Figure 2: Q3, What tools are used at your library to gather metrics? Select all that apply.

The fourth question was "Has your job description changed to include involvement in research metrics." Out of the 77 responses, 7.79 percent (n=6 of 77) indicated that their job description had changed. In contrast, 92.21 percent (n=71 of 77) indicated that there had been no change. In the twelve open-ended comments, most indicated that it was either informal or considered a part of research, reference or scholarly communication duties for all subject liaison librarians. Only one respondent indicated that an official change was in the works. One respondent indicated that although their job description hadn't changed, it was the focus of their work within research services.

The fifth question was "Do you have a research metrics web page (e.g. LibGuide) at your library?" Out of 79 responses, 49.37 percent (n=39 of 79) indicated 'Yes,' 43.04 percent (n=34 of 79) indicated 'No' and 7.59 percent (n=6 of 79) indicated that the webpage was 'Under construction.'

The sixth question was "Does your library offer training for faculty, students and university staff on research metrics? In response, 38.46 percent (n=30 of 78) indicated 'Yes,' 41.03 percent (n=32 of 78) indicated 'No' and 20.51 percent (n=16 of 78) indicated that training was in the planning stages.

The thirty respondents from question six who offered training gave details of their efforts in question seven: "What is included in the research metrics training?" The most common topics addressed in detail were Citation counts, 70.00 percent (n=21 of 30), Journal Impact Factor, 73.33 percent (n=22 of 30), h-index, 55.17 percent (n=16 of 29) and Google Scholar Metrics, 40.74 percent (n=11 of 27). Full details are given in Figure 3. Open-ended comments included one note that research metrics is "integrated into course instruction, not usually as a standalone course. One person mentioned ResearcherID – this task would be very important to the support of research metrics. One person noted that the training "varies depending on librarian and subject area."

	Not at all	Mentioned	In detail	Total
Citation counts	0.00% 0	30.00% 9	70.00% 21	30
Journal Impact Factor	0.00% 0	26.67% 8	73.33% 22	30
h-index	0.00% 0	44.83% 13	55.17% 16	29
Alternative metrics	3.57% 1	67.86% 19	28.57% 8	28
SCImago Journal Rank	48.15% 13	40.74% 11	11.11% 3	27
Google Scholar Metrics	3.70% 1	55.56% 15	40.74% 11	27
Eigenfactor	21.43% 6	64.29% 18	14.29% 4	28
Source Normalized Impact per Paper	74.07% 20	22.22% 6	3.70% 1	27

Figure 3: Q7, What is included in the research metrics training?

Seventy-eight respondents answered the eighth question "How would you rate the interest in research metrics of (University administration / Library administration / Library employees / Engineering faculty / Engineering graduate students / Personal interest)?" All except the personal interest were intended to be a perception of the engineering librarian. University administration was 'Definitely interested' according to 34.62 percent (n=27 of 78) of

respondents, ‘Somewhat interested’ by 33.33 percent (n=26 of 78) of respondents and ‘Don’t know’ by 21.79 percent (n=17 of 78) of respondents. Library administration was ‘Definitely interested’ according to 29.49 percent (n=23 of 78) of respondents, ‘Somewhat interested’ by 42.31 percent (n=33 of 78) of respondents and ‘Don’t know’ by 8.97 percent (n=7 of 78) of respondents. Personal interest was ‘Definitely interested’ according to 43.59 percent (n=34 of 78) respondents and ‘Somewhat interested’ by 35.90 percent (n=28 of 78) of respondents. Full details of the response are given in Figure 4.

	Definitely interested	Somewhat interested	Neutral	Somewhat not interested	Definitely not interested	Don't know	Total
University administration	34.62% 27	33.33% 26	7.69% 6	1.28% 1	1.28% 1	21.79% 17	78
Library administration	29.49% 23	42.31% 33	12.82% 10	5.13% 4	1.28% 1	8.97% 7	78
Library employees	8.97% 7	48.72% 38	23.08% 18	11.54% 9	1.28% 1	6.41% 5	78
Engineering faculty	23.08% 18	35.90% 28	14.10% 11	6.41% 5	0.00% 0	20.51% 16	78
Engineering graduate students	15.38% 12	29.49% 23	17.95% 14	11.54% 9	1.28% 1	24.36% 19	78
Personal interest	43.59% 34	35.90% 28	17.95% 14	0.00% 0	2.56% 2	0.00% 0	78

Figure 4: Q8, How would you rate the interest in research metrics of ... ?

The final two questions dealt with the demographics of the respondents. In order to maintain anonymity, the demographics were limited to two questions. Question 9 asked if the respondent’s institution was public or private or other. The results from 77 respondents were that 70.13 percent (n=54 of 77) were from public institutions, 27.27 percent (n=21 of 77) were from private institutions and that 2.60 percent (n=2 of 77) were from a composite of public and private funding. Question 10 asked for the respondents to indicate their institution’s Research Activity Carnegie Classification. Links were provided to alphabetical lists of institutions for Very High Research Activity (RU/VH) and High Research Activity (RU/H) designations and 75 respondents answered the question. The breakdown was 62.67 percent (n=47 of 75) were RU/VH institutions and 37.33 percent (n=28 of 75) were RU/H institutions.

Open-ended general comments included a mention that the promotion and tenure process drives interest in consultations on research metrics, a mention of consultation services to faculty as needed, a mention of the topic not being taught alone but as part of other classes, a mention that the sciences are interested but not engineering, a comment that “response from the university has been strangely “hot-and-cold,” a comment that spending money on these metrics tools is competing with what is being spent on collections, a comment from a respondent that “my institution has a longstanding tradition of focusing on TEACHING for undergraduates” and goes on to mention faculty skepticism on the topic of metrics, a mention that faculty were showing little interest and at times total rejection of the concept, a specific comment about the reliability

of a particular tool, a comment that a good library guide on citation research has resulted in "very specific questions that are not covered in the guide," and a comment about a respondent running metrics for a couple of department heads in engineering ("They use it to see their faculty publishing habits, activity and impact"). Finally, five comments were received that indicated that the respondent was looking forward to seeing the results.

Conclusions

The results provide an interesting snapshot of the current situation for university administrators, library administrators and engineering librarians. Most efforts in the United States, when present, tend to be informal in nature as perceived by the survey respondents. The exception was one-on-one consultations that may have been considered part of reference or research services. A working definition of formal versus informal would have been good to provide to bring clarity to the effort.

Overall, the response to "Q8, How would you rate the interest in research metrics of [various stakeholders]?" shows that engineering librarians perceive a great amount of interest from university and library administrations. Perhaps library administrators ought to be discussing research metrics with university administrators if they haven't done so already.

Engineering liaison librarians need to be more proactive about the emergence of these tools and services. The level of need for help with research metrics could be intense. One technique for broaching the topic with engineering faculty could be for librarians to let their engineering faculty know that if they are asked for metrics, the libraries have tools that can help to provide quality answers in an efficient manner. The authors believe that engineering librarians should be proactive and prepare in advance for the times when these services would be established at their institutions and even take the lead in development of such services. Basic critical knowledge includes the typical metrics that are generated by citation databases like *Web of Science, Scopus* and *Google Scholar* and corresponding research assessment tools like *InCites, SciVal* and *Publish or Perish* that use the data from the citation databases to generate metrics. It's important to note that extensive information about the strengths and weaknesses of the metrics that are generated using *InCites, SciVal* and *Publish or Perish* are available within the "Help" section available for each online tool. In addition, the Snowball Metrics web page (http://www.snowballmetrics.com/) will provide a great topical grounding for librarians to absorb. If engineering librarians study the available information, they will be poised to take the lead in development of research metric services.

Not surprisingly, the survey results show that expensive tools like *InCites* and *SciVal* are not as widely available as their respective citation databases. A couple of open-ended comments made a very important point – already stressed library collections budgets should not be tapped for funds to acquire research assessment tools, instead, university administrators need to find additional funds to support research metric services tools. For universities with no means for purchasing

InCites or *SciVal, Publish or Perish* offers a free alternative to clean up data available from *Google Scholar*.

In addition to the high level of reported informal services, some open-ended comments indicated that research metric services aren't falling into a predictable arrangement. In some cases, the scholarly communications librarian is the lead figure for library involvement in research metric services. In others, all liaison librarians are expected to know as much as possible about the topic. Six respondents did indicate that their job descriptions have changed to include research metric services. It will be interesting to see if job descriptions continue to change.

Survey results indicate that alternative metric tracking is not widely in use as a purchased tool by libraries, however, librarians need to recognize that publishers are providing these tools. Both Web of Science and Scopus are incorporating alternative metrics. IEEE Xplore does as well.

The authors believe that an important underlying tool will be author identifiers such as ORCID, ResearcherID and Scopus AuthorID. Their importance in alleviating the issues of ambiguity of author attribution is crucial for generating a quality improvement in metrics. Promoting the use of author identifiers will be important work for engineering and other subject liaison librarians.

Finally, the authors were surprised at the large number of RU/VH and RU/H libraries that don't have a web page on research metrics. More than 45 percent of libraries indicated not having a web page. Regardless of where service provision could emerge within a library workforce, creation of a guidance material would be a helpful step in assisting with things like tenure and promotion dossiers, impact statements, identification of publication venues and a framework for one-on-one consultations.

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