SCIENTIFIC COMMUNICATIONS

Bibliometric analysis as a catalyst for research quality and strategic science policy

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Abstract. *Introduction.* Bibliometric practices have become central to contemporary research evaluation, influencing academic careers, institutional rankings, and national science policy. However, their non-selective application has provoked serious concerns regarding fairness, epistemic bias, and the erosion of academic values. While reform initiatives such as the Leiden Manifesto and DORA have gained international visibility, the integration of their principles into institutional and national frameworks remains inconsistent. This article addresses the unresolved tension between the global discourse on responsible metrics and its uneven operationalization across contexts.

Purpose. This study offers a conceptual examination of bibliometric governance, advancing the argument that research metrics must be reconfigured as embedded instruments of multi-level science governance. To support this theoretical perspective, the article integrates illustrative bibliometric mapping and interpretive policy synthesis.

Method. Using a curated dataset of the 500 most cited publications on research evaluation (2015–2024) retrieved from Scopus, a co-occurrence analysis of keywords and abstract terms was conducted using VOSviewer. The resulting thematic clusters were used not as empirical evidence, but as heuristic anchors for the conceptual discussion. These were interpreted alongside key policy documents and reform agendas through a conceptually driven analytical framework.

Results. The bibliometric visualization revealed a fragmented discourse, where normative frameworks for responsible metrics are conceptually visible but poorly integrated into performance-driven evaluation literature. Illustrative national cases (e.g., China, Italy, Indonesia) further demonstrate the divergence between policy rhetoric and implementation. The article proposes a multi-level conceptual model of metric responsibility that captures individual, institutional, and national dimensions of reform.

Conclusion. The findings support the need for a governance-centered approach to metrics, one that balances quantitative indicators with contextual judgment, ethical reflexivity, and policy alignment. By combining conceptual reasoning with empirical illustration, the article contributes to the theoretical grounding of responsible metrics and provides a reflexive framework for science policy and institutional reform in the digital age.

Keywords: bibliometric analysis, research quality, science policy, responsible metrics, altmetrics, research evaluation, DORA, Leiden Manifesto

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Библиометрический анализ как катализатор качества исследований и стратегической научной политики

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Резюме. *Введение.* Библиометрические практики заняли центральное место в современной оценке исследований, влияя на академические карьеры, институциональные рейтинги и национальную научную политику. Однако их неселективное применение вызывает серьезные опасения, связанные с вопросами справедливости, эпистемологической предвзятости и размывания академических ценностей. Несмотря на то что инициативы по реформированию ответственного отношения к метрикам, такие как Лейденский манифест и DORA, получили международное признание, интеграция их принципов в институциональные и национальные рамки остается непоследовательной. В данной статье рассматривается неразрешенное противоречие между глобальным дискурсом об ответственном отношении к метрикам и его неравномерной операционализацией в разных контекстах.

Цель. Исследование представляет концептуальный анализ управления библиометрией, выдвигая аргумент о необходимости переосмысления исследовательских метрик как интегрированных инструментов многоуровневого научного управления.

Метод. Для обоснования теоретической позиции, авторы использовали иллюстративное библиометрическое картирование и интерпретативный синтез политики в сфере библиометрической оценки исследований и академической карьеры. В программе VOSviewer был выполнен анализ со-встречаемости ключевых слов и терминов на основе массива из 500 наиболее цитируемых публикаций по теме библиометрической оценки исследований (2015–2024 гг.), извлеченных из базы данных Scopus. Полученные тематические кластеры анализировались не как эмпирическое доказательство, а как интеллектуальные ориентиры для концептуальной дискуссии. Интерпретация материалов осуществлялась путем сопоставления с ключевыми документами в области библиометрической оценки исследований и с реформаторскими повестками научной политики, при этом аналитическая рамка опиралась на концептуально ориентированный подход.

Результаты. Библиометрическая визуализация выявила фрагментированность дискурса: нормативные рамки ответственного использования метрик концептуально обозначены, но слабо интегрированы в литературу, ориентированную на оценку эффективности научной деятельности. Описанные национальные кейсы (Китай, Италия, Индонезия) позволили усилить иллюстрацию расхождения между политической риторикой и практической реализацией. В статье предлагается многоуровневая концептуальная модель «метрической ответственности», охватывающая индивидуальное, институциональное и национальное измерения реформ в сфере оценки научной деятельности.

Выводы. Полученные результаты подтверждают необходимость управления метриками на основе принципов баланса: количественные показатели должны сочетаться с контекстуальной экспертизой, этической рефлексией и согласованностью политик. Комбинируя концептуальное рассуждение

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с эмпирическими иллюстрациями, статья вносит вклад в теоретическое обоснование ответственного отношения к метрикам и предлагает рефлексивную рамку для выстраивания научной политики и институциональных реформ в цифровую эпоху.

Ключевые слова: библиометрический анализ, качество исследований, научная политика, ответственное отношение к метрикам, альтметрики, оценка исследований, DORA, Лейденский манифест

INTRODUCTION

Over the past five decades, bibliometric indicators have transitioned from provisional tools of science studies to institutionalized instruments of academic governance. The journal impact factor, originally developed as a pragmatic aid for library curation, has acquired disproportionate authority within evaluation systems that extend across national borders and disciplinary boundaries. As Archambault and Larivière [1] demonstrate, this transformation occurred in the absence of methodological consensus and often without regard for the epistemological assumptions embedded in such indicators. Glänzel et al. [2] further traces how performance metrics were incrementally integrated into national research assessment exercises, thereby normalizing citation frequency as a proxy for scientific value. At present, bibliometrics informs global benchmarking initiatives such as the Global Innovation Index, which includes scientific publication output among its more than eighty indicators of national innovation capacity[1]. The operational reach of metrics has expanded beyond high-income countries: middle-income and emerging economies increasingly adopt these tools to restructure domestic research systems and to position themselves more competitively in transnational science networks [3].

Concomitant with this institutional expansion has been a diversification of bibliometric methods. Whereas earlier approaches focused primarily on citation-based indicators such as the impact factor, contemporary scientometrics employs advanced data-processing and visualization techniques to map the structural dynamics of scientific knowledge production. Cobo et al. argue that co-authorship networks, co-citation matrices, and thematic clustering enable more granular analyses of disciplinary evolution and collaborative patterns [4]. This quantitative enrichment is paralleled by the rise of alternative metrics or altmetrics which seek to capture forms of research visibility beyond the academy. Thelwall describes these as encompassing online mentions, policy citations, media uptake, and usage statistics across digital platforms [5]. While altmetrics offer a broader perspective on research dissemination, they also raise concerns regarding cross-disciplinary comparability, standardization of data sources, and vulnerability to manipulation. As Putera et al. note, these indicators lack universal validation criteria, particularly when applied across heterogeneous publication cultures [6]. Bornmann [7] adds that altmetric scores tend to exhibit weak correlations with traditional citations, thereby raising questions about their interpretive validity. Together, these developments illustrate the methodological pluralization of research

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[1] World Intellectual Property Organization (WIPO). Global Innovation Index 2024: Unlocking the promise of social entrepreneurship. Geneva: WIPO; 2024. Available from: https://www.wipo.int/publications/en/details.jsp?id=4756 (accessed: 20.05.2025).

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evaluation and the growing need for integrative frameworks that accommodate both epistemic complexity and social accountability.

Despite these methodological advances, the global distribution of bibliometric visibility remains profoundly unequal. Scientific output from institutions in the Global North continues to dominate indexed databases and citation networks, while research produced in the Global South is systematically underrepresented [8]. Structural barriers, including limited access to infrastructure, insufficient funding, and exclusion from international collaborations, constrain research capacity across many low- and middle-income countries [9]. These constraints are compounded by deficiencies in scholarly communication infrastructure, such as the absence of persistent identifiers, limited indexing, and the lack of interoperable digital repositories. As Turki et al. [10] emphasize, such exclusions reduce the discoverability, citability, and archival permanence of Global South publications. The result is a recursive dynamic in which epistemic marginalization is reinforced by technical invisibility. In response, regionally grounded initiatives such as SciELO have emerged to promote equitable participation in global knowledge flows. Yet the persistence of citation asymmetries indicates that deeper conceptual reform is required to address the structural politics of bibliometric systems.

Within this contested terrain, calls for responsible research evaluation have gained visibility. Normative frameworks such as the Leiden Manifesto and the San Francisco Declaration on Research Assessment[2] (DORA) advocate for transparency, contextual judgment, and the pluralization of evaluative criteria. However, the institutional uptake of these principles remains selective and uneven. Most notably, bibliometric standards continue to be operationalized in ways that prioritize output volume and impact metrics while marginalizing epistemic diversity and societal relevance. A survey of 130 journal editors conducted by Kirillova and Tikhonova [11] revealed that while Scopus-based criteria are widely acknowledged as benchmarks of quality, interpretations of journal standards remain conceptually fragmented and institutionally inconsistent. Such findings underscore the disjuncture between global discourse and local implementation, and they point to the need for a reconceptualization of metrics as embedded instruments of science governance rather than as neutral mechanisms of performance control.

This article is guided by three research questions that serve as both theoretical coordinates and points of departure for conceptual elaboration. First, how can a research evaluation framework be theorized and implemented in a way that integrates both quantitative measures and qualitative appraisals? Second, to what extent have the principles of responsible metrics been accepted, adapted, or ignored by national governments, research institutions, and funding agencies? Third, what practical approaches might be used to mitigate the behavioral distortions inherent in the publish-or-perish paradigm while promoting a more balanced distribution of scientific and societal value? These questions point to a fundamental need to reconsider the role of metrics not as objective instruments, but as socially embedded technologies that shape the production, recognition, and governance of knowledge.

The aim of this study is to develop a conceptual model of metric responsibility that captures the multi-level character of research evaluation. Rather than treating metrics as neutral indicators of scholarly productivity, the article reframes them as policy-relevant instruments whose function depends on their

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[2] DORA. Governance procedures of the San Francisco Declaration on Research Assessment. 2022. https://sfdora.org/governance/

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ethical alignment, contextual integration, and institutional intelligibility. To advance this argument, the study adopts a conceptual research design grounded in narrative policy analysis and informed by illustrative bibliometric mapping. A curated dataset of the 500 most cited publications on research evaluation (2015–2024) retrieved from Scopus is used to generate co-occurrence visualizations via VOSviewer. These thematic clusters are interpreted not as empirical findings in themselves but as heuristic anchors for conceptual reflection. By combining normative analysis with empirical illustration, the article contributes to the theoretical consolidation of responsible metrics and proposes a governance-oriented framework for rethinking research evaluation in the context of global academic transformation.

MATERIALS AND METHODS

This article adopts a hybrid methodological framework designed to support a conceptually driven analysis of bibliometric governance while incorporating empirical and technological scaffolding. The study integrates three interrelated components: (1) bibliometric landscape analysis, (2) narrative and thematic policy synthesis, and (3) the structured use of large language models (LLMs) for conceptual integration and discursive articulation. This multimethod strategy aims not at empirical generalization, but at constructing a theoretically grounded and context-sensitive account of how bibliometric regimes shape and are shaped by science policy across levels.

Bibliometric data collection and visualization

To provide an empirical baseline for the conceptual inquiry, a targeted bibliometric search was conducted in the Scopus database on March 25, 2025. The search aimed to capture international discourse on research evaluation and responsible metrics over the last decade. The final search string was constructed as follows:

(TITLE-ABS-KEY("responsible metrics") OR TITLE-ABS-KEY("bibliometric governance") OR

TITLE-ABS-KEY("Research Assessment") OR TITLE-ABS-KEY("Leiden Manifesto") OR TITLE-ABS-KEY("research evaluation"))

AND PUBYEAR > 2014 AND PUBYEAR < 2025

AND (EXCLUDE(DOCTYPE, "tb") OR EXCLUDE(DOCTYPE, "ip") OR EXCLUDE(DOCTYPE, "er") OR EXCLUDE(DOCTYPE, "ed") OR EXCLUDE(DOCTYPE, "cr"))

AND (LIMIT-TO(SUBJAREA, "SOCI") OR LIMIT-TO(SUBJAREA, "ARTS") OR LIMIT-TO(SUBJAREA, "BUSI") OR LIMIT-TO(SUBJAREA, "DECI") OR

LIMIT-TO(SUBJAREA, "MATH") OR LIMIT-TO(SUBJAREA, "ECON") OR LIMIT-TO(SUBJAREA, "ENVI") OR LIMIT-TO(SUBJAREA, "COMP"))

his query returned 2,505 documents, from which the 500 most cited were selected to ensure analytical focus on widely influential, policy-relevant texts. This heuristic sampling approach favored intersubjectively validated knowledge and prominent contributors in the field.

The metadata of the selected publications (titles, abstracts, keywords) were exported and processed using VOSviewer (v.1.6.19), developed at the Centre for Science and Technology Studies (CWTS), Leiden University. Co-occurrence analysis of terms was conducted using full counting and a minimum threshold of five term appearances. The LinLog layout with modularity-based clustering was applied to identify thematic structures within the literature.

The resulting bibliometric map revealed four major conceptual clusters:

(1) global governance and evaluation standards;

(2) national policy responses and resistance;

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(3) metric reform initiatives (e.g., DORA, Leiden Manifesto);

(4) technological enablers, including AI, open access, and altmetrics.

These clusters served as a conceptual scaffold for subsequent analysis and interpretive synthesis.

Thematic and narrative synthesis of policy literature

Building upon the bibliometric mapping, a narrative and thematic synthesis was conducted to trace how ideas of metric responsibility are embedded within, and sometimes diluted by, institutional and national science policy regimes. The corpus for this stage included:

(1) the most cited academic sources from the VOSviewer dataset;

(2) policy frameworks such as the Leiden Manifesto, DORA, and The Metric Tide;

(3) national reform documents (e.g., from China, Italy, Indonesia, the EU, and the UK);

(4) editorials and declarations issued by academic publishers and stakeholder associations.

Analysis proceeded inductively, using manual coding of themes such as: metric misuse, geographic inequality, incentives and gaming, ethical accountability, open science integration, and implementation barriers. The interpretive strategy emphasized comparative insight across four levels of policy articulation:

(1) individual researchers;

(2) research institutions;

(3) publishing ecosystems;

(4) national science systems.

Rather than quantifying outcomes or applying content analysis software, the synthesis followed qualitative principles of interpretive policy analysis, focusing on argumentative logic, normativity, context dependence, and rhetorical positioning of actors. This approach aimed to surface conceptual tensions, governance dilemmas, and reform logics that inform the contested evolution of metric regimes.

RESULTS

1. Mapping research quality: how bibliometrics drive strategic decisions

In recent research-quality assessments, dependence on purely quantitative indicators of publication and citation counts is no longer enough. Bibliometric tools have developed as powerful strategic tools with sophisticated methodologies and context-dependent applications. This section investigates the ability of innovation such as altmetrics, artificial intelligence (AI), and live analytics to revolutionize the measurement of scientific impact. It also evaluates how different states integrate bibliometric approaches in their research policies at the national level, focusing on the aspects of success and challenges in linking measurement and substantive outcomes.

1.1. Altmetrics, AI, and predictive tools

Bibliometric practice is undergoing a methodological shift characterized by the integration of heterogeneous data streams and computational techniques. As Ismail et al. [12] observe, such developments enable a more strategic and forward-looking application of bibliometrics in research policy and resource allocation, particularly in the health sciences. A central aspect of this transformation is the rise of altmetrics as alternative indicators capturing the online circulation of scientific outputs through social media discussions, media representation, and policy citations. Unlike traditional citation-based measures, which, despite their utility, reflect only a limited dimension of scholarly influence, altmetrics expand the evaluative horizon. As Bornmann [13] emphasizes, they provide a more multidimensional account of the impact of scientific work by combining academic recognition with indicators of societal engagement, thereby enriching and complementing the classical citation paradigm.

At the same time, using artificial intelligence and machine learning, is increasingly

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common in bibliometric work [14]. AI-facilitated tools can systematically acquire and curate comprehensive publication datasets and then apply algorithms like network analysis and natural language processing to reveal hidden patterns in the network of citations and research fields [15]. These tools increase the accuracy of mapping knowledge domains and enable predictive analytics to estimate the trajectories of follow-up research or forecast the pattern of publication citations in the future.

Finally, current bibliometric tools emphasize technological convergence through compatible databases and real-time analytical interfaces. Digital research analytics tools such as Dimensions and Scopus integrate data from multiple sources (e.g., publication indexes, funding data, patents, and social media) and continuously update corresponding impact indicators[3] [16]. The live monitoring allows institutions and policymakers to track research performance adaptively, as AI-facilitated visualizations of citations and interactive outputs inform timely, evidence-based decisions on research strategy.

2. Country case studies and policy implications

The global uptake of bibliometric indicators in national research assessment strategies demonstrates both convergence in terminology and divergence in implementation. To capture these variations, a conceptual co-occurrence analysis was conducted using VOSviewer, drawing on the 500 most cited publications in Scopus from 2015 to 2024 on the topic of research evaluation. The resulting visualization (Fig. 1) maps the key thematic clusters in the global discourse while highlighting how bibliometric governance is framed in four major geopolitical contexts: China, Italy, the United States, and the European Union.

The VOSviewer map identifies four dominant thematic clusters across the international literature: (1) global governance and evaluation standards; (2) national policy responses and resistance; (3) metric reform initiatives (e.g., DORA, Leiden Manifesto); (4) technological enablers, including AI, open access, and altmetrics. While these clusters appear in all contexts, country-specific projections of the data reveal significant differences in conceptual emphasis.

In China, the dominant discourse centres on large-scale, state-directed performance evaluation systems. The country-specific visualization emphasizes terms such as "research evaluation", "science policy", and "national strategy", reflecting a centrally coordinated model driven by state metrics and institutional mandates. This aligns with recent reforms eliminating cash incentives for high-impact publications and prioritizing research of domestic relevance [17].

In Italy, the conceptual map reflects tensions between European-level initiatives and national frameworks. The frequent co-occurrence of terms like "bibliometrics", "career advancement", and "evaluation thresholds" mirrors the country's controversial use of metric-based habilitation criteria for academic promotion. The Italian discourse foregrounds both administrative compliance and academic resistance to metricization[4].

The United States cluster, by contrast, reveals a decentralised, institution-driven landscape. Key terms such as "institutional benchmarking", "AI-based evaluation", and "research analytics" highlight a model where universities leverage bibliometric tools not only for accountability but also for strategic positioning.

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[3] Chawla D.S. Italian scientists increase self-citations in response to promotion policy. Nature Index News. 2018. Available from: https://www.nature.com/nature-index/news/italian-scientists-increase-self-citations-in-response-to-promotion-policy (accessed: 20.05.2025).

[4] Chawla D.S. Italian scientists increase self-citations in response to promotion policy. Nature Index News. 2018. Available from: https://www.nature.com/nature-index/news/italian-scientists-increase-self-citations-in-response-to-promotion-policy

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The integration of machine learning into evaluation practice underscores the American emphasis on technological innovation and market competitiveness [18].

The European Union discourse aggregates around policy instruments and reform-oriented initiatives. Terms such as "responsible metrics," "Leiden Manifesto," and "open science" dominate this space, reflecting a supranational approach to harmonizing evaluation standards across member states. The EU has emerged as a normative actor in promoting principles of contextualization, transparency, and pluralism in research assessment [19; 20].

These differences underscore that while bibliometric governance operates under a globally shared vocabulary, its national enactments are mediated by institutional legacies, policy frameworks, and epistemic cultures. The implications are profound: whereas some systems instrumentalize metrics for control and standardization, others embed them in broader reforms aimed at enabling diversity and accountability in knowledge production. Understanding these differences is crucial for interpreting global trends and identifying pathways toward more responsible and effective research evaluation models.
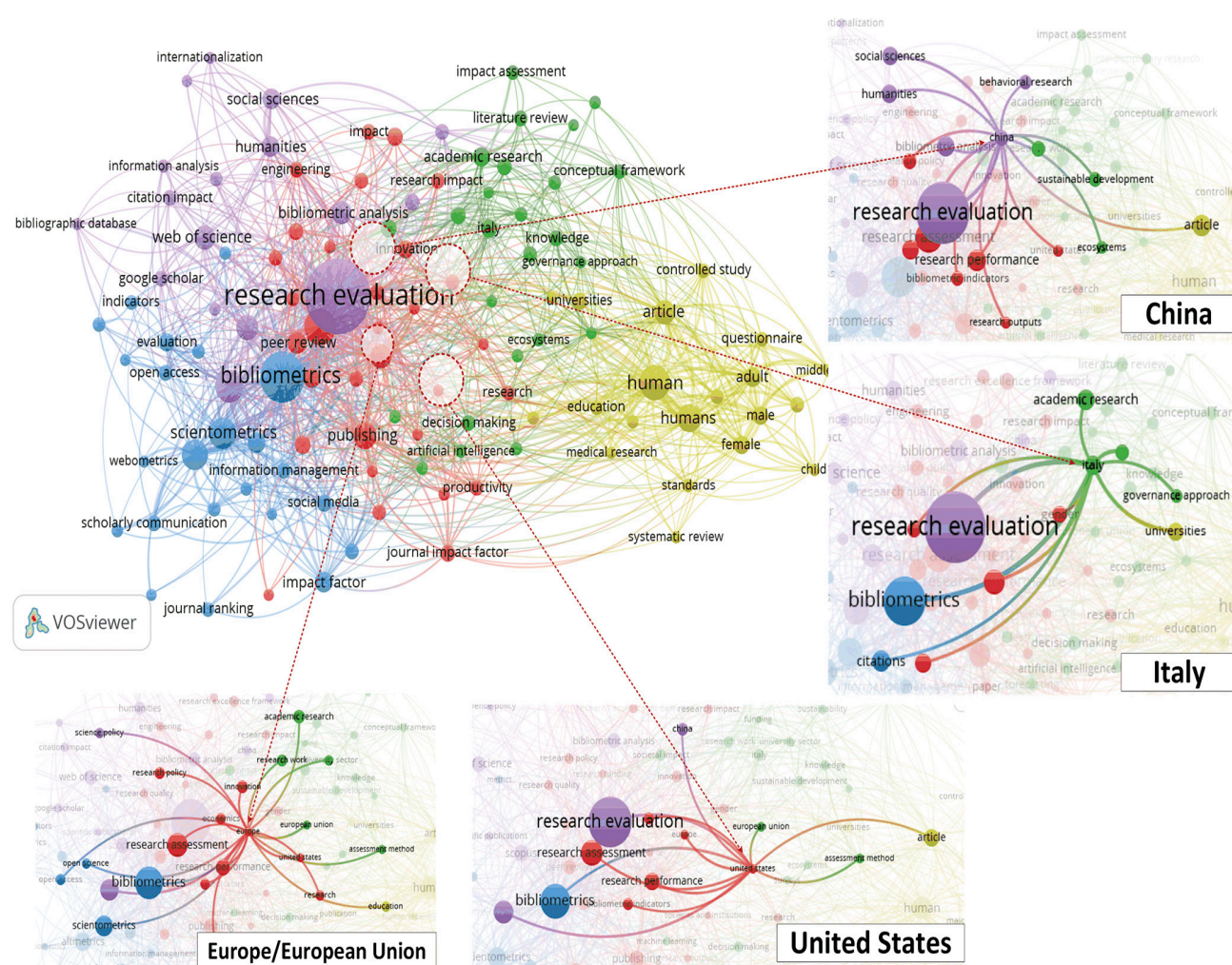
Fig. 1. Mapping the global landscape of bibliometric governance and research evaluation: a VOSviewer visualization of conceptual clusters and country-specific (China, Italy, United States, and European Union)

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3. Challenges and revaluation of bibliometric evaluation

As bibliometric analysis shapes research agendas, scholarly reviews, and the granting of funds more and more, there is a critical need to address its limitations and shifting methodologies carefully. Even as these tools offer tremendous capabilities in quantitative expressions of scholarly productivity, they are often used with insufficient consideration of their limitations, underlying assumptions, and possible unforeseen impacts. The rising dependence on these tools has raised questions regarding their validity, fairness, and influence on research cultures. As such, this section considers the main issues challenging bibliometric practices and the new viewpoints calling for more responsible, inclusive, and context-responsive ways of evaluating research accomplishments and societal impacts.

Several serious flaws in bibliometric research hinder its use as a measure of research. We describe three types of issues below: structural biases, collaborative research problems with credit division, and manipulation of metric use.

3.1. Structural biases

One of the primary issues with bibliometric research is the lack of a comprehensive, contextually rich measure of research output. Researchers consider it impossible that any measure can encompass a qualitative depiction of diversity of research quality within a highly diverse set of research fields [21]. Additionally, citation databases contain coverage biases inherent within them. Sub-Saharan Africa's journals, as an example, are severely underrepresented within top indexes: their estimated chance of being included is four times smaller than European journals. At the same time, the databases overrepresent scholarship conducted in English and that of STEM papers [22].

Such a fit failure carries over into bibliometric data, being unable to explain research productivity taking place outside Western settings or in social sciences and humanities fields. On this basis, therefore, such structural constraints negate equity-based, inclusive, and comprehensive global systems of research assessment [23].

3.2. Credit assignment under Co-A

Another inherent problem is with the equitable distribution of credit in an age of co-authorship. The initial bibliometric measures were created when sole-author papers were ubiquitous. Applying the same measures today, in which publication and citation credit are now automatically accorded to co-authors, can lead to inflated personal measures and spurious comparisons. A large grouping's authors will be overestimated as being highly productive unless co-authorship is the norm. The validity of bibliometric rankings is thus undermined, and most notably, between fields of research or research teams with differing norms of co-authorship [24].

3.3. Metric gaming practices

Apart from structural and attributional issues with problems, bibliometric assessment is also prone to harsh ethical and behavioral issues. The "publish or perish" environment allowed the spread of yet another set of metric manipulation schemes. These include honorary or "gift" authorship, salami slicing (frequent publication of thin papers on an everyday basis), excessively generous self-citation, and even creation of "citation farms" where investigators serially cite one another in hopes of padding their metrics [25; 26].

Journal-level manipulation is also standard. Editors are pressuring authors to include redundant citations to inflate impact factors, and low-quality or predatory journals profit from selling citation numbers [26; 27]. These manipulations can create misleading biblio-

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metric profiles. E.g., a high h-index may accumulate more from self-citation loops or editorial biases than actual scholarly influence.

Additionally, over-reliance on quantitative indicators is accompanied by the drawback of overlooking worthy but non-quantitative intellectual work like mentoring, data stewardship, and outreach. These arguments collectively highlight the danger of using bibliometric indicators mechanically. Lacking ethics and reform on the institutional basis, they can count scholarliness mechanically, and pay effort more than scholarship [19; 21; 28].

4. Rethinking research impact: beyond citations

The growing acknowledgment of such limitations has required rethinking the definitions and measures of research impact beyond simple citation counts. Citations broadly indicate academic visibility; however, truly impactful research has the potential to influence society, policy, technology, and practical applications in ways not exclusively tracked by academic citations [29; 30]. Therefore, researchers and assessors are exploring alternative metrics, so-called "altmetrics", and more comprehensive indicators that capture multiple types of impact. For example, the number of downloads, social media mentions, citations in news sources, and practitioner reports can signify an immediate interest in research results and their relevance outside the academic community [31; 32].

Specialized websites are now tracking these unconventional metrics; the Overton database, for instance, collects citations of scholarly research appearing in policy documents, thereby offering a quantitative view of policy impact [31]. Patent citations and adoption by industries can demonstrate research's technological or economic effects. While such alternative evaluations have limitations, demonstrating only weak correlations with traditional citation counts and varying by discipline, they provide complementary insights into how research gains broader visibility and applicability [7]. In considering the premise of "beyond citations", the academic community aims to achieve a more refined sense of influence that emphasizes public engagement, knowledge translation, concrete real-world changes, and traditional scholarly impact.

Operationalizing more complex conceptualizations of research impact requires moving away from simplistic indicators in favor of qualitative and context-dependent judgments. Projects like the San Francisco Declaration on Research Assessment (DORA) and the Manifesto call for research evaluation prioritizing intrinsic merit and multidimensional contributions over-reliance on elite journals or a sheer number of counts [19]. Even so, changing ingrained habits is a difficult challenge: Despite the official adoption of responsible assessment principles by many institutions, recent monitoring of the UK's Research Excellence Framework found that journal rankings remain influential in the judgments of the research community, indicating the persistence of conventional norms [1; 32].

To go above citation counts, recommendations include expert peer review, case studies, and qualitative evidence of societal impacts within the assessment process [33]. For instance, more universities and funders demand that scientists describe their impacts in terms of changes to policy, clinical guidelines, community outcomes, and standard publication counts. In addition, researchers have suggested the expansion of available indicators to include markers of research transparency and value: rates of data sharing, reproducibility, and other open science behaviours, to induce the behaviours that ultimately make impacts [25]. In short, re-examining the impact of research requires adding a broader range of quantitative indicators and reaffir-

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ming qualitative judgment to reflect the many ways research contributes to the advancement of knowledge and societal good.
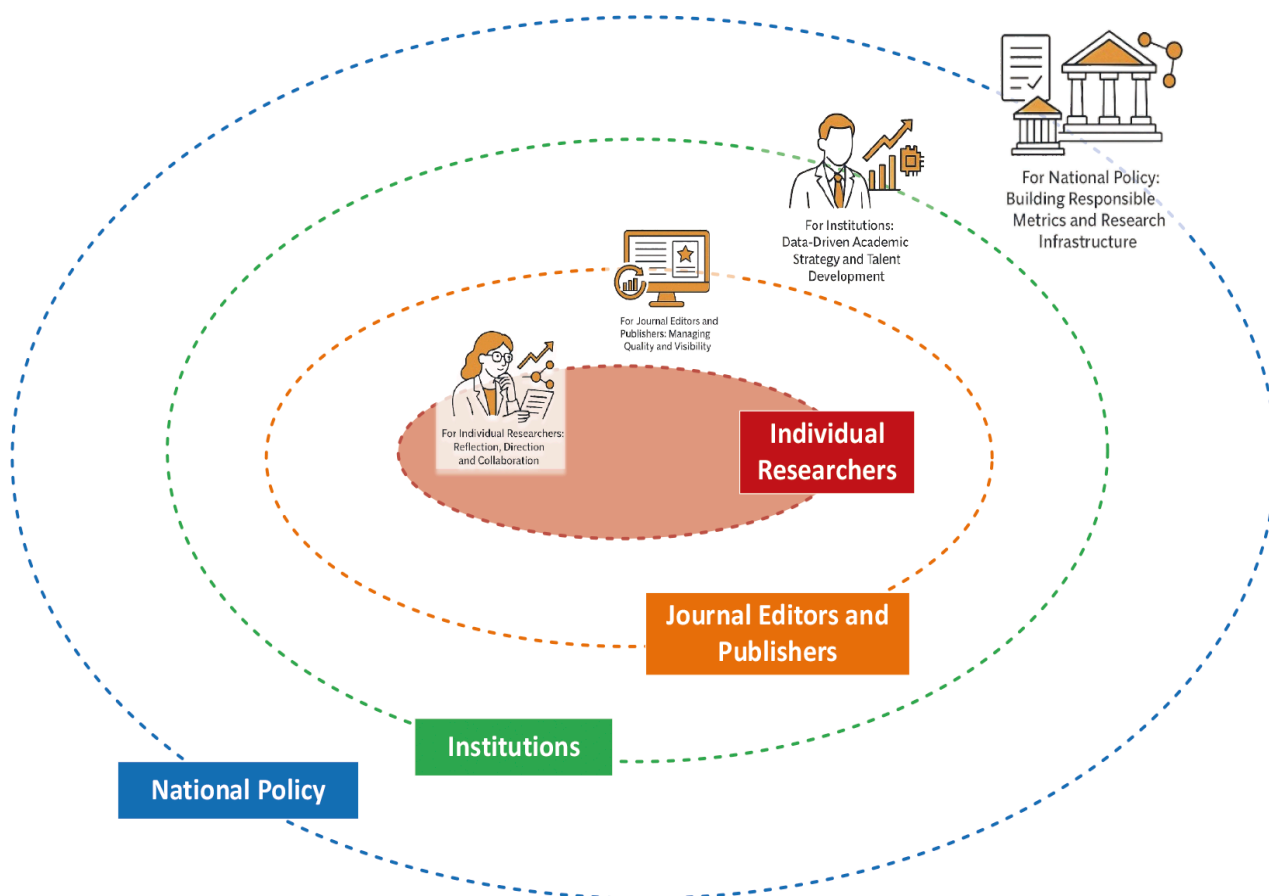
5. Responsible metrics and multi-stakeholder reform

Research assessment reform can only be achieved through concerted action at all levels of the scientific community. The chapter takes into account the role of individual researchers, journal editors, institutional universities, and national policymakers to facilitate responsible metrics (Fig. 2). Through facilitating researcher reflection and mentoring as much as through institutional and national evaluation paradigm reform, each of these stakeholders disproportionately influences values as well as processes of scientific achievement. By observing the interdependence of their roles, the chapter proposes diversity of stakeholders working in concert to facilitate a more egalitarian, more resilient research assessment regime.

5.1. Individual scholars: self-awareness, mentoring, and joint

Individual researchers are encouraged to conduct self-evaluation through the responsible application of diverse metrics. While conventional metrics like the h-index, which measures citation impact and productivity, are still dominant, they have significant limitations [34]. For instance, the h-index naturally favors more senior scholars and shows notable variation between disciplines, making cross-disciplinary comparisons uneven. Moreover, it fails to capture crucial research contributions, such as the accuracy of research findings, innovation, or mentoring activities.

Fig. 2. Empowering Science Through Responsible Metrics and Smart Policy

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Therefore, it is argued that a single metric cannot fully represent a researcher's worth[5]. Instead, the *h*-index should be complemented by other indicators and qualitative evaluations to provide a holistic view of a person's contributions [35; 36]. This approach requires researchers to prioritize their research's inherent value and merit over quantity and view metrics as just one of several evaluative instruments rather than as absolute targets.

Modern analytical tools offer researchers insights that go far beyond publication numbers. Among these tools, social network analysis is a valuable means of evaluating the impacts made through an author's work. By defining the citation and co-authorship networks, social network analysis can clarify an individual scientist's scope of influence and connectivity in the general scientific community. For instance, a recent study of medical faculty members revealed that network centrality measures, which measure a researcher's connectivity in collaborative networks, were significantly correlated to *h*-index rankings. However, this study also revealed different facets of impact, such as specialist clustering and the importance of interdisciplinarity in a researcher's profile [36].

These findings indicate that the analysis of an individual's position in a knowledge network includes qualitative impact indicators, such as leadership in the scientific community or the interweaving of different disciplines, which reductionist indicators might not fully capture. Extensive self-assessments ultimately require considering a broad range of indicators and feedback mechanisms, including citations, network influence, and peer reputation, to form an entire description of one's scholarly growth.

5.2. Editors of journals and publishers: maintaining quality and visibility

For publishers and journal editors, putting research quality ahead of the chase for metrics is a matter of responsible scientific practice. In the past, many editors have focused intently on improving the journal impact factor (JIF) sometimes at the expense of upholding ethical editorial practices. Studies have found that the JIF has been widely misused and manipulated in the publishing community [34]. Some editors have tried tactics such as asking authors to include unnecessary citations from articles in the same journal, artificially boosting citation counts and thus the impact factor [26]. Others have inflated the number of review articles or certain citable content, which will likely garner more citations while minimizing the content counted in the denominator of the JIF calculation [27]. These tactics, driven by the pressure to improve rankings, illustrate how focusing on a single metric can pervert editorial judgment. Overreliance on JIF as a proxy for quality has serious concerns.

The creators of the impact factor warned against its use as a measure of individual article or researcher assessment. In short, gaming metrics are not only ethically problematic but also have the power to distort the scientific record by valuing citation count over intellectual contribution. In light of these developments, many editors and publishers are embracing a more ethos-based approach to journal management [26]. There is increasing recognition that a publication's reputation and long-term success are founded on the published work's relevance and rigor, not on bibliometric measures alone. For example, journal community leaders have suggested that a publication's reputation is better served by raising standards of peer review, applying editorial standards more strictly, and ensuring greater transparency in the publication process rather than chasing marginal gains in impact factor [27].

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5 Apiata A., McCallum F., Smith G., Howie J., Apete K., Cassin M. et al. Exploring researchers' views on metrics and research impact. Internal Report. 2023. Available from: https://sfdora.org/wp-content/uploads/2024/07/Exploring-Researchers-Views.pdf (accessed: 20.05.2025).

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Practical operational steps include instituting editorial policies that disincentivize coercive citation practices and ensuring that Journal Impact Factor (JIF) is not disproportionately promoted in marketing communications. Many prestigious journals now provide a range of metrics (e.g., article-level citations, downloads, or Altmetrics scores) to provide a more nuanced picture of the impact of individual research contributions. Furthermore, publishers are increasingly affiliating with initiatives promoting responsible metrics; for instance, a large number of major publishers and editors have signed the San Francisco Declaration on Research Assessment, committing not to use journal-level metrics as proxies for the quality of individual research studies [37]. In championing content quality, responsible publication practices, and diversity in impact measurement, journal editors and their publishers are crucial in steering the research community away from metric-driven behavior and towards a culture of excellence in research communication.

5.3. Institutions: data-driven academic strategy and talent development

Data-driven academic strategy and talent development university and research institutions significantly shape the research culture in their recruitment, promotion, and grants policies. Traditionally, many institutions have relied on quantifiable criteria, like the number of publications, the citation count, or the impact factors of the journals where researchers work, as key indicators of scholarly success. This approach has faced significant criticism for giving more weight to quantity over quality. For example, focusing too heavily on the publication rate or using aggregated measures such as the h-index can have adverse incentives that drive researchers to overemphasize the speed of publication over rigor and novelty [33]. Indeed, value judgments relying mainly on productivity indicators often neglect the full scope of scholars' work. Significant work, such as mentoring new scientists, teaching, developing interdisciplinary communities, or ensuring transparency in research, is often not given its actual value in a system with a numerical emphasis. There is a rising concern that such dependence on indicators might contribute to escalating uncertainty and ambiguity regarding whether current evaluations leaning heavily on indicators accurately measure a researcher's worth or reflect the scholarly goals of the scientific community [38]. In conclusion, more quantity does not necessarily translate to more quality: bibliometric indicators, in isolation, are not good indicators of scientific merit or novelty, and their replacement might mislead institutional decision-making.

Given these concerns, universities increasingly implement frameworks that favor responsible research evaluation. One significant development in this area is the recognition of the San Francisco Declaration on Research Assessment (DORA) guidelines[6] and the Leiden Manifesto principles, which call on universities to redefine their approaches to evaluating scholars. In particular, DORA calls for institutions to abandon the practice of using journal-based metrics such as the impact factor as a proxy measure for evaluating the output of individual researchers.

Instead of simply analyzing numerical outcomes, it calls for a complete analysis of the material and the research implications, considering a vast range of outcomes and outputs [19]. In line with these guidelines, many universities and research institutions worldwide have signed DORA and updated their promotion and recruitment criteria accordingly. Similarly, the Leiden Manifesto, which specifies ten principles of research metrication,

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[6] Governance Procedures of the San Francisco Declaration on Research Assessment. DORA. 2022. Available from: https://sfdora.org/governance/ (accessed: 20.05.2025).

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highlights the need for judgments to recognize disciplinary differences, uphold research value over quantity, and apply metrics only as supplementary to peer judgment rather than as a proxy [39; 40]. For example, one of the principles of the Leiden Manifesto warns against the improper use of metrics in the absence of contextual data, cautioning institutions that quantitative indicators can mislead if interpreted in the absence of qualitative data [40]. By applying such reforms, institutions aim to foster an environment that rewards significant scholarship, creativity, and talent development. This means value is given to mentoring, collaboration, and the social impact of research over the sheer number of publications[7] [39].

Practically, some universities have commenced using narrative CVs or portfolios in faculty applications, allowing researchers to qualitatively describe their most impactful work on science and society. The shift towards responsible metrics at the institutional level encourages researchers to work on meaningful, high-quality projects rather than to optimize metric ratings.

5.4. National policy: setting accountability standards and research models

There is considerable momentum to incorporate responsible metrics into research assessment systems at national and international policy levels. Major research funders and government agencies have begun integrating these principles into grant, tenure, and award review frameworks. The influence of the Declaration on Research Assessment (DORA) and the Leiden Manifesto can be seen in the science policy of many countries [37]; for instance, national funding agencies in many countries (from the United States National Institutes of

Health (NIH) to the European Research Council) have officially signed on to the recommendations made by DORA [40]. These agencies are updating their application guidelines to minimize the focus on journal prestige and foster a narrative justification for the relevance of the applicant's work. Similarly, the Leiden Manifesto's call for context-sensitive and pluralistic metrics (including the use of field-normalized citation indicators where relevant and the combination of metrics with peer review) has shaped national research assessment programs [19]. For example, the United Kingdom's Research Excellence Framework (REF), in response to the publication of the independent report The Metric Tide, concluded that quantitative metrics should be used cautiously and only alongside expert judgments [20]. Consequently, the UK and several other countries now prioritize peer review, expert judgment, and case studies showing societal impact in assessing research performance, placing metrics as supporting evidence rather than determining factors.

National governments are also enacting specific policies to curb the misuse of metrics and incentivize more meaningful research outputs. A striking example is China: In 2020, China's ministries issued new regulations to reduce the obsession with publication quantity and high-impact journal papers. The ban on cash rewards for publications based solely on journal rank and impact factor has been introduced to reduce the practice of "publishing for points" and to encourage research that genuinely adds to societal well-being [17]. This policy change in China instructs institutions to value the content and novelty of research over the reputation of the publication outlet, marking a significant step forward for a system that has traditionally placed heavy weight on articles published in high-profile journals like Science and Nature. Internationally, a coalition of research institutions has gathered to push for sweeping changes to the existing system.

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[7] Science Europe. 2022. Agreement on Reforming Research Assessment. Available from: https://scienceeurope.org/media/y41ks1wh/20220720-rra-agreement.pdf (accessed: 20.05.2025).

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In 2022, multiple stakeholders, including the European University Association and Science Europe, developed an Agreement on Reforming Research Assessment, which over 350 institutions have signed in more than 40 countries[8].

The agreement outlines collective commitments, including recognizing varied research outputs (including datasets, software, and contributions to society), ending inappropriate metric use, and investing resources into research infrastructure that fosters open science alongside improved evaluative practices[9] [41]. By investing in infrastructure, such as developing a national database to track a broader range of impact indicators or supporting open-access repositories, countries can reduce their reliance on proprietary metrics and enable more refined, discipline-specific evaluations [42; 43]. In short, good policies follow the tenets of responsible metrics: they promote a holistic scorecard approach to research assessment, improve quality and integrity, and offer the investment and support necessary for implementing these changes. Such policies strengthen the scientific enterprise so researchers are rewarded for rigor, creativity, and contributions to society, not for accumulating superficially positive indicators.

6. Transforming research governance: national frameworks, ai integration, and accountable metrics

The changing character of research requires a changing management of direction, quality, and impact at its very heart. The current chapter considers three of the drivers of change: the design of national research systems, the marrying of artificial intelligence with bibliometrics, and responsible metrics as applied

on a foundation of fairness and contextuality. Together, they outline a strategic approach to research governance that is more responsible, inclusive, and future-proof.

6.1. Enhancing the significance and role of national research frameworks

Evidence-based government policies can shape research agendas' importance, direction, and quality. Empirical measures can be integrated into the research planning framework to effectively align the processes of funding and assessment with overall strategic goals. For example, in 2020, the government of China changed its policy to eliminate publication incentives and stimulate greater submissions to local journals, thus cultivating scientific research specific to local situations as opposed to the number of publications [44]. The opposite is the emphasis on international publications in Indonesia as a promotion criterion, which has created concerns over the research's local relevance and societal impacts [41]. These instances show the critical importance of designing country-specific research policies based on substantial impacts over quantitative outputs.

6.2. Artificial Intelligence: facilitating bibliometric compreh recent

Advancements in artificial intelligence have significantly enhanced the capabilities and efficiency of bibliometric analysis. Natural Language Processing (NLP) techniques facilitate the extraction and categorization of semantic content from large volumes of scholarly texts, enabling more nuanced topic modeling compared to traditional keyword-based approaches. For example, studies have demonstrated that deep learning methods outperform conventional techniques in identifying algorithm-specific publications by conducting comprehensive content-level analysis [17]. Furthermore, AI-powered predictive models are increasingly used to forecast ci-

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tation trajectories, detect emerging scientific trends, and identify novel research frontiers, providing valuable insights that allow policymakers and institutions to anticipate and adapt to shifts in the research landscape [41]. These technologies are rapidly revolutionizing bibliometrics from a descriptive mechanism to an active and strategic one.

6.3. Application of the accountable metrics principles global

The San Francisco Declaration on Research Assessment (DORA) and the Leiden Manifesto, have set clear criteria for the responsible evaluation of research increasingly being implemented at different institutions [40]. Diverse institutions worldwide have signed up to DORA formally, thus committing to reducing the undue reliance on the impact factors of journals and evaluating research based on their significant contribution and contextual value [41]. For example, the "Recognition & Rewards" process at Leiden University supports a more critical evaluation of scholarly accomplishment with a stronger emphasis on mentorship, interdisciplinary collaboration, and community engagement in addition to conventional research outputs [39]. These developments help to create a more favorable research climate in which quality, integrity, and social value count over quantity, ultimately advancing innovation and more sophisticated notions of scholarly distinction.

DISCUSSION

The study's findings contribute to an ongoing redefinition of bibliometric systems – not as instruments of quantitative control, but as embedded tools of institutional governance requiring ethical scrutiny. Grounded in a conceptual inquiry supported by targeted bibliometric mapping, the analysis traced the thematic evolution of the field and the shifting normative landscape surrounding metric-based research evaluation.

Reasserting the need for governance-centered metrics

A growing body of research has problematized the epistemological and ethical implications of overrelying on bibliometric indicators such as the journal impact factor and h-index, particularly when deployed as proxies for scientific merit in performance regimes [19; 27; 42]. The findings of this study reinforce these concerns. The co-occurrence clusters identified through VOSviewer analysis revealed a conceptual shift over the past decade toward terms such as "responsibility", "governance", "equity", and "AI". This discursive evolution signals a broader epistemic turn, wherein bibliometric indicators are no longer viewed as neutral descriptors of scholarly productivity but are increasingly recognized as socially constructed tools that shape and are shaped by institutional power relations and governance logics.

This view resonates with the principles outlined in the Leiden Manifesto [19], which advocated for pluralistic, field-sensitive, and context-aware evaluation; with The Metric Tide report [20], which identified the behavioral distortions and perverse incentives of indicator-based systems; and with the Science Europe Agreement on Reforming Research Assessment[10], which prioritizes values such as transparency and societal relevance. As Archambault and Larivière [1] and Kirchik et al. [45] have shown, the failure to account for linguistic, regional, and disciplinary contexts generates persistent blind spots in citation databases, particularly disadvantaging Global South scholarship and non-Anglophone disciplines. These insights are echoed in more recent analyses of Russian science [46; 47],

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[10] Science Europe. 2022. Agreement on Reforming Research Assessment. Available from: https://scienceeurope.org/media/y41ks1wh/20220720-rra-agreement.pdf (accessed: 20.05.2025).

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which reveal that linguistic shifts, coverage biases, and collaboration patterns distort the international perception of scholarly excellence.

These developments indicate that the core of the metrics debate now lies not in technical calibration, but in broader questions of fairness, legitimacy, and epistemic inclusion in global knowledge production. As Bornmann and Leydesdorff [42] argue, the problem is not merely about imperfect indicators but about the social systems in which these indicators acquire authority.

Divergence between normative declarations and institutional practices

Despite the proliferation of normative frameworks such as DORA and the Agreement on Reforming Research Assessment, the practical implementation of responsible metrics remains inconsistent. As Morgan-Thomas et al. [32] and Raitskaya & Tikhonova [47] have shown, universities often adopt these declarations symbolically while continuing to operate within entrenched indicator regimes. The bibliometric mapping in this study supports this observation. Documents citing DORA or Leiden principles appear in distinct clusters from those concerned with national evaluation frameworks, institutional benchmarking, or tenure policy. This indicates a persistent separation between reformist rhetoric and bureaucratic practice.

This disconnect between principles and practice is further illustrated by national case studies, which reveal how deeply institutionalized metric paradigms persist despite formal adoption of reformist declarations. In Italy, academic advancement is still largely governed by habilitation thresholds based on citation metrics[11], despite broad awareness of

their distortive effects. In China, state-directed reforms have banned monetary rewards for indexed publications, but performance evaluation remains deeply tied to quantifiable outputs [17]. In Russia and Indonesia, quantitative evaluation systems have reinforced nationalistic or bureaucratic objectives that are often at odds with the norms of responsible assessment [46; 41]. These examples confirm that policy change cannot be separated from institutional logics, political incentives, and historical path dependencies.

Theoretical contribution

This article advances a governance-centered model of bibliometric reasoning. It conceptualizes bibliometric indicators as multi-level policy instruments that operate simultaneously across researcher, institutional, and systemic levels [33]. From this perspective, metric reform must not only refine technical indicators but also interrogate the institutional conditions under which those indicators acquire normative force. For example, reliance on h-index rankings without regard to disciplinary norms of co-authorship or publication density can lead to inflated credit and misleading assessments of individual merit [23].

Moreover, this model insists on recognizing under-acknowledged scholarly contributions, including mentoring, community-building, and translational work: forms of value typically excluded from bibliometric calculus [28; 37]. As Kirchik et al. [45] and Archambault & Larivière [1] have shown, failure to account for linguistic and cultural contexts produces systematic blind spots, particularly with regard to Global South scholarship and the social sciences and humanities.

Implications and directions for reform

To advance responsible metrics in practice, three areas of reform are particularly salient. First, institutions should adopt pluralistic scorecard models that integrate bibli-

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[11] Chawla D.S. Italian scientists increase self-citations in response to promotion policy. Nature Index News. 2018. Available from: https://www.nature.com/nature-index/news/italian-scientists-increase-self-citations-in-response-to-promotion-policy (accessed: 20.05.2025).

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ometric data with narrative CVs, peer-review components, and qualitative impact narratives [19]. Second, training in metric literacy must become a standard feature of academic development programs, enabling researchers to interpret and resist simplistic indicator regimes [34]. Third, investment in open, non-commercial infrastructure (OpenAlex or national citation indexes) is essential to break dependency on proprietary databases with embedded structural biases [1; 45].

For reform to succeed, it must go beyond surface-level adjustments and fundamentally restructure the incentive systems that underpin research evaluation. This process should embed principles of epistemic justice, methodological pluralism, and institutional accountability across all levels of academic governance.

Limitations

The present study deliberately adopts a descriptive approach, grounded in bibliometric mapping and the analysis of policy and regulatory documents concerning research evaluation measures. The analytical focus is placed on identifying key trends, representative practices, and institutional reform efforts across different national contexts, without engaging in an in-depth assessment of implementation effectiveness, causal mechanisms, or the outcomes of specific policy decisions. This research design was chosen with the intention of delineating the initial contours of the global policy landscape in the domain of research metrics.

At the same time, this design choice entails limitations for the present study. First, it does not provide a systematic comparative and critical analysis of national models of research governance, which constrains the identification of regularities and differentiated effects. In particular, although the analysis broadly aligns with the principles of the DORA Declaration, it does not sufficiently examine cross-context differences in the consequen-

ces of its implementation or the factors that render institutional uptake largely superficial. Likewise, the discussion of AI-based metrics is limited to enumerating potential benefits and does not engage with the concomitant challenges associated with their ethical, epistemic, and infrastructural underpinnings. These considerations should be treated as a point of departure for future research employing analytical and comparative approaches. Such a perspective would enable a more granular decomposition of the strengths and weaknesses of specific reform measures, the identification of cross-national patterns, and the formulation of constructive conclusions regarding the normative and practical dimensions of responsible research assessment. Addressing these tasks would deepen the discourse on fostering a culture of responsible metric use and strengthen the methodological foundations of research policy.

The bibliometric mapping used in this study was illustrative and interpretive rather than predictive. While tools such as VOSviewer and CitNetExplorer [48] offer valuable visualizations of thematic structure, they represent attention patterns more than knowledge hierarchies. As Ellegaard [16] and Safder & Hassan [44] argue, the risk of misinterpreting such visual clusters lies in treating them as definitive taxonomies rather than contingent reflections of search strategies and indexing policies. This concern is especially acute in non-English-language contexts or emerging disciplines where database representation is uneven.

CONCLUSION

This article examined the evolving landscape of bibliometric practices and their implications for science policy and research evaluation systems at the individual, institutional, and national levels. Through conceptual analysis and comparative study of national strategies, the research demonstrated the poten-

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tial of responsible metrics, designed with disciplinary specificity and adapted to local contexts, as instruments for building more ethical, equitable, and strategically oriented research environments. The conclusions are grounded in recent developments in altmetrics, artificial intelligence-based analytics, and global reform initiatives such as DORA and the Leiden Manifesto, which call for evaluation systems that privilege substantive meaning and scholarly significance over simplified quantitative indicators.

At the same time, the analysis identified several tensions that demand further theoretical and practical reflection. One of the most significant concerns lies in the disjunction between global standardization of indicators and the requirements of local fairness, where universal publication criteria risk displacing research of particular relevance to specific social and cultural contexts. Institutional inertia remains another barrier, since the declarative endorsement of the principles of responsible metrics often fails to result in their genuine incorporation into governance practices. While the use of artificial intelligence and altmetrics promises a deeper understanding of the impact of research on both science and society, it also entails the dangers of epistemological distortion, algorithmic opacity, and automated judgments that may undermine the role of expert evaluation. Taken together, these findings underscore the importance of conceiving metrics not as substitutes but as complements to qualitative forms of assessment rooted in scholarly judgment, ethical governance, and the core values of the academic community.

AUTHORS' CONTRIBUTIONS

Amelya Gustina: conceptualization; data curation; formal analysis; investigation; methodology; software; validation; visualization; writing – original draft; writing – review & editing.

Prakoso Bhairawa Putera: conceptualization; data curation; formal analysis; investigation; methodology; software; validation; visualization; writing – original draft; writing – review & editing.

Elena V. Tikhonova: data curation; formal analysis; validation; writing – review & editing.

CONFLICT OF INTERESTS

The authors declare no relevant conflict of interests.

ACKNOWLEDGMENTS

DISCLAIMER

To support integration, the authors employed a structured and transparent use of GPT-4 via the ChatGPT Plus platform (OpenAI, April–July 2025 editions). The model was not used for data generation or interpretation, but for style and rhetorical assistance. All AI-assisted outputs were critically reviewed, reworked, and verified.

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