Exploring the Frontiers: Research Gaps, Informational Sources, and Evaluative Metrics

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Abstract: **The dynamic nature of scholarly research demands a thorough comprehension of the important information sources, essential gaps, and useful measures for assessing scholarly influence. In order to discover important research gaps that impede advancement in academic pursuits, this study investigates the uncharted territories within various fields. It looks into the various information sources that influence current research, from established scholarly journals to newly developed open-access platforms. The study also explores the several evaluative metrics used to gauge scholarly influence, examining their usefulness, drawbacks, and changing characteristics in an academic setting that is becoming more digital and linked. By combining these components, the study hopes to offer a comprehensive framework for negotiating the challenges of scholarly research and impact assessment, providing guidance to scholars, decision-makers, and organizations looking to promote scholarly activities.**

Key words: **Research gap, H index, impact factor, cite score, information source, altmetrics**

1 INTRODUCTION

In the constantly evolving world of research, both academic and practical, the quest for new knowledge often requires navigating unexplored areas and addressing the challenges that come with gaps in existing literature, the quality of informational sources, and the development of evaluative metrics to assess progress. The three interconnected elements research gaps, informational sources, and evaluative metrics are essential for advancing knowledge in any field and ensuring that findings are reliable, accurate, and impactful.[3] This exploration delves into how each of these components plays a key role in pushing the boundaries of understanding. Research gaps represent the areas in current knowledge that remain unexplored or inadequately studied. As technology progresses, new methods or tools make it possible to explore areas that were previously inaccessible. Existing theoretical frameworks may fall short of explaining new phenomena, creating space for further conceptual development. Some gaps arise due to the lack of relevant or high-quality data, which prevents deeper exploration. Additionally, there are gaps resulting from a lack of interdisciplinary integration, where knowledge from one field could enrich another and lead to breakthroughs. Identifying these gaps is crucial for steering future research efforts.[1] Scholars and researchers continuously examine literature, reports, and ongoing projects to pinpoint areas that need further attention. A research gap not only sparks the need for further inquiry but also ensures that new studies address significant and impactful issues. Informational sources are the backbone of research. These sources, which include primary data, experimental results, secondary literature, and expert analyses, significantly influence research outcomes. Informational sources can be categorized into primary, secondary, and tertiary sources. Primary sources include original data and firsthand accounts, such as experimental studies, surveys, interviews, and field reports.[2] These are essential for advancing research as they provide raw data that serves as the foundation for further analysis. Secondary sources offer interpretations and summaries of primary data. Literature reviews, meta-analyses, and books that consolidate and explain findings from primary sources are crucial for understanding existing knowledge and identifying research gaps.[4] Tertiary sources provide broad overviews and often compile secondary sources. Examples include encyclopedias, databases, and bibliographies. As technology continues to evolve, accessing and using informational sources is rapidly changing. Digital archives, open-access journals, and collaborative platforms like research repositories and preprint servers are transforming how researchers find, validate, and share information. However, this increase in available sources also brings the challenge of determining the credibility, reliability, and accuracy of the information. Evaluative metrics are tools used to assess the effectiveness and impact of research.[5] They help evaluate both the quality of the research process and the significance of its outcomes. These metrics can vary depending on the research stage, field, and intended audience. One common evaluative method is citation analysis, which measures how often a study, article, or paper is cited by others. This can help assess the influence of specific works within the broader research community. The impact factor, commonly used to evaluate academic journals, reflects how frequently articles from a journal are cited within a specific period. A high impact factor suggests that the journal's publications are influential. With the rise of social media and digital platforms, new ways of measuring research impact have emerged. [6]Altmetrics track attention on social media, blog mentions, news articles, and policy discussions, providing insight into a publication's broader societal impact beyond academia. Peer review remains a vital aspect of the evaluative process, ensuring that research meets a certain standard of quality and rigor before publication. Peer-reviewed publications are considered more credible due to the expert scrutiny they undergo. The reproducibility of experimental findings and the availability of data and methods for independent verification are increasingly recognized as key measures of research quality. Open science metrics emphasize accessibility and transparency, allowing other researchers to replicate or build upon findings. These metrics not only serve as indicators of research quality but also inform funding decisions, institutional priorities, and career progression. Ethical use of evaluative metrics is crucial, as relying too heavily on any single metric can distort perceptions of a researcher's or institution's true impact.[7]

2 EVALUATIVE METRICS

Evaluative metrics are essential tools used to assess and measure the effectiveness, quality, or impact of research, publications, or other forms of academic or professional work. These metrics provide quantifiable data that help researchers, institutions, publishers, and policymakers gauge the significance and contribution of specific work in the context of a particular field or discipline. Evaluative metrics are widely used in academia to assess the quality and impact of research outputs, but they can also be employed in other fields such as business, government, and healthcare to evaluate the performance of individuals, teams, organizations, or systems. Evaluative metrics are crucial for both individual researchers and larger academic systems, helping them understand their position within the global research landscape.[8] These tools also aid in identifying trends, tracking research outputs, and ensuring that research is aligned with the latest academic standards and priorities. However, it's important to note that these metrics should be used carefully and not as the sole indicators of a researcher's or institution's value. They often face criticism for oversimplifying complex academic work and can sometimes encourage quantity over quality in research. Therefore, while useful, evaluative metrics should be part of a broader assessment process that also considers qualitative aspects of research, such as originality, societal impact, and interdisciplinary contributions.[10]

2.1. Impact Factor

The Impact Factor (IF) is one of the most commonly used metrics to measure the importance or influence of a scientific journal. It was introduced by Eugene Garfield, the founder of the Institute for Scientific Information (ISI), in the 1950s and has since become a widely accepted tool for evaluating academic journals. The Impact Factor (IF) of a journal is calculated based on the frequency with which articles published in that journal are cited over a particular time frame. It is often used as a proxy to evaluate the relative importance of journals within a field. Journals with higher impact factors are often considered more prestigious or influential within their discipline. [9] Researchers and authors may target journals with high impact factors for submitting their work, seeking wider exposure. Universities, research institutions, and funding agencies may consider the impact factor of journals when evaluating the research output of their scholars. Impact factor can influence funding decisions, tenure evaluations, and career advancement within academia. The formula for calculating the Impact Factor for a specific year is as follows:

Impact Factor (IF)=Total Number of Articles Publis hed in Year (X-1) and (X-2)/ Citations in Year X to Articles Published in Year (X-1) and (X-2)

Citations in Year X: The total number of citations received by articles published in the journal during the previous two years (X-1 and X-2). Total Number of Articles Published in Year (X-1) and (X-2): The total number of articles published in the journal in those two years. The impact factor is typically calculated for journals on an annual basis by specialized organizations, such as Clarivate Analytics (formerly ISI), which provides the most widely used

Journal Citation Reports (JCR). Some of the strengths of Impact Factor are it is well-established, making it a common metric in academia for comparing journals. It provides an objective, numerical way of assessing journal influence. A high impact factor often indicates that research published in that journal is widely cited, suggesting that it is highly relevant and influential.[10]

5-Year Impact Factor

This metric is similar to the traditional Impact Factor but is calculated over a 5-year period instead of just two years. It gives a broader view of the journal's impact, accounting for research that takes longer to gain citations.[21]

Formula for 5-year Impact Factor:

5-Year Impact Factor = Citations in Years (X-1) to (X-5) to Articles Published in Years (X-1) to (X-5) / Total Number of Articles Published in Years (X-1) to (X-5)

Immediate Impact Factor

This is a more short-term version of the Impact Factor and measures citations in the current year to articles published in the current year. It focuses on how fast the work gets cited immediately after publication.[22]

2.1.1. Criticisms and Limitations of Impact Factor

Despite its widespread use, the Impact Factor has several limitations that have led to criticism:

Bias Toward Short-Term Impact: Impact factor emphasizes recent citations, which means journals with articles that gain attention quickly (but may not have long-term value) can have inflated impact factors. Conversely, journals that publish long-term, foundational research may be penalized[11].

Field-Specific Variations: Different fields of study have vastly different citation practices. For instance, in biomedical sciences, articles tend to be cited more frequently, leading to higher impact factors, whereas fields like mathematics or humanities have lower citation rates. Thus, comparing journals across disciplines using impact factor can be misleading.[8]

Influence of a Few Highly Cited Articles: A small number of very highly cited papers can dramatically inflate a journal's impact factor, even if most articles in that journal are not widely cited.[6]

Focus on Journal, Not Article: The impact factor measures journal-wide citations, not the citation impact of individual articles. A highly cited article in a low-impact journal may have a greater impact than the journal's overall IF suggests.[4]

Manipulation Risk: Some journals might use strategies like publishing more review articles (which tend to be cited more often) or "self-citation" to artificially boost their impact factor. This undermines the reliability of the IF as a measure of genuine scholarly influence.[3]

Does Not Reflect Societal Impact: Impact factor mainly measures academic impact (citations in academic journals), but it does not capture broader societal or policy impacts of research, such as influence on industry, media, or public policy.[12]

The Impact Factor is a widely recognized metric for assessing the influence of academic journals, primarily through citation frequency. While it provides useful insights into the reputation and influence of a journal, it has several significant limitations, such as its reliance on a short citation window, its inability to account for non-academic impacts, and its potential for manipulation. Given these limitations, it is increasingly important to use the Impact Factor alongside other metrics (like altmetrics, h-index, and Eigenfactor) to gain a fuller understanding of a journal's and researcher's overall impact. Moreover, when evaluating research, one should not solely rely on Impact Factor but should also consider the content, relevance, and quality of the research itself.[13]

2.2. Altmetrics

Altmetrics (short for "alternative metrics") are a set of metrics that measure the attention and engagement that scholarly content receives online and through social media platforms, in contrast to traditional citation-based metrics like the Impact Factor. They focus on the broader, more immediate engagement that academic work receives outside the traditional academic citation network. [19]While traditional bibliometric measures, like citation counts, assess scholarly impact based on how often a research paper is cited in academic publications, altmetrics provide insights into the public impact of scholarly research. They measure how widely a paper, article, dataset, or research output is shared, discussed, and used in non-academic contexts. Altmetrics focus on capturing and analyzing the interactions and attention that research receives on platforms outside the traditional academic journal citation network. They include any scholarly output, such as journal articles, conference papers, datasets, preprints, books, and even blog posts or social media shares, that gets attention in non-academic communities.[14]

2.2.1. Key Types of Altmetrics

Altmetrics focus on various types of engagement or interactions with research content. Below are common forms of altmetric data:

Social Media Mentions

Twitter: Tweets, retweets, hashtags, and mentions.

Facebook: Shares, comments, and likes related to research.

LinkedIn: Shares and mentions in professional networks.

Reddit: Discussion and links to research shared in subreddits.[13]

These social media platforms provide immediate, informal feedback about research, and the frequency with which research gets shared and discussed can indicate its broader engagement.[15]

Article Views and Downloads

How often an article is viewed or downloaded from repositories, databases (like PubMed, arXiv, or SSRN), or publisher websites (e.g., Elsevier, Springer).

Full-text downloads and abstract views can provide an indication of how much interest an article generates, even if the article hasn't yet been widely cited in other papers[16].

Mentions in Blogs

Research articles and papers that are cited or discussed in blogs or online articles provide a gauge of how accessible and relevant the research is to a broader audience. Many researchers and scholars write blogs about recent findings in their field, offering commentary, analysis, and even informal peer review of published work.[17]

News Media Coverage

News outlets (mainstream or specialized) may cover a specific piece of research, and the number of mentions or articles that reference the work can be tracked.

This includes mentions in mainstream media (newspapers, magazines, television) and more specialized publications (e.g., health or technology-focused media).[16]

Policy Documents and Reports

Research can also have an impact through policy engagement. Mentions or citations in policy briefs, government reports, or even international organizations' documents can be captured by altmetrics.

Such mentions indicate that the research has influenced or contributed to policy debates and decisions.[18]

Video and Multimedia Mentions

Research that is referenced or discussed in video content, such as YouTube, Vimeo, or educational platforms like Khan Academy or TED Talks, can also be tracked as part of altmetrics.

Videos discussing research findings in an engaging, multimedia format can help translate complex academic topics to a broader audience[19].

Citations in Wikipedia

Articles cited or referenced in Wikipedia pages are another form of altmetric. Many researchers track mentions of their work in Wikipedia as it demonstrates a connection between academic knowledge and public access.[20]

Data and Software Citations

The sharing and use of research datasets, software, or tools on platforms like GitHub, Figshare, or Dryad are also measured by altmetrics. These metrics give insight into how often datasets or software tools are downloaded, forked, or reused by other researchers or practitioners.[21]

Comments and Peer Reviews

Some altmetric platforms capture post-publication peer reviews or comments (e.g., PubPeer or F1000). These comments can provide insights into the post-publication impact and community engagement with the research.[9]

Altmetric data is collected by tracking scholarly content across a wide range of platforms and media.

Different altmetric providers (companies and tools that aggregate and analyze altmetric data) track various types of online interactions. Some of the most widely used tools include:

Altmetric.com

Altmetric is one of the leading companies that aggregates altmetric data. Their Altmetric Attention Score is a popular metric used to measure the online engagement of scholarly work. The score reflects the total volume of attention the work has received across multiple platforms like Twitter, news outlets, blogs, and policy documents. The Altmetric Attention Score is a weighted aggregate, so a mention in a high-impact news source or an academic journal will contribute more to the score than a mention in a lesser-known blog or on social media.[22]

PlumX Metrics

PlumX is another tool used to track and visualize the altmetric data. It provides a "Plum Print," which shows various categories of engagement (e.g., usage, captures, mentions, social media, citations), giving a more detailed view of how an article is being interacted with across different platforms. PlumX Metrics is a system designed to track and visualize the impact of scholarly work across multiple dimensions. Unlike traditional citation-based metrics that focus solely on academic citations, PlumX Metrics provide a broader view of how research outputs are being engaged with and utilized across various platforms. [22]The system allows users to assess research impact based on five key categories of engagement: usage, captures, mentions, social media, and citations. PlumX Metrics was developed by Plum Analytics, which was acquired by Elsevier in 2017. It aims to provide a comprehensive picture of research impact that includes both traditional academic and non-academic forms of engagement. Researchers, institutions, and publishers use PlumX Metrics to understand how their work is being used, discussed, and disseminated. PlumX Metrics offers a comprehensive, multidimensional approach to tracking the impact of scholarly work. By including not only traditional academic citations but also social media mentions, blog posts, downloads, and captures, PlumX provides a more holistic view of how research is being used and discussed across various fields. For researchers, institutions, and publishers, PlumX is a valuable tool for assessing both the immediate and long-term impact of research. It can be used to highlight a paper's public impact, its contribution to ongoing debates, or its potential to shape industry practices or policy decisions. However, researchers should remember that while PlumX provides valuable insights into engagement, it should be used in conjunction with other metrics and qualitative assessments to fully understand the significance of a research output.[23]

ImpactStory

ImpactStory (now integrated into ORCID) offers another altmetric dashboard that focuses on tracking non-traditional academic engagement with scholarly outputs. It provides metrics for things like social media mentions, blog coverage, and citations in non-academic venues.

Altmetrics are a crucial addition to the traditional metrics used to assess scholarly impact. They provide a more holistic view of the influence of research by measuring engagement across a wide range of platforms, including social media, blogs, and mainstream media. Altmetrics can help capture the public-facing impact of research, providing valuable insights into how research affects policy, practice, and the wider community. However, because altmetrics measure the volume rather than the quality of engagement, and because they may be subject to manipulation or biases, they should be used in combination with other metrics (such as citation-based measures) to gain a fuller, more accurate understanding of research impact. In essence, altmetrics can complement traditional academic metrics, providing a more comprehensive view of scholarly work's influence in today's interconnected world.[24]

2.3. Citation count

It refers to the number of times a research paper, article, or study has been referenced or cited by other scholarly works. It serves as an indicator of the impact, relevance, and influence of a particular piece of research in the academic community. A higher citation count often suggests that the research has been widely recognized, utilized, or built upon by other scholars. A higher citation count typically reflects the importance or value of the research within its field. Citations are often considered a form of acknowledgment by other researchers and can indicate that the work has contributed significantly to advancing knowledge in that area. Researchers often use citation counts as a metric to gauge the recognition and influence of their work. It can contribute to career advancement, funding opportunities, and academic reputation. The number of citations can help assess how well-known or widely read a particular study is. High citation counts may imply that the research has been useful for other scholars, practitioners, or policymakers.[25]

2.3.1. Sources to Track Citation Count

Google Scholar: This free tool allows you to track citation counts for specific articles, authors, and journals.

Scopus: A comprehensive database for academic research that includes citation tracking features.

Web of Science: Another database for citation counts, providing detailed information about the influence and reach of academic research.

PubMed: For biomedical and life sciences research, PubMed offers citation tracking tools that can be useful for researchers in those fields.

ResearchGate: A networking site for researchers where you can find citation counts, particularly for papers uploaded directly to the platform.[26]

2.4. SCImago Journal Rank (SJR)

The SCImago Journal Rank (SJR) is a metric that assesses the prestige of scholarly journals by considering both the number of citations they receive and the prestige of the journals where these citations originate. Developed by the SCImago Research Group, the SJR indicator is based on the Scopus database and is designed to reflect the scientific influence of journals. To determine the SJR of a specific journal, you can use the SCImago Journal & Country Rank portal. This free resource allows you to search for journals by title, subject area, or publisher and provides detailed information about each journal's SJR, H-index, and other relevant metrics. The SJR indicator is used to assess the visibility and impact of scholarly journals. It incorporates the number of citations a journal receives and adjusts for the prestige of the journals where those citations appear. In essence, the SJR rewards journals that are cited in more influential or well-regarded publications. The SCImago Journal Rank is based on data from Scopus, a large abstract and citation database of peer-reviewed literature. Scopus tracks articles from a broad range of disciplines and is widely used for academic citation analysis.[27]

The SJR formula considers two main factors:

Citations: How often articles published in a journal are cited by other research papers.

Prestige: The prestige of the journals that cite these articles. Citations from high-impact journals (with high SJR scores themselves) are weighted more heavily than those from journals with lower scores.[11]

SJR takes into account the prestige of the journals citing the articles, which helps mitigate the influence of journals that may artificially inflate their citation counts. It offers a more holistic and sophisticated measure of a journal's impact compared to traditional impact factors. It allows comparison between journals across different disciplines, as it accounts for citation behaviours that differ from one field to another. The inclusion of the quality of citing journals adds a level of sophistication to the metric.[19] SJR accounts for different citation behaviours across disciplines, making it suitable for comparing journals in diverse academic fields. SJR is freely accessible on the SCImago Journal Rank website, offering users the ability to search for journals by title, subject area, or country. While the SJR is field-normalized, some subject areas may still experience more favorable citation patterns than others. The emphasis on citation quality means that certain influential but less-cited journals might be undervalued. Like many citation-based metrics, SJR is limited in that it measures the impact through citations, which doesn't capture all forms of scholarly influence, such as books or non-cited research. The SCImago Journal Rank (SJR) offers a more sophisticated and nuanced measure of journal impact, considering both the quantity and quality of citations. It provides valuable insights for evaluating scholarly publications, making it an essential tool for researchers and institutions looking to assess the prestige and influence of academic journals in a more meaningful way.[28]

2.5. Eigen factor Metrics

The term Eigen factor is not as widely recognized or standardized as eigenvalue in mathematical contexts. However, in some specific fields or applications, Eigen factor could refer to a concept related to the Eigen factor score or Eigen factor Metrics, which is used to assess the importance of academic journals. This is not directly related to eigenvalues in linear algebra but rather to a journal ranking system. The

Eigen factor score is a measure of the importance or influence of a scholarly journal based on citation patterns. It is somewhat similar to the impact factor but incorporates additional factors that account for the "prestige" of the journals that are citing the articles.[5] It was developed as part of a larger initiative to improve journal impact measurement beyond just the raw number of citations. The Eigen factor score uses a network-based approach to measure the journal's influence. It evaluates the citation patterns of journals, taking into account not just the number of citations but also the source journals that are doing the citing. Citations from highly-ranked journals are given more weight than citations from less prestigious journals, making this metric more reflective of the overall influence of a journal in the scientific community. Similar to the SCImago Journal Rank (SJR) metric, the Eigen factor score normalizes for differences in citation practices across different academic fields. This means it accounts for the fact that some fields tend to cite more frequently than others, ensuring fairer comparisons between journals from different disciplines. The Eigen factor score is based on data from a large citation network, typically derived from the Web of Science and similar databases. It incorporates citation information across multiple years to assess long-term journal influence. Unlike traditional impact factor metrics that only consider citation counts, the Eigen factor score takes into account the structure of the citation network and the "quality" of the journals citing the articles, thus giving a more accurate picture of a journal's overall academic significance.[29]

2.6. Field-Weighted Citation Impact (FWCI)

The FWCI is a metric that compares a researcher’s citation count to the average citation count for publications in the same field. It normalizes for differences in citation behaviour across disciplines. FWCI measures how often a researcher's work is cited relative to the average for similar articles in the same field, year, and document type. It normalizes citation data based on field-specific citation behaviour, helping to provide a fairer comparison across disciplines, as citation patterns vary widely between different academic fields. FWCI adjusts for the fact that some fields tend to cite more frequently than others. [15]For example, biomedical research typically has higher citation rates compared to humanities research. FWCI accounts for this variation, allowing more accurate comparisons between researchers from different disciplines. FWCI compares a researcher's publications to the average citation impact of articles in the same field. A score of 1.0 means that the researcher's work is cited at the same rate as the field average. A score greater than 1.0 indicates higher-than-average citation impact, while a score below 1.0 indicates lower-than-average citation impact. FWCI is calculated using the following formula:

$$\text{FWCI} = \frac{\text{Citations received by the article}}{\text{Expected citations based on field, year, and document type}}$$

This allows FWCI to account for the citation expectations in specific fields, ensuring that the metric is not biased toward fields with higher or lower citation practices. It provides a more equitable comparison of citation impact across different fields of study, eliminating the bias introduced by varying citation habits. Unlike raw citation counts, FWCI gives a clearer picture of a researcher's influence relative to their peers in the same field. It considers not only the volume of citations but also the "quality" of those citations relative to the field norms. While it normalizes for field differences, it still depends on accurate and up-to-date citation data for each field. In some niche or emerging fields, there may be less reliable data. FWCI focuses on citation impact, but doesn't fully reflect other types of scholarly influence, such as policy changes, social media engagement, or public outreach. The metric may be more difficult for non-experts to interpret compared to simpler metrics like citation counts or h-index.[30]

2.7. Journal Citation Reports (JCR)

Journal Citation Reports (JCR) is a comprehensive tool for evaluating and analyzing journals based on citation data. Published annually by Clarivate Analytics (formerly part of Thomson Reuters), JCR provides essential metrics to assess the impact and influence of scholarly journals across various academic disciplines. JCR compiles citation data from a wide array of academic journals, covering fields from sciences to social sciences. [20]The tool is mainly used by researchers, academic institutions, and publishers to understand the performance of journals and make informed decisions about where to submit research papers, where to invest in publishing, or how to assess the impact of academic research. JCR includes journals indexed in the Web of Science database, which is one of the most respected citation databases globally. Researchers, academic institutions, and libraries use JCR to assess which journals are regarded as the most influential or prestigious in their field. Researchers use JCR metrics to decide where to submit their papers, as publishing in higher-impact journals can enhance the visibility and credibility of their work. It allows for comparisons between journals within the same field or across different disciplines, helping to highlight which journals have higher citation counts, broader reach, or more influence. JCR's metrics focus on citation data, but they don't capture other important aspects of academic journal quality, such as peer review processes, editorial quality, or the journal's role in advancing knowledge.[23]

2.8. H-index (Hirsch Index)

The H-index is a measure that quantifies both the productivity and citation impact of the researcher's publications. It was proposed by physicist Jorge Hirsch in 2005. A researcher has an H-index of h if h of their papers have been cited at least h times, and the rest of their papers have no more than h citations. The H-index balances the number of publications and the number of citations they receive. It indicates the researcher's consistent ability to produce highly cited papers.[19] A higher H-index generally reflects a stronger influence in the research field. If a researcher has 10 papers, and 5 of them have been cited 10 or more times, the researcher has an H-index of 5. This means they have 5 papers that are each cited at least 5 times. The H-index is one of the most widely adopted metrics for academic impact. It provides a balanced view of a researcher's productivity and the citation impact of their work. However, it has limitations in terms of flexibility, sensitivity to outliers, and variations across fields and roles. To get a comprehensive picture of a researcher's impact, it's often useful to consider the H-index alongside other metrics (like citation counts, g-index, and even qualitative assessments of their research contributions).[25]

2.9. I-index (Individual Index)

The I-index is a more recent metric proposed by Gusmao et al. that focuses on the "individual" citation performance of a researcher. The I-index is defined as the number of papers with at least I citations, where I represents a given number. The I-index aims to provide a more detailed picture of an academic's citation impact than the H-index. The I-index focuses more closely on individual papers and their citation count rather than averaging them across all publications. It's designed to avoid some of the drawbacks of the H-index, particularly the fact that the H-index is less sensitive to papers with very high or very low citation counts. The I-index is a powerful and detailed metric that complements the H-index by providing more specific information about a researcher's citation patterns. [21]It offers a more nuanced view of a researcher's work, especially when considering citation thresholds. While it is not as widely used as the H-index, it can be a valuable tool for those who need a more granular and comprehensive analysis of citation impact. However, the I-index has its limitations, such as complexity in calculation and lack of wide adoption. For a comprehensive assessment of a researcher's contributions, it is often helpful to use the I-index alongside other metrics like the H-index, citation counts, and other qualitative assessments.[27]

2.10. g-index (Egghe index)

The g-index is a metric designed to improve upon the h-index (which measures the productivity and citation impact of a researcher) by giving more weight to highly-cited articles. It was introduced by Leo Egghe in 2006 as a way to better account for researchers who may have a few papers with very high citation counts. The g-index is a citation-based metric used to evaluate a researcher's productivity and impact. [24]It aims to measure how many of the most-cited papers a researcher has published, but unlike the h-index, the g-index gives more weight to those papers that are highly cited. It is considered an improvement over the h-index because it gives more attention to top-cited works rather than focusing on the number of papers that meet a minimum citation threshold. The g-index is a powerful tool for measuring the impact of researchers who have produced a few highly-cited, influential papers. It improves upon the h-index by emphasizing the impact of the top-cited works, providing a better reflection of a researcher's most influential contributions to their field. However, it is important to use the g-index alongside other metrics (such as the h-index, citation count, and altmetrics) to get a fuller picture of a researcher's impact and productivity.[29]

The g-index is calculated based on a researcher's most-cited papers. Here's how it works:

Sort the researcher's papers by the number of citations (from highest to lowest).

Find the largest number "g" such that the top g most-cited papers have at least g citations each. This means:

The g-index is the largest integer g such that the sum of citations for the top g papers is at least g^2.

Essentially, the g-index is based on a cumulative citation threshold — it looks for the point at which the researcher's most-cited papers can still meet a critical mass of citations.[30]

2.11. P- index

The p-index is a relatively lesser-known bibliometric metric that is designed to assess a researcher's productivity and the impact of their work. Unlike the h-index and g-index, which focus on citations and the number of highly-cited papers, the p-index provides a measure that combines both the quantity of a researcher's publications and their average impact (as measured by citations). The p-index is a citation-based metric that aims to quantify a researcher's overall productivity while taking into account the average impact of their publications. It is designed to provide a comprehensive measure of how productive a researcher is, not only by the number of papers they have published but also by how influential those papers are in terms of citations. The p-index is a valuable metric for evaluating a researcher's overall productivity and the average impact of their work. It provides a more comprehensive view of a researcher's output compared to metrics like the h-index or g-index by taking into account both quantity (number of publications) and quality (average citation impact per paper). While it offers useful insights into a researcher's academic performance, it should be used alongside other metrics to get a full picture of a researcher's influence and contributions to their field. Thus, the p-index reflects the average citation impact per paper. This allows researchers to understand not only how much they have published, but also how impactful their work is on average.[22]

The p-index is typically calculated as follows:

p-index=Total Citations/Total Publications

Total Citations: The sum of all citations a researcher has accumulated across all their published papers.

Total Publications: The total number of papers a researcher has published.[19]

Table 1 gives the comparision between H index, i-10 index, g and p index.

Metric	h-index	i10-index	g-index	p-index
Definition	The h-index is the highest number h such that a researcher has published h papers with at least h citations each.	The i10-index is the number of publications with at least 10 citations.	The g-index is the highest number g such that a researcher has published g papers with at least g 2 citations in total.	The p-index is a metric that adjusts the h-index by giving more weight to papers with high citation counts, focusing on the impact of individual papers.
Focus	Balances the number of publications and their citation impact.	Focuses purely on the number of publications with at least 10 citations.	Prioritizes publications with higher citation counts, giving more weight to highly cited papers.	Focuses on individual paper impact, adjusting for citations to highlight the most impactful work.
Purpose	Measures both productivity and citation impact.	Measures the number of publications with significant impact (10+ citations).	Measures citation impact with an emphasis on highly cited papers.	Adjusts the h-index to highlight highly cited papers and the impact of fewer but more influential works.
Strengths	Well-established metric; considers both number of	Simple, easy to calculate, useful for gauging significant publications.	More sensitive to highly cited papers; emphasizes	Adjusts for the number of highly cited papers, providing a better

	papers and citation count.		citation quality over quantity.	measure of the most impactful work.
Weaknesses	Does not distinguish between papers with extremely high or low citations; can be biased for researchers with many publications.	Does not account for citations beyond the threshold of 10.	Can overemphasize highly cited papers, ignoring overall productivity.	Can be less useful if the researcher has few highly cited papers; may not reflect overall productivity.
Use Case	Used to assess the general academic productivity and impact.	Often used as a simpler metric to count impactful publications.	Useful for highlighting highly influential papers in a scholar's work.	Useful for understanding the impact of a researcher's top papers, adjusting for the weight of citations.

2.12. Arithmetic Mean of Citations

The Arithmetic Mean (also called the average citation count) of a researcher's publications is simply the total number of citations divided by the total number of papers. The arithmetic mean, often referred to simply as the mean, is a basic statistical measure of central tendency. It represents the average of a set of numbers, giving you an idea of the "central" value or typical value in a data set. It is one of the most commonly used measures in statistics and is widely applied in various fields such as economics, science, business, and everyday life. The arithmetic mean is a fundamental concept in statistics, offering a simple yet effective way to summarize a data set by identifying the "central" value. However, while it is widely used and easy to calculate, it has its limitations, especially when dealing with skewed data or outliers. Understanding when and how to use the mean, along with other measures like the median and mode, is crucial for making informed decisions in research, business, and data analysis.[24]

Arithmetic Mean = $\sum$ Citations of All Papers / Total Number of Papers

Arithmetic Mean = Total Number of Papers / $\sum$Citations of All Papers

In research, the sources of information are typically categorized into three main types: primary, secondary, and tertiary sources. These sources play distinct roles in the process of collecting and analyzing data. Understanding the differences between them is crucial for ensuring that the information you use is appropriate for your research objectives.

3 SOURCES OF INFORMATION

When conducting research, identifying and understanding sources of information is crucial for acquiring reliable and relevant data. Sources of information can be broadly categorized into primary, secondary, and tertiary sources. Additionally, with the rise of digital information and global access to data, there are now diverse types of sources, each with its own strengths and weaknesses depending on the research topic and objectives. The sources of information which we select must depend on our research goals, methodology, and the type of data we are seeking. A combination of primary, secondary, and tertiary sources, is often the best approach for comprehensive research.[26]

3.1. Primary Sources of Information

A primary source is original material or firsthand information that has not been altered or interpreted. It provides direct, unmediated evidence of a subject or event. Primary sources present information directly from the source or event without any interpretation, analysis, or modification. They include documents or objects created by individuals who were directly involved in the event or subject being studied. Primary sources are considered the most reliable and authentic type of information because they offer direct evidence. Researchers use primary sources when conducting original research or when they need to work with firsthand accounts or raw data to draw conclusions.[28]

3.2. Secondary Sources of Information

A secondary source interprets, analyzes, or summarizes information from primary sources.

These sources provide a second-hand account or a scholarly interpretation of an event, process, or phenomenon. Secondary sources evaluate, discuss, or synthesize information from primary sources. These sources often rely on primary sources for their content, but they offer commentary, criticism, or reflection. Secondary sources are helpful for gaining a broader understanding of a topic and can be used to build upon existing knowledge. Researchers rely on secondary sources when they want to see how others have interpreted primary data, to gain context, or to understand the broader implications of primary data.[16]

3.3. Tertiary Sources of Information

A tertiary source compiles, summarizes, and organizes information from primary and secondary sources. It serves as a reference tool that provides an overview or quick facts on a specific topic. Tertiary sources provide concise and easily accessible information, typically in a highly structured format. These sources do not provide detailed analysis but instead offer general summaries, overviews, or categorized information. Tertiary sources are often used as a starting point to quickly get familiar with a subject. Researchers use them for background information, definitions, or references to primary and secondary sources. They are generally not used for in-depth analysis but provide a solid foundation for understanding the basics.[18]

Table 2 represents the classification of different sources of information[6]

Aspect	Primary Sources	Secondary Sources	Tertiary Sources
Nature	Original, firsthand data or evidence	Analysis, interpretation, or commentary on primary data	Compilations and summaries of primary and secondary sources
Examples	Diaries, interviews, original research papers, photos	Books, articles, reviews, documentaries	Encyclopedias, dictionaries, factbooks, indexes
Purpose	To provide direct evidence or firsthand accounts	To analyze, interpret, or critique primary sources	To provide quick, general information or an overview
Use in Research	When creating new knowledge or understanding	To gain insight, interpretation, or context on a subject	To gather foundational information or references
Level of Detail	High, detailed information	Moderate, analysis and interpretation	Low to moderate, general information

4 RESEARCH GAP

A research gap refers to an area in a specific field or topic where there is a lack of sufficient or adequate knowledge, understanding, or study. It is essentially an unanswered question, an unresolved issue, or a part of the subject that has not been fully explored or analysed. Identifying a research gap is one of the foundational steps in conducting new academic or scientific research, as it helps to contribute to existing literature and advance knowledge in the field. Identifying a research gap is crucial for moving science, technology, and other fields forward. It allows researchers to focus on questions that matter, solve problems that haven't been addressed, and fill important voids in knowledge. Whether driven by academic curiosity or the need to address real-world challenges, research gaps provide the foundation for groundbreaking discoveries and advancements.[20]

4.1. Key Components of a Research Gap

Unanswered Questions:

These are aspects or specific queries within a research area that have not been addressed in previous studies. These questions may arise from the limitations of prior research, new developments in the field, or evolving societal needs.[2]

Understudied Areas:

Some areas or aspects of a topic may have been neglected or not studied in-depth. This could be due to a focus on more prominent aspects of the field, leaving certain elements unexplored. These understudied areas are potential research gaps[11]

Inconsistent or Contradictory Findings:

Sometimes, research in a particular area might yield inconsistent results or contradict previous findings.

Such discrepancies create a gap, where further studies are needed to clarify the issue and arrive at more reliable conclusions.[4]

Outdated Knowledge:

In many fields, especially fast-evolving ones like technology, healthcare, and environmental science, research can quickly become outdated. As new tools, methodologies, and perspectives emerge, older studies might need re-examination, and fresh research is required to update or confirm existing knowledge.[13]

Methodological Limitations:

Some gaps may exist due to the limitations of research methods used in previous studies. This could include the inability to generalize findings due to small sample sizes, lack of longitudinal data, or the need for more diverse approaches to studying the issue.[15]

Emerging Trends:

As new trends, theories, or technologies arise, they can create new avenues for research that were not previously considered. These are often linked to innovations or changing societal contexts that require investigation to understand their implications fully.[17]

4.2. Steps to Identify a Research Gap

Literature Review:

A thorough review of existing literature helps identify what has already been researched and what remains unexplored. It provides insights into what questions are yet to be answered and what issues are unresolved.[9]

Analyzing Past Research:

Carefully examining past research helps spot patterns, contradictions, and limitations. Researchers can look for areas that are under-explored or overly general in scope.[11]

Consulting Experts:

Asking professionals or experts in the field can help identify areas that have potential for deeper investigation or problems that need solving.[1]

Exploring New Data and Trends:
Keeping track of emerging technologies, policies, or societal needs can reveal fresh gaps in knowledge. This could also include looking at global issues like climate change or advancements in artificial intelligence.[10]

Exploring Interdisciplinary Connections:

Sometimes, a research gap appears at the intersection of two or more fields. Combining knowledge from different areas can lead to innovative research directions.[3]

Examples of Research Gaps

In Healthcare:

Despite extensive research in cancer treatment, gaps still exist in understanding how specific genetic mutations influence drug efficacy, particularly in rare cancers.[17]

In Education:

Although digital learning tools have become widespread, there remains limited research on the long-term effects of virtual classrooms on student mental health, particularly in rural or underserved areas.[20]

In Technology:

While AI has made significant strides in industries like healthcare and finance, there is a lack of research into how AI can be ethically applied to social justice issues, such as addressing bias in predictive policing systems.[14]

In Environmental Science:

While much research has focused on mitigating climate change, there is still a gap in understanding the socio-economic impacts of transitioning to renewable energy sources on different communities, especially in developing countries.[5]

4.3. Importance of Identifying Research Gaps

Advancing Knowledge:

Identifying and addressing research gaps allows scholars to make original contributions, furthering understanding and developing new theories or practices.[8]

Filling Knowledge Deficiencies:

Research gaps highlight areas where society or a field of study lacks knowledge, which can then be explored to fill those deficiencies and benefit industries, policy-making, and communities.[2]

Practical Applications:

Filling gaps can often lead to practical outcomes, such as new technologies, treatments, or policies that directly impact people's lives.[7]

Developing Novel Theories:

Researchers who explore gaps in knowledge often develop new theories or frameworks that expand existing paradigms, which may lead to transformative changes in understanding.[4]

Funding Opportunities:

Research gaps can often attract funding from both public and private sectors, as addressing these gaps is seen as a priority in advancing knowledge and technology.[6]

CONCLUSION

In exploring the frontiers of research gaps, informational sources, and evaluative metrics, it becomes evident that while significant strides have been made in various fields, there remain numerous challenges and opportunities for further exploration. Research gaps are often characterized by the lack of comprehensive data, emerging technologies, or the need for interdisciplinary approaches that bridge knowledge across different domains. Identifying and addressing these gaps is crucial for the advancement of scientific, technological, and societal progress. Informational sources, ranging from academic journals to online databases and governmental reports, continue to play an essential role in providing the foundation for research. However, there is a growing need to ensure that these sources are accessible, up-to-date, and inclusive of diverse perspectives, including those from underrepresented regions or groups. The democratization of information through open-access initiatives and collaborations can significantly reduce barriers to knowledge. Evaluative metrics, particularly in assessing research outcomes, need continual refinement. Current metrics such as impact factors and citation counts often fail to fully capture the nuances of research impact. As the nature of research evolves, so too should the metrics used to evaluate it. Alternative metrics, including qualitative assessments and real-world applications, should be integrated to offer a more holistic view of research contributions. In conclusion, bridging research gaps, enhancing the quality and accessibility of informational sources, and developing more comprehensive evaluative metrics are key to push the boundaries of knowledge. Continued interdisciplinary collaboration, innovation in data collection, and the evolution of evaluative frameworks will play pivotal roles in shaping the future landscape of research.

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