

Fundamentals of Journal Impact Factor and Indexing Database Metrics

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Abstract

An impact factor is a measure of citations to articles published in a journal. A citation is a reference to a specific work cited in another work. The work is a scholarly work such as one in a peer reviewed journal. To find out how much impact of a particular article or author has had by showing that other authors cited work within their own papers. An abstracting and indexing service is an important part of the publishing process. It indexes content at the article level by specifying subject headings at each level and then making them searchable in the product's database. These services also list other bibliographic elements of journal articles, including author, title and date of publication etc.

Keywords: Impact factor, indexing, abstracting, citation metrics, Pubmed

Introduction

Impact factor (IF) is the measure of the frequency with which the average article is cited in a particular year. It is used to measure the importance or rank of a journal by calculating the time when an article is cited.^[1] Impact factor is often used as an indicator of the importance of a journal's own field.^[2] The impact factor was first introduced by Eugene Garfield, the founder of the Institute for Scientific Information (SI). In 2018, Thomson ISI was sold to Onex Corporation and Baring Private Equity Asia.^[4] They founded a new corporation, Clarivate, now the publisher of JCR.^[5] Although IF is widely used by institutions and practitioners, there is widespread confusion about the way people calculate IF, its importance, and how it can be used.^[6] Journal which publishes more review articles will get highest IFs. Journals with higher IFs believed to be more important than those with lower ones. Eugene Garfield said "impact simply reflects the skill of the journals and editors to attract the best paper available". The

journal that publishes more review articles will receive the highest IFs. Journals with higher IF are considered more important than lower ones.^[7,8,9] The first automated citation indexing was done by "CiteSeer" in 1997.^[10] Indexation of a journal is considered a reflection of its quality. The reputation of any journal is considered by how many abstraction and indexing services cover that journal. Indexed journals are considered to be of higher scientific quality than non-indexed journals. The Index Medicus has been the most comprehensive index of medical scientific journal articles. It has been published since 1879. Over the years, many other popular indexing services have evolved. These include MEDLINE, PubMed, EMBASE, SCOPUS, EBSCO Publishing's electronic database, SCIRUS etc. Recently more indexation services have come up. These include Caspar, DOAJ, Expanded Academic ASAP, Genamics Journal Seek, Hinari, Index Copernicus, Open J Gate, Primo Central, Pro Quest, SCOLOAR, SIIC databases, Summons by Serial Solutions, Ulrich's International

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Periodical Directory and many more. ^[11,12]

Widely Accepted Tools for Measuring Impact Factors and Citation Analysis

i. Journal Citation Reports (JCR)

Journal Citation Reports[®] is also known as Clarivate analysis that was formerly known as Thomson Reuters ISI impact factors. JCR provides rank in the fields of science, technology and social science related journals. More than 12,000 journals in the field of Arts, Humanities, Sciences and Social Sciences are indexed in JCR.^[1] Clarivate Analytics publish Journal Citation Reports[®] that provides a combination of impact and influence metrics from 2018 Web of Science source data. The report includes 11,877 journals from 81 countries. The most well-known indicator within the JCR is that the Journal Impact Factor (JIF). This measure provides a ratio of citations to a journal during a given year to the citable items within the prior two years.^[13] Clarivate Analytics release the journal impact factors annually as part of the Web of Science Journal Citation Reports[®]. Only journals listed in the Science Citation Index Expanded[®] (SCIE) and Social Sciences Citation Index[®] (SSCI) receive an impact factor.^[14]

IF Calculation

In any given year, the impact factor of a journal is that the number of citations received therein year of articles published therein journal during the two preceding years divided by the entire number of citable items published therein journal during the two preceding years.

$$IF_y = \frac{\text{Citations}_{y-1} + \text{Citations}_{y-2}}{\text{Publications}_{y-1} + \text{Publications}_{y-2}}$$

For example, any journal had an impact factor of 6.36 in 2017.

$$IF_y = \frac{\text{Citations}_{2016} + \text{Citations}_{2015}}{\text{Publications}_{2016} + \text{Publications}_{2015}} = \frac{3000+4000}{720+380} = 6.36$$

ii. Eigenfactor Metrics

The Eigenfactor[®] Project is an academic research project co-founded in January 2007 by Carl Bergstrom and Jevin West and sponsored by the West Lab at the Information School and the Bergstrom Lab in the Department of Biology at the University of Washington.^[15] Eigenfactor ranks and maps, scientific knowledge. It ranks journals similar to Google ranking of websites. It uses the structure of the entire network to evaluate the

importance of each journal. Journals are rated consistent with the amount of incoming citations with citations from highly-ranked journals weighted to form a bigger contribution to the Eigenfactor than those from poorly ranked journals. Eigenfactor metrics consist of the Eigenfactorscore and the article influence score. Eigenfactor score is a measure of the overall value provided by all of the articles published in a given journal in a year. The article influence score is a measure of a journal's prestige based on per article citations and comparable to impact factor. Eigenfactor metrics calculations are based on the citations received over a 5-year period vs. 2 years in JCR.^[16]

iii. SCImago Journal Rank (SJR) Elsevier

SCImago is a research group from the Consejo Superior de Investigaciones Científicas (CSIC), University of Granada, Extremadura, Carlos III [Madrid] and Alcalá de Henares, dedicated to information analysis, representation and retrieval by means of visualization techniques.^[17] The SCImago Journal & Country Rank is a portal that includes the journals and country scientific indicators developed from the information contained in the Scopus[®] database (Elsevier B.V.). Scopus is a citation database provided by Elsevier. Scopus and SCImago are owned by Elsevier an international publication group. Scopus provides four types of quality measures for each journal title, i.e. SCImago Journal, h-Index, CiteScore and SNIP. Scopus contains more than 15,000 journals from over 4,000 international publishers as well as over 1000 open access journals.^[1] The SCImago Journal Rank (SJR) indicator was developed by SCImago from the widely known algorithm Google PageRank[™]. This indicator shows the visualness of the journals contained within the Scopus[®] database from 1996.

SJR Calculation

$$\text{Average \# of weighted citations received in a year}^{16} \div \# \text{ of documents published in previous 3 years}$$

iv. CiteScore Metrics

The CiteScore metric was introduced by Elsevier in 2016. The CiteScore calculates the average number of citations received in a calendar year by the number of items published by the journal in the previous three years. All items are included in the denominator whereas some types of documents are excluded by the journal impact factor. The window for citation tracking is three years rather than two.^[15,18,19] CiteScore metrics are a suite of indicators calculated from data in Scopus, the world's leading abstract and citation database of peer-reviewed literature. CiteScore itself is an average

of the sum of the citations received in a given year to publications published in the previous three years divided by the sum of publications in the same previous three years. CiteScore is calculated for the current year on a monthly basis until it is fixed as a permanent value in May the following year, permitting a real-time view on how the metric builds as citations accrue. Once fixed, the other CiteScore metrics are also computed and contextualise this score with rankings and other indicators to allow comparison.^[20] CiteScore is the number of citations received by a journal in one year to documents published within the three previous years, divided by the number of documents indexed in Scopus published in those three years. CiteScore for 2015 counts the citations received in 2015 to documents published in 2012, 2013 or 2014, and divides this by the number of documents published in 2012, 2013 and 2014.^[21]

v. Source Normalized Impact per Paper (SNIP)

SNIP was created by Professor Henk F. Moed at Centre for Science and Technology Studies (CWTS), University of Leiden and is based on Scopus data. The SNIP metric corrects for differences in citation practices between subject areas. SNIP measures contextual citation impact by weighting citations supported the entire number of citations during a discipline. The impact of one citation is gives higher value in subject areas where citations are less likely and the other way around. Unlike the popular journal impact factor, SNIP corrects for differences in citation practices between scientific fields, thereby allowing more accurate between-field comparisons of citation impact. CWTS Journal Indicators also furnish stability intervals that show the reliability of the SNIP value of a journal.^[1,22-27]

$$\frac{\text{Journal's citation count per paper}^{[21]}}{\text{Citation potential in its subject area}}$$

vi. Google Scholar Metrics

Google Scholar provides a journal ranking based on the number of citations that papers receive. The rankings are based on the *h5*-index and the *h5*-median. This is a free ranking that is generated automatically by Google. The citations may not be as well-curated as in other metrics databases. The advantage of Google Scholar is that it will have data for journals that are not included in other databases.^[15]

Authors Impact Metrics/Citation Analysis

i. *h* index

The *h* index is a metric determining both the quantity and quality of an author's scholarly output and performance comparing publications to citations. The *h*

Table-1: List of top 10 highest impact factor journals in 2019

Rank	Name of Journal	Impact factor ^[28]
1	<i>CA: A Cancer Journal for Clinicians</i>	223.679
2	<i>Nature Reviews Materials</i>	74.449
3	<i>The New England Journal of Medicine</i>	70.67
4	<i>The Lancet</i>	59.102
5	<i>Nature Reviews Drug Discovery</i>	57.618
6	<i>Chemical Reviews</i>	54.301
7	<i>Nature Energy</i>	54
8	<i>Nature Reviews Cancer</i>	51.848
9	<i>Nature Reviews Immunology</i>	44.019
10	<i>Nature Reviews Genetics</i>	43.704

Table-2: List of popular publishers of Journal

S.No.	Name of publishers
1	Springer Groups
2	Wiley-Blackwell
3	SAGE Publishing
4	Taylor & Francis
5	Wolter Kluwer Health
6	Nature Publishing Groups
7	Oxford University Press
8	BMJ Publishing Groups
9	Cambridge University Press
10	SciELO
11	Hindawi
12	Medknow Publication
13	Karger Publication
14	Cross Mark
15	Jaypee Brothers Medical Publishers

index was proposed by J.E. Hirsch in 2005 and published in the Proceedings of the National Academy of Sciences of the United States of America.^[29] Several commonly used databases such as Elsevier's Scopus, Clarivate Analytics' Web of Science, Publish [Perish], SciFinder, PsychINFO, CINAHL and Google Scholar provide *h* index values for authors.^[30]

Calculation of *h* index

In the example below, the researcher would have an *h*-index of 8, as 8 articles have been cited at least 8 or more times, and the remaining articles have each been cited 8 times or less.

ii. *m* value [Alternative to the *h* index]

The *m* value is a correction of the *h* index for time

Publication	Times cited
1	85
2	70
3	67
4	52
5	48
6	30
7	11
8	9 Cut-off
9	8
10	7
11	5
12	2
13	1

[$m = h/y$]. According to Hirsch m is an “indicator of the successfulness of a scientist” and can be used to compare scientists of different seniority. The m value can be seen as an indicator for “scientific quality” with the advantage [as compared to the h index] that the m value is corrected for career length.

How Calculated: m value = h index [h]/ number of years since first paper [n] ^[31]

iii. i10 index

Created by Google Scholar and used in Google’s My Citations feature. This very simple measure is merely employed by Google Scholar and is different to assist to gauge the productivity of a scholar.

i10-Index = the number of publications with at least 10 citations. ^[32]

Journal Indexing/Abstracting Metrics

Indexing is a database of scientific journals having a good track record of maintaining the ethics and quality in terms of publication. Indexing journals considered to be of higher quality as compared to any non-index journals. The Indexing of a journal furnishes a better appearance of the journal with a wider user. Being visible and accessible to larger people will cause better quality papers and results. ^[33] Following are some of the most popular journal indexing agencies where journal mostly applies to indexing.

i. SCI and SCI Expanded

SCI was originally produced by ISI [a part of Thomson Reuters] and created by Eugene Garfield (1964). The SCI’s electronic version is called Web of Science. SCI-expanded indexes 8073 journals with citation references across 174 scientific disciplines in science edition. ^[34,35]

ii. Scopus

Scopus (Elsevier) is a bibliographic database containing abstracts and citations for academic journal articles. It covers 21,000 titles from over 5,000 publishers. It is available online only. The large-scale abstract and citation database of research literature and grade web sources. Designed to find the information scientists need fast, Quick, easy and comprehensive. It is updated daily and provides a range of tools to help users find and refine results among millions of titles, abstracts, web pages, patents and references. ^[36]

iii. Indian Citation Index (ICI)

An online citation database. ICI is a new web platform for estimation of performance of Indian research periodically. This online bibliographic database was launched in 2009. ICI covers 800 plus journals which are published from India on science, technical, medical, and social sciences. ^[37]

iv. MEDLINE and PubMed

John Show Billings, Head of the Library of the Surgeon General’s Office, United States Army, which later evolved as the United States National Library of Medicine (NLM), started Index Medicus (IM). IM was a comprehensive bibliographic index of scientific journal articles related to medical science, in print form, published between 1879 and 2004. NLM began computerizing indexing work in 1960 and called it MEDLARS, a bibliographic database, which later became MEDLINE. Thus, IM became the print presentation of MEDLINE databases content. Both print presentation (IM) and online database (MEDLINE) continued until 2004. In December 2004, the last issue of IM was published (volume 45). The stated reason for discontinuing printed publication was obvious because online resources supplanted it. The electronic presentations of MEDLINE’S contents also evolved, first with proprietary online services (accessed mostly at libraries) and later with CD-ROMS, then with Entrez and PubMed. PubMed is thus a free search engine which accesses the Medline data base. PubMed greatly accelerated the shift of online access to MEDLINE from something one did at the library to something one did anywhere. ^[38]

v. National Center for Biotechnology Information (NCBI)

The NCBI houses a series of databases relevant to biotechnology and biomedicine. Significant databases comprise GenBank for DNA sequences and PubMed, a bibliographic database for the biomedical literature. Other databases include the NCBI Epigenomics database. All these databases are obtainable online through the Entrez search engine.

vi. EMBASE

Embase is the database of *Experta Medica* (a print version), and it is a biomedical pharmacological database formed of published literature. Embase is produced by Elsevier and contains over 28 million records of over 8,400 files up to date, information about drugs, published in literature. Embase enables tracking and retrieval of drug information.^[39]

vii. Index Copernicus International (ICI)

Index Copernicus is a Poland based online indexing database create a global database of scientific journals. The database gathers information on international scientific journals from various sources.^[40]

Viii. PubMed Central

PubMed Central is a free digital repository that archives publicly accessible full-text articles. About 1600 journals automatically deposit their articles in PubMed Central. There are four major online bibliographic sites—MEDLINE, PubMed Central, ISI, and Scopus. Inclusion in MEDLINE confers a mark of quality upon a publication. PubMed Central gives greater access to open access contents, and ISI provides an official impact factor. Inclusion in Scopus gives a clear view of journal metrics and provides h Index and citation impact.^[36] Medical Council of India consider following as indexing agencies: Scopus, PubMed, MEDLINE, Embase/*Excerpta Medica*, Index Medicus, and IC.^[41]

viii. Chemical Abstracts Service (CAS)

A division of the American Chemical Society is the world's authority for chemical information. CAS is the only organization in the world whose purpose is to search, collect, and organize publicly disclosed chemical substance information. CAS delivers the most current, complete, secure, and interlinked digital information environment for scientific discovery.

ix. The Directory of Research Journal Indexing (DRJI)

The Directory of Research Journal Indexing is to increase the visibility and ease of use of open access scientific and scholarly journals thereby promoting their increased usage and impact.^[42]

x. Directory of Open Access Journals (DOAJ)

The Directory of Open Access Journals (DOAJ) gives researchers access to high-quality, peer-reviewed journals. It has archived more than two million articles from 9,519 journals, allowing you to either browse by the subject or search by keyword. The site was launched in 2003 with the aim of accelerating the visibility of open access to scholarly journals. Content on the location covers subjects from science to law to fine arts and everything in between.

xi. J-Gate

The largest e-Journal portal for more than 28,000 academic, research, and industry journals, indexing more than 3.0 million articles a year with dynamic links to full-text.

xii. BASE

BASE is one of the world's most voluminous search engines especially for academic open access web resources, operated by Bielefeld University Library.

xiii. CiteFactor

Citefactor is a service that provides access to quality controlled Open Access Journals. The Directory indexing of journal aims to be comprehensive and cover all open access scientific and scholarly journals that use an appropriate quality control system.^[43]

xiv. BioMed Central

BioMed Central provides open access research from more than 290 peer-reviewed journals in the fields of biology, clinical medicine, and health. Researcher can browse these journals by the subject or title, or can search all articles by required keyword.^[44]

xv. Google Scholar

Google Scholar is a freely accessible web search engine that indexes the full text of scholarly literature across an array of publishing formats and disciplines.

xvi. Elsevier BIOBASE

Elsevier BIOBASE is a bibliographic current awareness database providing comprehensive coverage of biological research worldwide form over 1,9000 source journals.

xvii. Crossref

The official DOI [digital object identifier] link registration agency for scholarly and professional publications. Crossref operates a cross-publisher citation linking system that permits a researcher to click on a reference citation on one publisher's platform and link on to the cited content on another publisher's platform, which relates to the target publisher's access control practices. This citation-linking network covers millions of articles and other content items from several hundred scholarly and professional publishers.^[45]

xviii. Some Other Indexing Database

CORE, Science Open, ERIC, PLOS, OpenDOAR, DLC Repository, CIA World Factbook, Paperity, JURN, Dryad, EThOS, Semantic Scholar, Zenodo, Biological Abstracts, BIOSIS, British Library, CAB Abstracts, CABS, Current Contents, EBSCO Publishing, Global Health, Infotrieve, Ingenta Connect, ISI Web of Knowledge, Ovid, Science Citation Index, Ulrich's periodicals directory, The National Library of Greece

(NLG), HEAL-Link, Research Gate, EBSCO host, Academic Journals Database, Journal Seek, Science Gate, The Journal Database (TJDb), Scirus, MedOAnet, EyeSource, Open Access Journals Search, Engine (OAJSE), Open Access Library (OALib), Open Science Directory, ROAD, Directory of Open Access scholarly Resources, Advanced Science Index, Open Access Articles, Journal Rate, SciTitles, Open Access Library (JourLib), Journal Directory, Journal Guide, InfoBase Index, Open Academic Journals Index, Global Impact Factor, International Impact Factor Services, EuroPub, Eurasian Scientific Journal Index, Genamics Journal Seek, Indian Science Abstract, Journal TOCs, NISCAIR, Social Science Research Network [SSRN], WorldCat, SJIF, CNKI (China National Knowledge Infrastructure), Scientific Commons, QSensei, SemanticScholar, Scirate, DBLP, ResearchBib, Citeseer, e-Library, Scientific Indexing Services, Google Search, AOL, Base Search, CiteSeerX, RefSeek, Semantic Scholar, iseek, InfoBaseIndex, I2OR, Sifactor, Wikicfp, IJIF, JIFactor, Directory of science, World Journals Alert, Endnote, Searchdl, Publons, Orcid, PdfSR, Edocr, BibSonomy, Publication List Researcher ID, Researchbib, SlideshareIssuu, Archive, Scribd, Academia, Mendeley and many more indexing database are available for journals.

Conclusion

The journal impact factor is a measure of journal quality. It is a number that attempts to measure the impact of a journal in terms of its impact on the academic community. The journal citation matrix is constructed by abstracting and indexing the database using their respective datasets. A citation index is a type of bibliographic database, an index of citations between publications, which allows the user to simply set up documents citing previous documents. An abstraction and indexing service is a product that the publisher sells, or provides. These metrics represent a variety of methods for measuring the citation impact of published research at the journal level.

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