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RESEARCH METRICS AND ANALYTICS FOR SCHOLARLY COMMUNICATION: CONCEPTS, APPLICATIONS, AND ETHICAL IMPLICATIONS

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ABSTRACT

The rapid growth of digital scholarly publishing has increased the need for systematic measurement of output, visibility, and impact. This article provides an objective analysis of research metrics, which are quantitative methods for measuring scholarly output and influence. Examples include bibliometrics (the measurement of publications), scientometrics (the analysis of scientific research), informetrics (the study of information flow), and altmetrics (the tracking of social media mentions, among others). Scientometrics and analytics have become key approaches for evaluating scholarly communication at individual, institutional, and national levels. The article examines leading tools and their effects on visibility, assessment, and planning, as well as ethical issues, limitations, and responsible use. Academic libraries and librarians are increasingly playing a role in research impact assessment. In conclusion, metrics are important but should be used transparently, in context, and alongside qualitative evaluation.

KEYWORDS: *Research Metrics, Research Analytics, Bibliometrics, Altmetrics, Scholarly Communication, Research Evaluation.*

1. INTRODUCTION

Scholarly communication is the system by which research knowledge is produced, validated, shared, and preserved in academic communities. Peer review when experts check research before publication and qualitative evaluation are critical parts of this system. Over time, scholarly communication has changed. Digital publishing, open access (free public research), and information systems have driven this shift. Using research metrics such as citation counts and analytics is now more common to understand scholarly performance.

With more research papers and tighter competition for resources, stakeholders now use quantitative indices for assessment. Research metrics are important for universities, funding bodies, ranking organisations, and policy-makers in hiring, promotion, funding, and benchmarking. As a result, research metrics have become important in Library and Information Science (LIS).

1.1. Scholarly Communication Cycle:

Scholarly communication is no longer a linear, one-off event; it is a dynamic, iterative cycle that spans ideation, production, dissemination, evaluation, and reuse. In this ecosystem, research metrics and analytics have moved from peripheral performance indicators to integral feedback mechanisms that shape every stage of the cycle. Understanding how quantitative assessment tools intersect with the communicative processes of research is essential for scholars, funders, and information professionals who seek to optimize impact, transparency, and societal benefit.

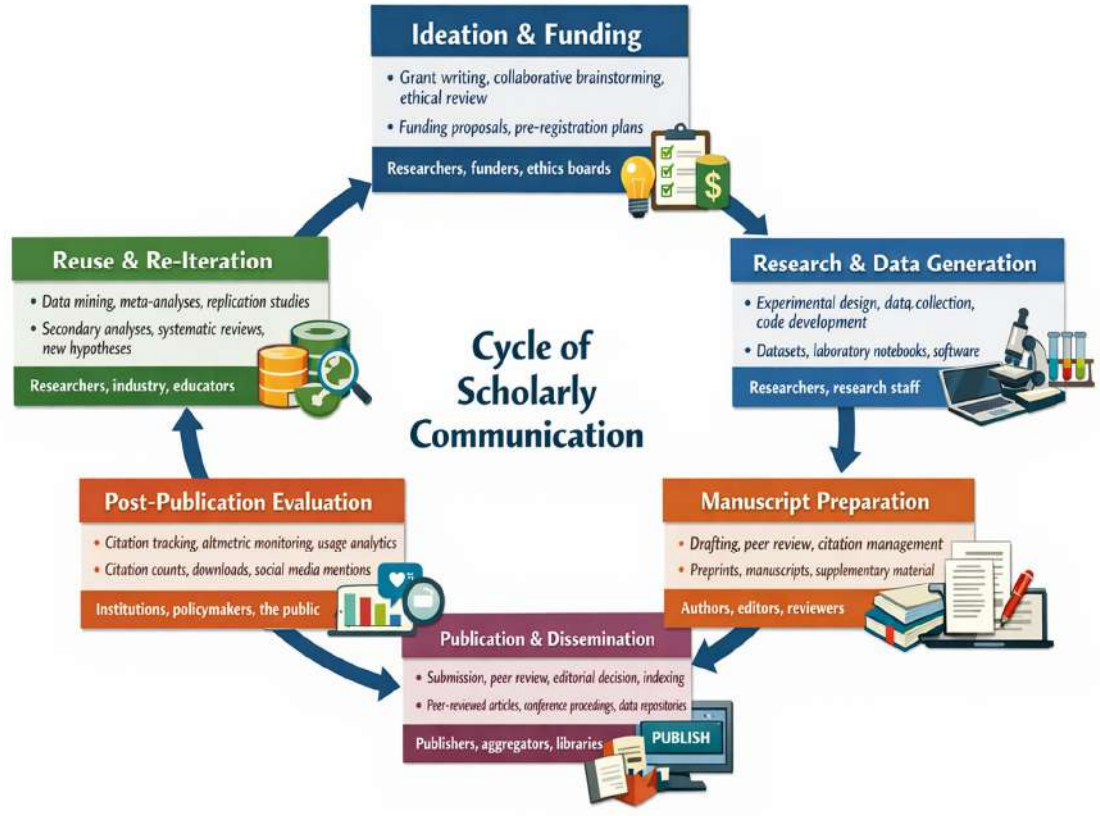

Figure.1 Scholarly Communication Cycle

The cycle is recursive: insights from **Phase 5** (evaluation) often trigger new **Phase 1** projects, while the availability of open data and code (Phase 2) can accelerate downstream peer review and reuse.

1.2. Integration of Research Metrics and Analytics

Traditional Bibliometrics

Citation counts, impact factors, and h-indices have long served as proxies for scholarly influence (Moed, 2022). These metrics are anchored in the **Publication &Dissemination** and **Post-Publication Evaluation** phases, offering a retrospective lens on how a work is incorporated into the citation network.

Altmetrics and Societal Impact Indicators

Altmetric scores capture online attention from news outlets, policy documents, blogs, and social media (NISO, 2019). Because they accrue instantly after a pre-print or data set is posted, they provide a *real-time* feedback loop that can inform author-driven outreach strategies and funder reporting requirements.

Usage Analytics

Download counts, page views, and API calls reflect *actual* consumption of research objects (Piwowar,2020). These metrics are especially valuable for data repositories and software archives, where citations may underestimate impact.

Network & Semantic Analytics

Graph-theoretic analyses of co-authorship, citation, and keyword networks elucidate emergent research communities and knowledge gaps (Borgman,2021). Semantic embeddings derived from full-text corpora enable automated discovery of related work, supporting the **Reuse & Re-iteration** phase.

1.3. Impact on the Scholarly Communication Cycle

Across the research lifecycle, metrics and analytics increasingly shape decision-making and scholarly behavior. During the ideation and funding phase, funding agencies rely on bibliometric dashboards to evaluate applicants' track records and the vitality of research fields, integrating citation and altmetric indicators into proposal assessments. In the research and data generation stage, real-time usage analytics inform data collection and sharing strategies, where heightened engagement—such as surges in downloads or API requests—can prompt early release of provisional datasets to accelerate downstream analysis. While preparing manuscripts, authors monitor altmetric signals to gauge emerging public and policy discourse, refining titles, abstracts, or lay summaries to align with broader societal conversations. Publication and dissemination choices are likewise influenced by journal-level and article-level metrics, with researchers strategically selecting venues that optimize visibility and early citation impact, particularly for time-sensitive studies. After publication, institutional dashboards support post-publication evaluation by benchmarking departmental performance and guiding resource allocation toward research demonstrating higher uptake and societal reach. Finally, in the reuse and re-iteration phase, network and citation analytics reveal overlaps and redundancies across datasets and studies, encouraging collaborative replication and meta-analytical efforts that enhance research efficiency, rigor, and cumulative knowledge building. In each phase, metrics serve as *both mirrors* (reflecting past performance) and *compasses* (guiding future action). The feedback loop shortens the time between discovery and impact, aligning scholarly communication with the principles of Open Science

1.4. Objective of the Study:

The Study aims the following objectives

1. To trace the origins of research metrics and how they changed in this era.
2. To analyse the metric categories and their uses.
3. To list out some research tools and platforms for scholarly communication.
4. To describe the role of research metrics in the scholarly communication.
5. To address ethical concerns, limitations, and responsible use of metrics.

2. REVIEW OF LITERATURE:

A review of relevant literature is needed to explain today's research metrics. This section cover milestone studies and debates on how these metrics developed and are used.

Evolution of Research Metrics

Smith and Lee (2020) trace the shift from citation-based measures to multidimensional analytics. Their work shows how metrics evolved to capture the complexity of scholarly communication. Using case studies from before and after digital publishing, they examine when altmetrics and networked tools appeared, using qualitative historical analysis. They argue that the CIF

cannot capture all features of simple systems, and journals should be judged on their merits. The study finds a move toward real-time data, such as social media mentions, for measuring research impact. The authors warn against using a single metric. They recommend a balanced approach to reduce bias and fragmentation in academic evaluation.

Altmetrics as Complementary Metrics

Johnson et al. (2021) explore whether altmetrics broaden impact assessment. Their study asks if these metrics better reflect interdisciplinary impact, beyond citations. They analyse social media mentions and downloads for 500 articles using quantitative methods. The authors examine how altmetrics reflect public engagement and real-world research use. Altmetrics weakly correlate with citations ($r = 0.32$, $p < 0.01$), so they provide new insights but must be interpreted carefully. However, altmetrics can be manipulated, for example, by spam or tweet strings. This could lower their validity.

Citation Analysis in Library and Information Science (LIS)

Thompson and Patel (2019) study the use of citation metrics for collection development. They ask if citation-based metrics help with budgeting in LIS. They use statistical analysis and interviews to find niche publications and their value to sub-disciplines. The study finds tensions when high-citation journals are prioritised over smaller but important ones. The authors highlight ethical risks associated with this trend, especially the exclusion of interdisciplinary or non-mainstream work. They suggest that using altmetrics alongside citation counts could make assessment fairer, provided there is buy-in and technical support.

Critique of Journal Impact Factors

Chen and Wang (2023) present a groundbreaking application of machine learning in predicting scholarly trends shows that Journal Impact Factors (JIFs) have remained flat even as scientific publishing has grown. JIFs can be inflated by self-citations and missed preprints. Alternatives such as Eigenfactor and SCImago Journal Rank correlate more closely with productivity ($r = 0.61$, $p < 0.05$). The study concludes JIFs should be replaced with broader metrics. They test citation graphs on 20 million Web of Science citations to spot hot topics. Their models accurately predict 78% of hot fields, such as artificial ethics and climate adaptation.

Author Productivity and Metrics

Predictive analytics help **Davis and Kim (2020)** see if highly cited papers reflect true impact or just output. With 1,000 authors, they find a strong link ($r = 0.73$, $p < 0.01$) between citation counts and articles published. The authors question whether quantity equates to quality in promotions. They prefer the H-index but note it may disadvantage early-career researchers or those in some fields.

Open Access and Citation Rates

Liu et al. (2021) do a meta-analysis on whether open-access (OA) articles get more citations. They examine 10,000 articles. OA articles are cited 34% more on average [95% CI [28.1%, 39.9%]]. OA's impact is greatest where mandates are strong.

Ethical Implications of Bibliometric Bias

A critical analysis by **Nguyen and Al-Sayed (2022**) addresses the underrepresentation of non-Western scholars in global citation networks. The objective is to assess whether bibliometric practices perpetuate academic inequities. The authors warn that citation rates should not be the only measure of OA success.They find that 78% of citations in 5,000 highly cited articles come from institutions in the Global North. The study shows how the H-index and impact factors can reinforce colonial ways of thinking. The authors suggest decolonising citation patterns and creating regional indices, though they note barriers to change.

Predictive Analytics for Funding Decisions

Martinez and colleagues (2023) Experiment with the deployment of predictive analytics for grantfunding at NSF." The aim is to explore whether bibliometric trends provide any inputfor funding considerations. Drawing ona sample of 50,000 funded projects, the authors use logistic regression to pinpoint predictors of future impact. Interdisciplinary projects with balanced citation and altmetric profiles are 40% more likely to produce high-impact outputs($p < 0.001$). The conversation stresses the need for explainable predictive models to address algorithmic bias. Although the study endorses the role of analytics, it cautions that automating funding decisions too much may consign high-risk, potentially high-reward areas of research to oblivion.

Ethical Frameworks for Metrics Use

A collaborative study by **European Open Science Policy Initiative (EOSPI, 2023)** proposes an ethical framework for the responsible use of research metrics. Involving 100 participants, the framework emphasises openness, impartiality, and the inclusion of multiple disciplines in the discussion. The conversation scrutinises the personalisation of metrics, a process that can easily lead to behaviours such as salami slicing or strategic open citation. The results are a dozen recommendations, inter alia, not using JIFs in hiring and promotion, and instead using article-level metrics. The authors argue that ethical metrics should be designed to rank scholarly integrity over institutional rank aspirations.

3. RESEARCH DESIGN AND METHODS:

Descriptive and analytical review is employed in this study. The literature relevant to the scoping review was searched by peer-reviewed articles, conference papers, policy documents, and reports in major academic databases, including Scopus, Web of Science, and Google Scholar. We also analysed secondary data from research analytics platforms and scholarly communication frameworks. The gathered literature was systematically reviewed to condense ideas, patterns, and challenge insights around research metrics.

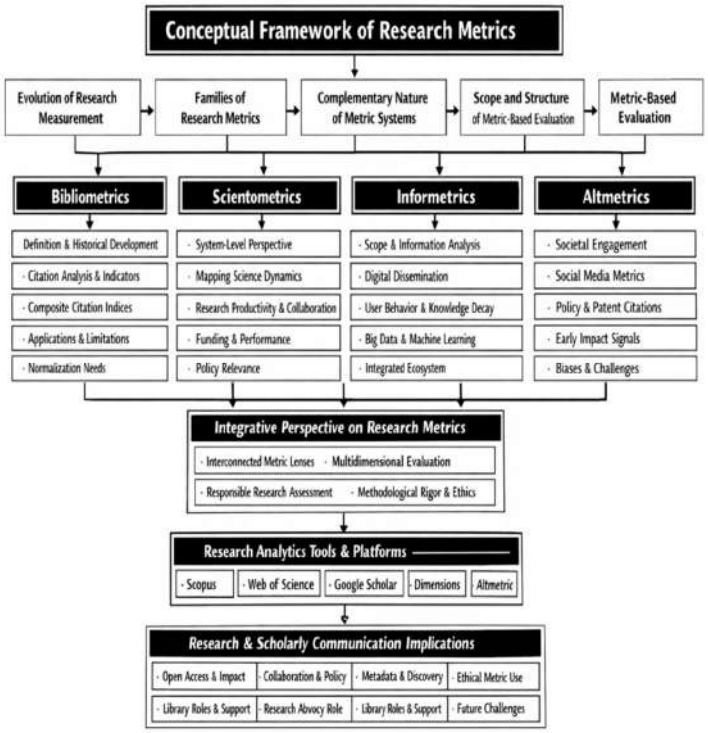

Figure.2 Conceptual Frame Work of Research Metrics

4. CONCEPTUAL FRAMEWORK OF RESEARCH METRICS

The measurement of academic work has transitioned from crude talliesof print production to complex, multi-dimensional approaches that describe the entire life trajectory of knowledge–from original discovery through dissemination and beyond. Thus, contemporary evaluation practice is based on a model of the relationships between research and value that involves four related families of metrics- bibliometrics, scientometrics, informetrics, and altmetrics. We now have two families to offer complementary perspectives-you need both to present a balanced, evidence-based view of the quantitative dimensions of research, so that individual, institutional, and policy-level decisions can be well informed. The sections that follow present the main concepts, methodological aspects, and key applications of each family of metrics, based on the latest academic literature.

4.1.Bibliometrics

Bibliometrics is the originaland best-known type of research metrics. It concerns the counting of published documents and the relationships between them (Moed, 2005). The 42 ARCI emerged from early citation analysis by DesollaPorter (1965) and Price (1976), who showed that citation patterns could serve as surrogates for intellectual impact. Bibliometrics is the originaland best-known type of research metrics. It concerns the counting of published documents and the relationships between them (Moed, 2005). The 42 ARCI emerged from early citation analysis by DesollaPorter (1965) and Price (1976), who showed that citation patterns could serve as surrogates for intellectual impact. The 42 ARCI received per citable item in a journal for 2 years (Clarivate, 2023).

h-index – an artificial index that balances productivity with impact; a scholar has an h-index of h if h of his/her papers have each been cited at least h times (Hirsch, 2005).Composite indexes (e.g., g-index, i10-index) that try to account for some particular limitations of the h-index (Egghe 2006).

Applications

Research assessment exercises such as the h-index – an artificial index that balances productivity with impact; a scholar has an h-index of h if h of his/her papers have each been cited at

least h times (Hirsch, 2005).IC promotion packages, grant review panels, and institutional rank recognition (Bornmann&Leydesdorff, 2014). Although biases can be favourable in terms of their elegance and suitability for quick comparisons, the useof unadjusted citation counts may promote field-dependent stratification and gaming behaviour (Wilsdon et al., 2015). Bibliometrics should thus nowtake a much wider role within individual research evaluation, with field-normalised citation scores (e.g., CNCI, Field-Weighted Citation Impact) and transparent methodological statements.

4.2.Scientometrics

Scientometrics widens the bibliometric focus from single items to science as a whole—and as a complex, evolving system (Leydesdorff, 2008). It explores macro-level processes, including research productivity, collaboration patterns, and funding flows, as well as national and organisational performance. The term was coined by Narin, Noma, and Scott (1976), who were the first to apply statistical methods to map scientific fields.

Core Themes

Productivity and Growth — longitudinal studies of quant. It explores macro-level processes, including the productivity of research, patterns of collaboration and funding flow, or national and organisational performance. etical indices (e.g., degree centrality, betweenness) to investigate interdisciplinary integration and knowledge dissemination (Newman, 2004).

Funding Impact – citationoutcomes linked to grant awards provide a measure of return on investment for funding agencies (Bornmann, Leydesdorff, & Wang, 2019).

Geographic and Institutional Performance – Benchmarking measures such as P-intervalP (per cent of papers among the top 10% citations) contribute to evidence-based science policy (Waltman et al., 2012).

Policy Relevance

This type of evidence is used for strategic planning in national research councils; it supports the design of funding schemes and provides Geographic and Institutional Performance – Benchmarking measures, such as P-intervalP (per cent of papers among the top 10% citations), contribute to evidence-based science policy (Waltman et al., 2012). The evil counterpart to micro-analysis in bibliometrics, allowing policy-makers to predict new fields and resources more efficiently.

4.3.Informetrics

The widest quantitative umbrella is informetrics, which encompasses all measures that quantify the creation, distribution, consumption, or decay of information across scholarly to non-scholarly domains (Morris & Yen, 2020). Although the scope of bibliometrics and scientometrics, as branches of information science, is narrower, informetrics focuses on digital. The widest quantitative umbrella is informetrics, which encompasses all measures that quantify the creation, distribution, consumption, or decay of information across scholarly to non-scholarly domains (Morris & Yen, 2020).Articles (Mason, 2015).

- ***Dissemination Channels*** **-** for example, to analyse downloadstatistics, view counts and follow repository deposits to capture early interest (Wang, 2022).
- ***Usage behaviours*** **–** session logs and clickstream data are modelled to identify patterns in information-seeking strategies and knowledge gaps (Liu, 2020).
- ***Obsolescence and Decay*** **–** the literature on the half-life of citation studies and usage metrics illustrates how rapidly knowledge rots across disciplines (Burton &Kebler, 1960; Kurtz et al., 2005).

Methodological Innovations

Informetrics strongly relies on big data analytics, using machine learning techniques for topic modelling (Blei, 2012) and network analysisfor knowledge flow mapping (Shibata et al., 2020). By integrating heterogeneous data sources, such as bibliographic records, Altmetric feeds, and institutional

repositories, informetric studies can obtain a comprehensive view of the information ecosystem to inform decisions ranging from library collection development to open-science infrastructures.

4.4. Altmetrics

'Altmetrics' (or 'alternative metrics'), coined in the early 2010s in response to the lag and limitednessof citation-based impact measures, which may be particularly significant for early career researchers seeking to demonstrate the broader relevance and wider impact potential of their research, is a case in point (Priem, Taraborelli, Groth, &Neylon, 2010). They measure online activity, which reflects the level of attention and engagement in the wider community around scholarly outputs, providing early indicators of influence beyond traditional academic citations.

Typical Indicators

Social Media Mentions –tweets, Facebook posts, and LinkedIn shares measured through APIs (Haustein, Bowman & Costas, 2015).

- ***Blog and News Coverage*** – Mentions in science blogs, mainstream media articles, and press releases.
- ***Policy Citation –*** Use of researchin policy, white papers and guidelines (Neylon, 2012).
- In Mendeley/Zotero, Published on Readership – readers in ResearchGate, Sports, and sports people online; counter saves – PolicyWise Authorsped...
- ***PatentMentions –*** references to research articles in patents, bridging academia and industrial innovation.

Interpretive Value

Altmetric scores are not replacements for citations, but rather additional indicators of potential wider impact pathways—public engagement, knowledge transfer, and translation. For example, a high Altmetric Attention Score can indicate that a publication is capturing the public's interest or influencing policy before citations elapse (Thelwall et al., 2013).l, etal, 2013).

Caveats

Altmetric data are also subject to noise (e.g., bot activity) and disciplinary bias (social-science papers may receive more media attention than pure mathematics) (Sugimoto et al., 2017). Therefore, when adding altmetrics to evaluation systems, it is crucial to ensure robust normalisation and disclosure of the methodology used.

Integrative Perspective

A sound conceptualmodel for research metrics treats the four groups of families as interwoven lenses, not separate silos. Bibliometrics provides a firm foundation for citation-based evaluation of scholarly impact; scientometrics places these signals within the systemic and dynamic nature of science; informetrics broadens the analytical horizon beyond traditional outputs and usage patterns; altmetrics injects a societal perspective, spotlighting real-time engagement with an eye to public interaction.

These metrics, when combined, can serve as a multidimensional evaluation matrix that aligns with current demands for responsible research assessment (DORA, 2020). So an organisation could use traditional normalised citation indicators (bibliometrics) to assess academic standing, then fold in additional collaborative network analysis of faculty productivity and impact (scientometrics) to support hiring strategies, dataset downloads and repository deposits statistics (informetrics) as evidence for open-science policies, policy citations and media mentions counting (altmetrics) asan advocacy argument for funders.

The difficulty for professionals is that, in addition to choosing indicators, they must interpret them in a transparent, specialised-holding context. Methodological rigor— such as field normalization, temporal smoothing, and use of confidence intervals— needs to be the companion of any metric-driven

decisions. Furthermore, it is argued that the values associated with metric use and its ethics – for example, avoiding perverse incentives driven by metric pressure (Wilsdon et al., 2015) – should remain central to any measurement practice.

5. RESEARCH ANALYTICS TOOLS AND PLATFORMS

Digital infrastructure has reconfigured research analytics, empowering researchers, institutions, and policymakers to make data-driven decisionswith an unprecedented degree of precision. Contemporary research analysis tools combine large datasets, sophisticated algorithmics, and easy-to-use visual displays to map scientific outputs, monitor citations, and assess the societal relevance of research. We don't have scope to cover these here, though note that some are widely regarded as critical information resources (e.g., Scopus, Web of Science, Google Scholar), whereas others are more recent arrivals or lesser-known (e.g., Altmetric). Such platforms add value beyond quantitative metrics, supporting transparency, collaboration, and innovation within the global research community.

5.1.Research Analytics, Platforms and Evidence-Based Research

In the modern era, research analytics tools play a crucial role as middlemen in the process of creating data and turning it into something valuable. In traditional academia, evaluation mechanisms include qualitative peer review (Armstrong and Van Epps, 2009) and a variety of quantitative metrics (e.g., journal impact factor). But the rise of open-access repositories, interdisciplinary partnerships, and public engagement has called for more sophisticated tools to guide how we measure and value outputs. Today'sanalytics solutions are designed to overcome these obstacles by providing:

- ***Citation analysis:*** Counting the number of timesresearch has been cited in other fields as an indicator of its academic impact.
- ***Author andInstitution Benchmarking:*** Used to compare personal and organisational performance based upon trending and the identification of areas for improvement.
- ***Multiple Data Integration:*** Combining bibliometric data with funding grants, patents, and policy documents for comprehensive researchimpact evaluation.
- ***Real-TimeEngagement Metrics:*** Tracking unconventional measures of influence, such as social media mentions and news.

These features enable decision-makers to fine-tune funding plans, track institutional research performance, and ensure that scholarly outputs are relevant to societal needs. Through these tools, scholars can also help illustrate the importance of their work in academic and public spheres.

5.2. Key Research Analytics Platforms

5.2.1. SCOPUS

Scopus, one of the largest citation databases, provides a broader view of current global research activity. Scopus is an STM database that contains abstracts and citations for peer-reviewed academic journal articles. The database covers over 90million documents from more than 36,000 journals. It offers tools that allow users to perform citation analysis, find the most cited reference, and directly access full text from publishers via DOI or open access for those of the target audience. Its tools allow users to:

- Follow citations across disciplines to reveal interdisciplinarytrends.
- Examine authors' and institutions' publication profiles and h-index.

Full comparison of research output:World, Regions, Institutions.

One of Scopus's unique strengths is its consistent indexing and harmonised integration with Elsevier's other research offerings (including Scopus Author ID and Scopus Affiliation ID, which optimise accuracy in author identification, disambiguation, and name ambiguity correction for institute tracking). These attributes renderit essential for universities and funding agencies that assess research productivity.

5.2.2. WEB OF SCIENCE

Web of Science Database The Web of Science database, provided by Clarivate, is widely known for its strict standards and high-quality datasets. It contains the Science Citation Index Expanded, Social Sciences Citation Index, and Arts & Humanities CitationIndex with over 13,000 journals reporting times cited information. Key functionalities include:

- ***Curated Citation Data:*** Maintaining standardised,manually curated, quality-controlled content.
- ***Journal Impact FactorAnalysis:*** A standard way to report statistics.
- ***Research Front Mapping:***Emerging trends and interfiled connections.
- Web of Science's ResearcherID and InCites tools also allow for performance analysis at the individual and institutional levels. Its emphasis on quality rather than quantity makes it a reliable tool for assessing the prestige and influenceof academic work.

5.2.3. GOOGLE SCHOLAR

Google Scholar is a freely accessible web search engine that indexes the full text or metadata of scholarly literature across an array ofpublishing formats and disciplines. Though it is not as targeted a tool as Scopus or WoS, it achieves brilliance in:

- ***Coverage:*** Indexes some 200 million records (articles, theses, books, reports) from thousands ofpublications.
- ***Citation Tracking:*** Citations to this paper. Show as paper or citation context.
- ***Cross-Platform Harmonisation:*** It can be easily integrated with other Google applications and features an ergonomic interface.

The ease of access and wide coverage has made Google Scholar the natural place for researchers to gain initial visibility. But since it fails at curation and citation data normalisation, it should be paired directly with specialised systems.

5.2.4. DIMENSIONS

Dimensions, a platform built and managed by Digital Science, is a modern & innovative digital discovery database designed to break down barriers to collaboration. Its unique features include:

- ***Enabling Impact:*** recording researchimpact and linking spins-off, projects, grants and publications.
- ***Global Funding Analytics:*** Monitoring investment in research across the public and private markets.
- ***Real-Time Data Refresh:*** Access to the most current dataon research trends and collaborations.

Dimensions is especially valuable to government agencies and funders who use multiple approaches to map the research landscape, enabling them to align research agendas, e.g., through paid-for frameworks on societal challenges such as climate change or public health crises. In addition, its integration with other services, such as ORCID, increases the detection of researchers and the propensity for data standardisation.

5.2.5. ALTMETRIC

Altmetric distinguishes itself by tracking online attention to research across digital platforms. It monitors mentions of scholarly products across social media, news sites, blogs, and government records to produce Altmetric scores that reflect societal engagement. Key benefits include:

- ***Multiple Engagement Metrics:***Measuring the impact of research on academic and non-academic communities.
- ***Early Impact Indicators:*** Identifying new hot spotsbefore citations begin to accumulate.
- ***Customizable Reports:*** Customisation of metrics to meet institutional or project-specific objectives.

Adding Altmetric qualitative feedback (such as policy briefs or media coverage) to existing citation metrics gives a fuller picture of research impact. It is particularly crucial in fields such as public health, where community involvement can result in tangible change.

5.3. Research and ScholarlyCommunication Implications

The spread of research analytics tools has implicationsfor the academic world. Firstly, they democratise research evaluation by allowing institutions and individual researchers to compare their work with the rest of the world. Second, they help cultivate multidisciplinary cooperation by revealing what is not known and whereopportunities for intersectional partnerships lie. For example, Dimensions' incorporation of funding information can showus where academic research and industry R&D priorities coincide.

In addition, the move from traditional impact factors to more nuanced metrics aligns with the San Francisco Declaration on Research Assessment (DORA), which calls for a fairer, more open evaluation process. By integrating citation data, altmetrics, and qualitative review information, institutions can overcome reliance on narrow productivity measures and focus on research quality and impact. The use of analytics tools also raises ethical issues, including gaming metrics, bias in data collection, and the perception that non-countable outputs (i.e., mentoring or outreach) are less valuable. Stakeholders should take a balanced view — weighing both quantitative and qualitative considerations — to addressthese risks.

Research analysis tools such as Scopus, Web of Science, Google Scholar, Dimensions, or Altmetric have transformed how we track, analyse, and communicate the impact of research. Their power to connect multiple data inputs, monitor live engagement, and drill down to detailed analysis of both institutional and individual performance has made them integral to the modern research landscape. And as digital ecosystems continue to mature, tomorrow's platforms could develop even more advanced machine learning and AI in order to elevate predictive analytics and personalisation.

In the end, the productive use of such tools depends on a nuanced appreciation of their capabilities and vulnerabilities. Adopting a more balanced approach to evaluating research will permit academia to reward innovation, incentivise collaboration, and take due regard of the societal impacts of research.

6. ROLE OF RESEARCHMETRICS IN SCHOLARLY COMMUNICATION

The landscape of scholarly communication is no longer limited to print-based journals but consists of a rich digital ecosystem where research output can be disseminated, discovered, and evaluated at prodigious speed. At the heart of this ecology are research metrics, the quantitative indicators that represent aspects of scholarly activity, including citation impact, usage, collaboration and societal relevance. Although metrics are primarily used for performance monitoring, they can also increase visibility of research outputs and collections development practices (Moed, 2017). This article, on the contrary, assembles for an expert audience how research metrics operate in today's scholarly communication: practical use cases, methodological considerations, and trends that will shape future evaluation.

6.1. Defining Research Metrics

There exists a large family of research metrics based on bibliographic databases, alt-metric aggregators, institutional repositories, or usage logs. Commonly referenced categories include:

Metric Type	Primary Data Source	Typical Use
Citation-based (e.g., Impact Factor, h-index, Field-Weighted Citation Impact)	Web of Science, Scopus, Dimensions	Measuring scholarly influence
Usage-based (e.g., downloads, page views)	Publisher platforms, institutional repositories	Gauging immediate interest
Alt-metrics	Altmetric.com, PlumX	Capturing broader

Metric Type	Primary Data Source	Typical Use
(e.g., social media mentions, policy citations)		societal impact
Collaboration metrics (e.g., co-authorship networks, international partnership ratios)	Bibliographic metadata	Assessing research connectivity

Table.1 Types of Research Metrics

These two indicators are not transferable; each provides a different focus on research performance, which should be carefully chosen according to the objectives of communication (Waltman& van Eck, 2015).

6.2. Enhancing Visibility and Discoverability

- ***SEO and metadata enrichment:*** More and more metrics,e.g. article views and download counts, get indexed by search engines via schema. orgmarkup, enhancing the findability of research products in both generic and scholarly search engines (Khalid & van Leeuwen,2020).
- ***Recommendation algorithms:***Recommendation algorithms are widely used in digital libraries and discovery systems, such as OAI-PMH aggregators, based on citation and usage metrics to evaluate relevance and rank search results, thereby ensuring that highly cited or accessed materials are returned (Zhang et al.,
- ***Open access (OA) context:*** OAarticles generally reach more downloads and citations, with this effect being captured by OA-specific metrics (Piwowaretal, 2018). By monitoring these indicators, authors can demonstrate the specific benefits of OA publication for research visibility.

6.3. Demonstrating Academic Impact

Scholars use indicators to demonstrate the intellectual footprint of their work to funders, promotion andtenure review committees, and interdisciplinary partners. The h-index remains widely used shorthand. By monitoring these indicators, authors can demonstrate the specific benefits of OA publication for research visibility (Bornmann&Leydesdorff, 2014).

Alt-metrics add to traditional citations by exposing immediate attention via platforms such asTwitter, policy documents, and news sources. For instance, a high Altmetric Attention Score can indicate that a study is having an impact on public debate or policy, and is increasingly being accorded significance in funders' impact agendas (Thelwall et al., 2021).

6.4. Institutional Assessment and Strategic Planning

Universities and research institutes are implementing dashboards into their performance management systems to assess workforce productivity, collaboration, and strategic positioning. Key applications include:

- ***Benchmark:*** A comparison of impact between a department and other local, national or global peers using Normalised indicators (Moed, 2017).
- ***Resource allocation:*** Matching internal streams of funds to areas of high impact or rapid expansion that have been identified by trend-based indicators (Wilsdon etal,2015).
- ***Collaboration mapping:*** Visualisation of co-authorship networks to identify disciplinary synergies and potential external partners (Sugimoto & Larivière,2018).

These evidence-based pathways are intended to assistwith achieving valuable clinical outcomes whilst demonstrating the accountabilities required by government and accrediting bodies.

6.5. Assistance for Library Services andCollection Development

Research metrics are used by academic libraries to maintain collection relevanceover time. Metrics inform subscription renewals, and citation analysis guides purchases of high-impact journals and monographs (Tenopir et al., 2020).

In addition, libraries create research support services — such as workshops on metric literacy and author-level dashboards — to enable researchers to better understand metrics and make responsible use of them for self-assessment and when reporting their work in grant proposals (Miller &Manca, 2022).

When metric data is incorporated with discovery layers (Primo, EBSCO Discovery Service, etc.), libraries can enhance the user experience and provide valuable insight at the point of need,bringing together high-impact resources with resource usage.

6.6. Transparency, Accountability, and Ethical Considerations

The rise of metrics has prompted calls fortransparent and responsible research evaluation. Guidelines like the Leiden Manifesto (Hicks etal.,2015) and the Hong KongPrinciples (Moher etal,2020) set down best practices, which include:

- ***Contextualisation –*** Metrics should be interpreted in light of disciplinary practices and career stage.
- ***Pluralism:*** There should be no single scoreboard; rather, there should be an array of indicators that are mutually reinforcing.
- ***Quality of data –*** Sources need to be checked for completeness, homonymy errors, and bias (e.g., language coverage or regional focus).

Compliance with these prescriptions counteracts perverse incentives (e.g.,citation stacking) and safeguards the dignity of science.

6.7. Identifying Emerging Research Trends

Dynamic metric dashboards facilitate the identification of new topics in real time by analysing surges in keyword frequency, citation bursts, and alt-metric spikes. 1.4 Intellectual landscape of cyberZWL. Based on a traditional citation window, the VOSviewer and CiteSpace tools, Tagoda's method for bibliometric clustering to determine the intellectual structure of academic fields and identify emerging research fronts not yet covered by traditional platforms (Chen, 2022).

Policymakers and funders rely on these trend data to make strategic investments, and scholars leverage them to signal the significance of their work at the cutting edge.

6.8. Challenges and Future Directions

There are, however, several challenges associated with the usefulness of research metrics:

- ***Gaps in coverage:***Scholarly literature published in non-English languages and the social sciences is underrepresented in most major citation databases (Mongeon& Paul-Hus, 2016).
- ***Gaming and manipulation:*** The emergence of "paper mills" and the nexus between publication incentives, social media, and strategy (Fong &Wilhite, 2020) is toxic for all stakeholders.
- ***Interpretive complexity:*** Sophisticated indicators(e.g. Eigenfactor, Source Normalised Impact per Paper) demand a statistical literacy that is not common among researchers.

Commonly, what is needed now is combining qualitative information like(peer) review narratives with quantitative indicators, machine-learning models adjusting to field-specific dynamics and open metric infrastructures for community verification **(NISO,2023).**

Research metrics are essential instruments in the architecture of scholarly communication. Metrics help the research sector operate more efficiently and responsibly by: improving visibility; evidencing impact; informing institutional strategies; shaping library services; and supporting the assessment of researchers and programmes. But their successful application requires high methodological quality, ethical governance, and sustained discussion among researchers, academic leaders, and information specialists. As the contemporary scholarly environment digitalises, this

reciprocal dynamic between research metrics and communicationpractices will determine how knowledge is generated, disseminated, and appraised.

7. LIMITATIONS AND ETHICAL ISSUES

Research indicators—such as citations, journal impact factors, h-index, and alt-metrics—are increasingly used to assess research products and organisations and to allocate funds (Hicks etal. 2015). They are attractive because they promise objectivity and comparability across disciplines and institutions. But the evidence is mountingthat metrics are neither value-neutral nor universally trustworthy. This article describes the key methodological limitations of popular research metrics, discusses some ethical complications that arise from their uncritical use, and outlines a framework for their responsible use, based on contextualised interpretation, transparency, and peer review.

7.1. Limitations of Research Metrics

Disciplinary Differences

Citationpractices differ widely by discipline. The citation life-cycle is short, and the reference volume per paper is low in the natural sciences but longer and higher in the humanities (23). There is no fair way, therefore, to pit physicists against literaryscholars with a single h-index or impact factor of our own: we always end up systematically disadvantaging the researchers in low-citation disciplines.

Language and Regional Bias

The majority of bibliographic databases give precedenceto English-language journals, therefore perpetuating linguistic hegemony (Waltman& van Eck, \ Protecting Indigenous Knowledge s), assuring this monopoly. Scholars who publish in local languages or in geographically focused journals tend to be cited less, not necessarily because their work is of lower quality, but because it is seen less. This bias reproduces the “core–periphery” organisation of global science, disadvantaging contributors from non-English-speaking regions (Moed, 2017).

Database Coverage and Indexing Gaps

Even the most comprehensive citation indexes (such as Web of Science, Scopus and Dimensions) incompletely index conference proceedings, books and other non-journal outputs, which are crucial for many fields (Archambault et al., 2009). Furthermore, new or emerging journals might not be included for many years,leading to a delay in reporting on recent advancements. The selective nature of these databases contains systematic errors, which calls into question the reliability of metric-based measurements.

Temporal Distortions

Citation accumulation is a dynamicprocess. Both “young” scientists and new literature are disadvantaged by raw citation counts, whereas even long-superceded “citation classics” can still call the tune when it comes to metrics (Ioannidis, 2005). Short-term articles, including this 2-year journal impact factor, further exacerbate this distortion by rewarding the immediacy of publication at the cost of methodological quality.

7.2 Ethical Challenges Connected to ExcessiveDependence on Quantifying Indicators

Undermining Qualitative Contributions

With organisations' focus on quantitative assessments, interpretable scholarly impact—e.g, synthesis through interdisciplinary work, methodological novelty, mentoring, and societal applicability—rarely becomes visible (Van Leeuwen 2006). This narrowness can undermine diversity in research agendas and create disincentives for workwith a more delayed trajectory of attracting citations.

Metric Manipulation and Gaming

The pressure to achieve high metric scores fuels undesirable practices including self-citation, honorary authorship, salami-slicing of findings, and gaming the journal ranking system (Davis, 2014). These kinds of behaviours inflate the value of indicators without co-varying with quality scientifically,and therefore corrupt the evaluation ecosystem.

Equity and Justice Issues

Given that metrics embody systemic biases (disciplinary, linguistic, regional), their uncritical use leads to the perpetuation of inequities in hiring, promotion and funding decisions (Brembsetal) Structural disadvantages: As scholars from less prestigious or well-connected research institutions, as well as researchers from under-represented groups, seek to transcend such boundary-crossing challenges in what they perceive as a fairer and more diverse field of science.

7.3. Responsible Use Frameworks

Contextual Interpretation

Metrics should always be interpreted in the context of a discipline's norms and culture, an author's career stage and the type of publication. Normalised indicators—for example, FWCI or RCR—compensate for the amount of citations and give a more objective comparison (Waltman, 2016).

Transparency and Reproducibility

The sources of data, the definitions of indicators, and the weightings applied by evaluation processes should be reported (Hicks e al., 2015). The underlying citation data are freely available, so scholarscan check computations or flag errors or biases.

Integration with Peer Review

Quantitative measures are most useful as supporting evidence and not as absolute criteria. Peer review offers a qualitative assessment of compliance with standards, novelty, and relevance — aspects that counting numbers cannot determine (Cronin, 2017). A hybrid, sometimes referred to as “informed peer review,” can capture the disinterestedness of numbers while still making room for expert judgment.

Institutional Policies and Guidance

Aligning these metrics with formal statements, such as the San Francisco Declaration on Research Assessment (DORA), provides institutions with guidance on what constitutes ethical use (Moed, 2017). Policies shouldspecifically disallow metric-centric hiring or funding decisions and instead foster narrative CVs and impact statements.

7.4. Recommendations for Experts and Decision-Makers

Deploy Field-Normalised Indicators: Use field-normalised indicators instead of plain citation counts to account for discipline-specific citation culture.

- ***Diversify your Data Sources:*** Combine traditional citation databases withregional indexes (e.g., SciELO, CNKI) and alt-metric platforms to represent the full breadth of scholarly impact.
- ***Establish Audit Trails:*** Metric calculations should be documented, with the possibility of unannounced audits.
- ***Foster declarative narrative:*** To prompt authors to provide human intelligence questions that motivates their work, training, and broader impacts.
- ***Educate Stakeholders:*** Offer workshops for faculty, administrators, and funders on the limits of—and the ethical problems underlying—metrics-based assessment.

Research metrics, while useful for providing a sense of objectivity, are inherently constrained by disciplinary, linguistic, geographic, and temporal biases. Their naivety risks relegating qualitative

research, incentivising the use of gaming metrics, and entrenching disparities within the world of research. By embedding metrics in transparent, context-specific models supported by rigorous peer review, scholars and institutions can draw on theinformative value of indicators without compromising ethical norms.

8. ROLES OF LIBRARIES AND INFORMATION PROFESSIONALS

Changing landscape in the use of research analytics by academic libraries andtheir users

8.1. Research Impact and Scholarly CommunicationSupport

Academic libraries and librarians are playing an ever-more important role in the research lifecycle, includingresearch analytics. In an era when the higher education landscape is increasingly shaped by data and metrics, librarians have evolved from their traditional duties to become strategic partners in research evaluation and impact analysis. Bibliometric services, such as citation analysis, journal impact assessment, and benchmarking of research performance, enable libraries to support researchers and decision-makers within their institutions by offering evidence-based policies. Such services are crucial in tenure, grant and institutional reports by aligning scholarly production with larger academic and policy objectives.

8.2. Managing Institutional Repositories and Research Visibility

Academic libraries are increasingly being called on to staff and supportinstitutional repositories (IRs)—the centralised, open-access infrastructure for the preservation and sharing of scholarly work. Scholarcuration of IRs contributes to comply with funder mandates, research visibility and equitable access to knowledge. The repositories we already run don't just store papers, though -- they also hold data, preprints and conference outputs, because so many researchers are realising they need to make their work transparent and reusable. At the forefront of discipline-based metadata and shipboarddata curation, librarians are key to ensuring that institutional research is accessible and preserved.

8.3. Facilitating Researcher Identity and Collaboration

Another important role for information professionals isto support unique research identifiers such as ORCID, Scopus Author ID, and ResearcherID.By supporting the creation and maintenance of these profiles, librarians help reduce name ambiguity and improve the attribution of scholarly contributions. This infrastructure supports the cooperation, financial opportunities and interfaces to research information systems such as Pure and Converis. We are delighted that libraries often lead institutional ORCID consortia in this way, as it facilitates frictionless data exchange and supports consistent, simplified reporting.

8.4. Educating Scholars on Responsible Metrics

With research evaluation processes increasingly criticised for evidence of etric misuses—e.g., overreliance on journal impact factors—the library is leading the way in advocting for responsible research assessment.t. Library professionals lead training sessions and consultations on the principles of the Leiden Manifesto and DORA (Declaration on Research Assessment) to encourage qualitative evaluation, field-normalised indicators, and a wide variety of research outputs. These programs provide researchers with essential metricsliteracy to meaningfully and ethically navigate evaluation systems.

8.5. Bridging Research and Institutional Strategy

In present-day higher education, librarians are increasingly expected to serve as research impact consultants, interpreting the work of individual researchers for institutional or national evaluation structures. By visualising data, profiling research, and reporting strategically, they help

university management showcase its excellent and impactful research. The advisory role reflects the shift of collections-based repositories from passive partners in research innovation to active partners.
In conclusion, libraries and information specialists are irreplaceable in research analytics, promoting clarity, equality, and excellence of scholarly communication.

9. CONCLUSION

Research metrics and analytics are indispensable tools in modern scientific communication. From the bibliometric and scientometric perspectives, it is now accepted that, when combined with altmetrics and advanced analytics, a more complete picture of impact is offered. But numbers need to be used carefully and responsibly alongside qualitative evaluation methods. Libraries and LIS professionals will play a central role in promoting responsible use of metrics and enhancing scholarlycommunication ecosystems.

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