Publishing Research Quarterly
https://doi.org/10.1007/s12109-024-09983-3

More Transparency is Needed When Citing h-Indexes, Journal Impact Factors and CiteScores

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Abstract
h-indexes, Journal Impact Factors and CiteScores are often presented as a single numeric value, without providing any context. Under such circumstances, the reader is unable to fully appreciate, or comprehend, the information being presented. By not being transparent, it also presents the opportunity for unscrupulous operators, such as predatory journals, to provide non-sensical information in the hope that the potential author will misinterpret it and submit an article in the expectation that they are submitting to a high-quality journal. Dubious metrics are also able to enter the sector, again in the hope that their metric will be read under an incorrect assumption. Following an overview of the main metrics that are commonly used, this paper suggests how these metrics should be cited. Adopting these proposals would not only provide the reader will full information but also enable bogus measures, which have proliferated in recent years, to be recognized more easily.

Keywords Impact factor · h-index · Citations · Transparency · Research integrity

Introduction

Whether or not you agree with the use of citation metrics, such as Journal Impact Factors, CiteScores and h-indexes, you cannot ignore them. Scholars and/or journals may decide not to engage, but others will still make a judgement based on these

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Published online: 19 March 2024

metrics. You could decide not to participate in the game, but it will continue nonetheless. For example, if you apply for a new job or promotion, the decision-makers may look up your metrics, even if you have not supplied that information on your application, even though one of DORA's[1] primary recommendations is "to eliminate the use of journal-based metrics, such as Journal Impact Factors, in funding, appointment, and promotion considerations." A more detailed discussion on DORA is given in "DORA: Declaration on Research Assessment" section.

The purpose of this paper is not to promote the use of these metrics. However, as they are so widely used, we propose that, when they are used, they are presented in a way that provides more than just a headline numerical value. For example, simply stating an impact factor of 2.89 is meaningless unless the source of the metric is also given, along with other details, including the year and the quartile. Adopting these proposals will provide greater confidence to the reader about the scholar, or journal, which is making claims about the impact of their research articles.

Predatory publishers and their (predatory) journals are often keen to present metrics to give the impression of a quality journal. They often resort to using measures that are not legitimate or try to pass themselves off as being indexed by a reputable metric when this is not the case. If the proposals in this paper are followed, it would make it much more difficult for predatory journals to make unsubstantiated claims and/or cite illegitimate metrics.

This paper focuses on three products—Clarivate's Web of Science, Elsevier's Scopus and Google Scholar; these are the main ones that scholars and journals use when evaluating the quality of their research. If there is ever a move away from these metrics, the proposals in this paper remain valid in that any new metrics that are introduced needs to be transparent in the way the data is presented, and their introduction should come with guidelines as to how they should be used and, as equally as important, how they should be presented.

Related Work

Impact Factors

The idea of impact factors can be traced back to at least 1927. Gross and Gross [12] gauged journals using the number of references, which was used to rank them as a guide for libraries to decide which journals they should buy or subscribe to. Nearly one hundred years later, it is perhaps somewhat surprising that this is still being done [3]. Gross and Gross [12] never used the term *impact factor*, but it was likened to an impact factor in Garfield [6]. Garfield [6] (reproduced in Garfield [8]) proposed a "bibliographic system for science literature that can eliminate the uncritical citation of fraudulent, incomplete, or obsolete data." Garfield drew on the way that book/library catalogues were managed, as well as the legal profession that had, since

[1] DORA (San Francisco Declaration on Research Assessment), https://sfdora.org/read/ (accessed January 11, 2024).

1873, used a tool (Shepard's Citations) that provided citation records for court cases. The early work of Garfield led to him establishing a company called Documation (1956), later renamed to Institute for Scientific Information (ISI) (1960). ISI hosted the Science Citation Index (SCI), which was sold to the Thompson Corporation in 1992 and then acquired by Clarivate in 2016. Garfield [9], Wouters [36] and Pendlebury [26] provide more details of the work of Garfield and later developments. Clarivate also has an history of ISI and the work of Eugence Garfield, including a timeline.[2] In 1963, Garfield and Sher [10] first proposed the idea of a journal impact factor.

In 1975 [36] (or 1976, according to Clarivate), the first Journal Citation Reports were published, which gave journals an impact factor, which is one of the main measures that is used today when gauging the quality of a journal. Garfield [7] likened the impact factor to "nuclear energy" and it being a mixed blessing. He noted that the impact factor is often used interchangeably between journals and authors, which is inappropriate, and he was uncomfortable with them being used as performance indicators, saying that he expected impact factors "to be used constructively while recognizing that in the wrong hands it might be abused."

Others have also warned against journal impact factors as an indicator of quality (see "Research Assessment Initiatives" section). Seglen [29] said that it was unfortunate these measures found use in evaluating individual scholars and research groups. Hoeffel [16] argued that impact factors were not a perfect tool, but there was nothing better, they already existed and that journals with high impact factors generally deserved that recognition. In Callaway [2], Stefano Bertuzzi, Chief Executive of the American Society of Microbiology, is quoted as saying that "We want to make it [journal impact factors] so tacky that people will be embarrassed just to mention it."

In 2016, Elsevier launched the CiteScore index, which mimics Web of Science's Journal Impact Factor (JIF). It produces different results as it uses different time periods and different content. Whether Elsevier, which publishes thousands of journals, should maintain such an index has been questioned [34]. Okagbue and Teixeira da Silva [25] presented an analysis that showed a strong, significant positive correlation between JIFs and CiteScores.

In 2021, Clarivate introduced a new version of its Journal Citation Reports, which now includes Arts and Humanities and an Emerging Sources Citation Index (ESCI) [32].

Gorraiz et al. [11] raised the following question, which is important in the context of this paper: Which version of the Journal Citation Reports (JCR) should be used? They suggested that there were three options: use the Journal Impact Factor from the latest JCR edition, the impact factor from the year the article was published or the mean value of the impact factor.

There are now many other companies providing impact factors. Some are legitimate, some operate in a gray zone, and some are just there to provide legitimacy to predatory journals. The purpose of this paper is not to review the legitimacy, or not,

[2] https://clarivate.com/the-institute-for-scientific-information/history-of-isi/ (accessed: January 11, 2024).

of all these providers, but we briefly mention their existence as our later recommendations apply equally to them as it does to citing JIF, CiteScore and Google Scholar.

In 2013, Jalalian and Mahboobi [19] reported the emergence of fake impact factor companies. In a follow-up article, Jalalian [18] reported that there are as many as 20–30 fake impact factor companies, but the actual number is unknown. Gutierrez et al. [13] provided a list of 21 providers of impact factors of "dubious validity." Dadkhah et al. [4] provided an overview of the "cybercriminals" (as they call them), which provided bogus impact factors.

h-Index

In 2005, Hirsch [15] proposed the h-index, which aims to evaluate an individual researcher. The definition for an h-index is "A scientist has index h if h of his or her N_p papers have at least h citations each and the other $(N_p - h)$ papers have $\leq h$ citations each" [15]. For example, if a researcher has 20 papers that have each been cited 20 times, or more, and all of their other papers have been cited fewer than 20 times, then that researcher has an h-index of 20.

An individual's h-index will be different depending on the platform from which it is calculated. The three platforms in common use are Clarivate's Web of Science, Elsevier's Scopus and Google Scholar. These typically give an increasing h-index (Web of Science the lowest and Google Scholar the highest) due to the number of papers/citations that are captured.

Many papers have focused on the h-index and its development, along with several surveys. As a starting point for the interested reader, we would suggest Schubert and Schubert [28], which provided a literature survey of the h-index between 2005 and 2016. More than 3,000 papers were analyzed. Hu et al. [17] noted the simplicity of the h-index and the potential for abuse in research evaluation, as well as its value being dependent on the database being used. They further noted that different h-index values can be derived even when using the same database. It also addressed the same problem that we address in this paper: that is the importance of how a given value is derived.

Suggested improvements to the h-index have been proposed, some of which have been discussed in the papers mentioned above and in others such as Bi [1], who said that an h-index did not take into account the number of authors on a paper, and Mryglod et al. [24], who warned against using departmental h-indexes to rank universities.

Research Assessment Initiatives

DORA: Declaration on Research Assessment

The San Francisco Declaration on Research Assessment (DORA) seeks "to improve the ways in which the output of scientific research is evaluated by funding agencies, academic institutions, and other parties." The declaration was made after a meeting by a group of editors and publishers at the Annual Meeting of The American

Society for Cell Biology in San Francisco on December 16, 2012. At the time of revision (January 11, 2024), 21,364 individuals and 3,078 organizations had signed the declaration.

A number of themes run through the declaration (these are taken from the DORA website)[3]:

1. The need to eliminate the use of journal-based metrics, such as Journal Impact Factors, in funding, appointment and promotion considerations
2. The need to assess research on its own merits rather than on the basis of the journal in which the research is published
3. The need to capitalize on the opportunities provided by online publication, such as relaxing unnecessary limits on the number of words, figures and references in articles, and exploring new indicators of significance and impact.

DORA, from the perspective of a journal editor, is given by Sinclair [30]. Looking at it through the lens of the UK's research environment, it is supportive of the initiative. Others have also been supportive, encouraging the declaration to be signed [33].

The Leiden Manifesto

The Leiden Manifesto [14] suggested ten principles for the best practice in using metric-based research assessment. The manifesto was made in response to the ways research metrics were used by university-ranking organizations as performance measures and to allocate research funding. Concerns were also expressed about PhD students being told which journals to submit to based on perceived quality.

The ten principles emphasize that qualitative expert assessment has an important role to play, which can be supported by quantitative metrics. This observation also extends to h-indexes. There is also a need for transparency and for the individual being assessed to have the opportunity to verify the data that has been collected. It is also important to account for different disciplines and the need for normalized metrics.

Coalition for Advancing Research Assessment

The Coalition for Advancing Research Assessment (CoARA),[4] a European Union initiative, believes that there is a need to reform research assessment. It has developed an agreement that it is encouraging organizations to sign up to. The agreement has several overarching conditions that include complying with research ethics, safeguarding the freedom of scientific research, respecting the autonomy of research organizations and being clear on how data is collected and used.

[3] https://sfdora.org/ (accessed: January 11, 2024).

[4] https://coara.eu/ (accessed January 11, 2024).

The ten core commitments in the agreement include basing research assessment on qualitative evaluation, supported by quantitative indicators. It commits to abandoning inappropriate uses of journal impact factors and h-indexes.

Resources

In this section, we discuss the three commonly used resources, mention accessibility and comment on illegitimate resources.

Clarivate Web of Science

Journal Citation Reports

Web of Science's Journal Citation Reports (JCR) contains 21,762 journals (as at January 11, 2024). These are split into 21 category groups and each group has a number of categories. Journals can appear in more than one category. For example, the *Journal of the Operational Research Society* (*JORS*) (ISSN: 0160-5682)[5] appears in the Management category and the Operations Research and Management Science category.

As well as categories, Web of Science has *Core Collections*—Science Citation Index Expanded™ (SCIE), Social Sciences Citation Index® (SSCI®), Arts & Humanities Citation Index® (***AHCI***®) and Emerging Sources Citation Index (***ESCI***). Each category belongs to one of these core collections.

Transparency Issues

Researchers are often advised, or say they would like, to publish in Q1 journals. Without any other context, this is likely to mean that they want to publish in journals that are in the first quartile of a Web of Science category.

In 2021 *JORS* had a JIF of 3.051. In one category (see Table 1), *JORS* is ranked (by impact factor) 163 out of the 228, placing it in the third quartile. In another category (see Table 2), it is ranked 36 out of 87, placing it in the second quartile. Web of Science also publishes the JIF percentile, which provides its exact position within the ranking. It is calculated using the following formula $(N-R+0.5)/N$, where $N=$ the number of journals in the category and $R=$ the journal's position in the category. Therefore, the JIF percentile of the two rankings mentioned are 28.73 and 59.20 (for 2021). The JIF percentile may be important as it shows how close (or not) a journal is to a quartile boundary. This is shown in Fig. 1. Your attention is drawn to the SSCI category. This shows that, since 1997, the journal has predominately been in Q3 (25% to 50%), only appearing twice in Q2 (1998 and 2000) and once in Q4 (2003). We note the variance in

[5] We choose this journal as we are familiar with it, but it is widely representative.

Table 1 Web of Science (2021): *Journal of the Operational Research Society*—Management (SSCI)

Year	Impact factor	Journals in category	Position in category	Quartile	Percentile
2021	3.051	228	163	Q3	28.73
2020	2.860	226	155	Q3	31.64
2019	2.175	226	132	Q3	41.81
2018	1.754	217	138	Q3	36.64
2017	1.396	210	144	Q3	31.67
2016	1.077	194	142	Q3	27.06
2015	1.225	192	102	Q3	47.14
2014	0.953	185	116	Q3	37.57
2013	0.911	173	109	Q3	37.28
2012	0.989	174	104	Q3	40.52
2011	0.971	168	97	Q3	42.56
2010	1.102	144	79	Q3	45.49
2009	1.099	112	61	Q3	45.98
2008	0.839	89	64	Q3	28.65
2007	0.784	81	53	Q3	35.19
2006	0.597	79	54	Q3	32.28
2005	0.603	71	51	Q3	28.87
2004	0.515	67	44	Q3	35.07
2003	0.416	67	52	Q4	23.13
2002	0.493	65	45	Q3	31.54
2001	0.438	61	40	Q3	35.25
2000	0.648	60	28	Q2	54.17
1999	0.401	61	37	Q3	40.16
1998	0.552	61	26	Q2	58.20
1997	0.525	59	30	Q3	50.00

its Q3 rankings. In some years, it is close to the Q2 boundary; in other years, it is close to the Q4 boundary. This is why full information is required, rather than simply citing an impact factor and a quartile.

The SCIE category always has a higher ranking (even with the same impact factor). It also features heavily in Q2; and for three years (1997, 1998, 2000), *JORS* was a Q1 journal. This further highlights the importance of providing full information and specifying the category that is most closely related to the research area at hand.

The JIF and category position change over time, as does the number of journals in each category. For example, *JORS*, in the Operations Research & Management Science category, has been in Q2 for the past four years (2018–2021). In 2017, it was ranked in Q3; and prior to this, it moved regularly between Q2 and Q3 and occasionally made it into Q1 (1997, 1998 and 2000). This leads to another question: From which year should you take the JIF, along with the quartile in which it is placed?

Table 2 Web of Science (2021): *Journal of the Operational Research Society*—Operations Research & Management Science (SCIE)

Year	Impact factor	Journals in category	Position in category	Quartile	Percentile
2021	3.051	87	36	Q2	59.20
2020	2.860	84	34	Q2	60.12
2019	2.175	83	34	Q2	59.64
2018	1.754	84	42	Q2	50.60
2017	1.396	84	46	Q3	45.83
2016	1.077	83	56	Q3	33.13
2015	1.225	82	41	Q2	50.61
2014	0.953	81	50	Q3	38.89
2013	0.911	79	49	Q3	38.61
2012	0.989	79	37	Q2	53.80
2011	0.971	77	35	Q2	55.19
2010	1.102	75	30	Q2	60.67
2009	1.099	73	36	Q2	51.37
2008	0.839	64	35	Q3	46.09
2007	0.784	60	26	Q2	57.50
2006	0.597	60	33	Q3	45.83
2005	0.603	56	29	Q3	49.11
2004	0.515	56	31	Q3	45.54
2003	0.416	57	38	Q3	34.21
2002	0.493	54	27	Q2	50.93
2001	0.438	53	23	Q2	57.55
2000	0.648	51	11	Q1	79.41
1999	0.401	50	24	Q2	53.00
1998	0.552	44	7	Q1	85.23
1997	0.525	39	9	Q1	78.21

Most scholars/journals take the latest available impact factor/quartile, but it might be fairer to take the figures from the time the paper was submitted (in the case of a scholar), accepted, published online or when it actually appeared in print. In many ways, it does not matter which figure is used, if a given scholar is consistent, across all their papers, and is transparent.

It is not appropriate to cite JIFs in isolation of any other contextual information. Looking at the Management category (in SSCI; there is another Management category in ESCI), the top-ranked journal, *Academy of Management Annals*, has a JIF of 19.241. Looking at Operations Research & Management Science (in SCIE; the same category is also in ESCI) the top-ranked journal is *Technovation*, which has an impact factor of 11.373. By comparison, in the Oncology category (in SCIE), the highest-ranked journal has an impact factor of 286.130. It is nonsensical to cite an impact factor without also stating the category, the quartile and the percentile, else you cannot compare across categories.

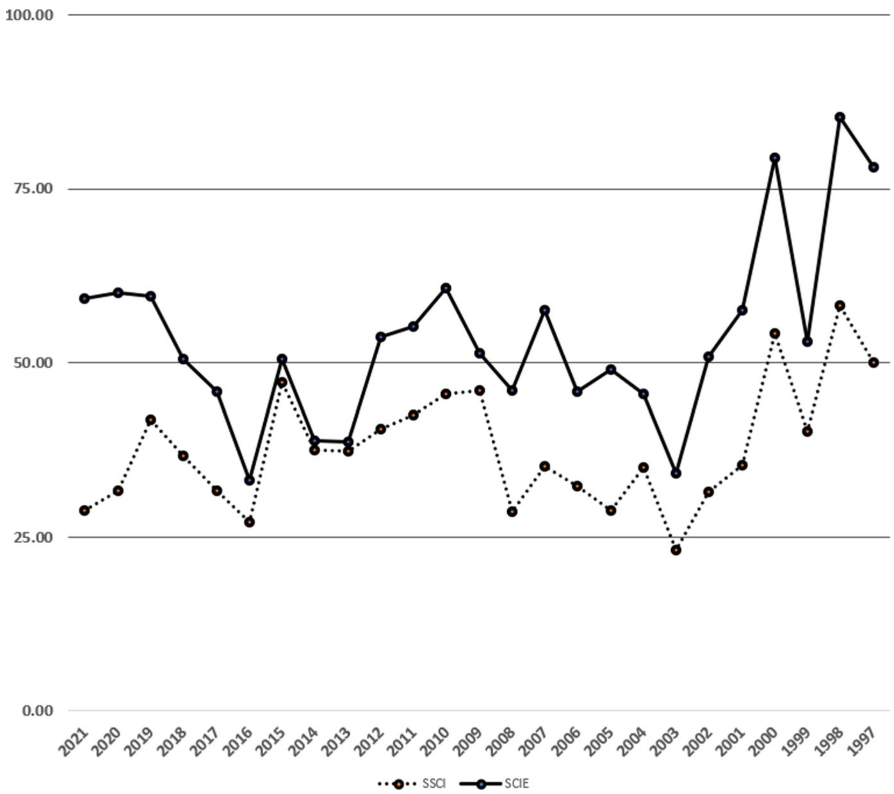

Fig. 1 *Journal of the Operational Research Society*: Web of Science Journal Impact Factor (1997–2021), showing the quartile in which it was placed for its two categories

h-Index

You can get an h-index from Web of Science, although it can be difficult to ensure that you are getting the h-index for the correct set of papers, and it is often necessary to derive the correct search term(s). It is possible to search by "Author ID" using their ResearcherID or ORCID identifier [22], but this does not guarantee that you will find all the papers by that author as the underlying metadata may not be accurate. Finding all the papers for a specific journal is easier.

However, if you locate the full set of papers by a given author/journal, you can produce a citation report that shows the number of publications, the number of citing articles (with and without self-citations), the number of times the paper has been cited (with and without self-citations) and the h-index.

When providing an h-index from Web of Science, it is important that it is done in a transparent way. Our proposal is given in "Citing Journal impact factors, CiteScores and h-indexes" section.

Table 3 Scopus (2021): *Journal of the Operational Research Society*

CiteScore	2021	4.800
CiteScore Tracker	2022	5.400
SNIP	2021	1.322

Elsevier's Scopus

Scopus Coverage

The Scopus database (as at January 11, 2024) has 45,806 entries. Scopus, like Web of Science, splits its content into different categories. The four broad subject areas—Physical sciences, Health sciences, Social Sciences and Life Sciences—are split into a further 27 categories [5].

Scopus Metrics

Scopus provides four main metrics (see Table 3), with the most common being CiteScore, which measures the average number of citations received for a journal. It follows the same methodology (citations/citable items) as that of Web of Science's JIF, with the difference being that CiteScore uses a four-year window and JIF uses a two-year window.

Comparison with Web of Science

If we draw on the same journal as the previous section—*Journal of the Operational Research Society*—the values stored in Scopus (for 2021) are shown in Table 3.

The journal's CiteScore is 4.8, compared to the Web of Science's JIF of 3.051. The difference is due to the different sources that Scopus draws upon, as well as the different time window. The fact that they are different is not an issue. An issue arises if a scholar cites an impact factor of 4.8, without stating where it came from, perhaps giving the impression that it is from Web of Science.

A journal may be placed in more than one Scopus category. Within each category, journals are ranked by their CiteScore and fall into a given quartile, which is referred to as a percentile. Table 4 shows the four categories into which the *Journal of Operational Research Society* appears and their ranking.

Like Web of Science, the journal can appear in different quartiles, depending on the category; therefore, the same misrepresentation is possible if contextual information is not provided.

We also note that during its lifetime, the *Journal of the Operational Research Society* has appeared in six different categories, always appearing in Q1 or Q2 (unlike Web of Science, where it has also appeared in Q3 and Q4). This reinforces

Table 4 Scopus (2021): *Journal of the Operational Research Society*

Journal CiteScore (2021)	4.8
Category	Decision Sciences: Statistics, Probability and Uncertainty
# journals in category:	152
Category position	18
Percentile	88th
Quartile:	Q1
Category	Mathematics: Modeling and Simulation
# journals in category:	303
Category position	65
Percentile	78th
Quartile:	Q1
Category	Business, Management and Accounting: Strategy and Management
# journals in category:	456
Category position	112
Percentile	75th
Quartile:	Q1
Category	Decision Sciences: Management Science and Operations Research
# journals in category:	184
Category position	47
Percentile	74th
Quartile:	Q2

the need to be transparent when citing these metrics. The full CiteScore data, for the *Journal of the Operational Society*, is available in the supplementary file.

h-Index

Similar to Web of Science, you can search for an author's/journal's publications on Scopus. Scopus assigns a unique identifier to each author (as it does for a journal via an ISSN), which can be used as a search term. You are able to search using an ORCID identifier [22], or use a combination of search terms such as an author's name and affiliation. Like Web of Science, caution should be exercised to ensure that you have the correct set of publications before carrying out the citation analysis to calculate the h-index value.

Google Scholar

Google Scholar is a popular bibliographic database that records the papers written by a given author. A Google Scholar page is maintained for registered users (both scholars and journals), largely automatically, although some maintenance is required to maintain its accuracy and integrity. An h-index is automatically calculated and displayed on the Google Scholar home page for a given user.

Table 5 Google Scholar figures for two Chemistry Nobel Prize winners (2021)

	All	Since 2018
Benjamin List 7OSgjtMAAAAJ		
Citations	44,657	11,723
h-index	96	59
i10-index	240	173
David MacMillan 7×48vOkAAAAJ		
Citations	62,729	31,373
h-index	118	86
i10-index	185	172

Google Scholar, as well as a list of articles, provides six key pieces of information. Table 5 shows the Google Scholar figures for two Nobel Prize winners in Chemistry from 2021 (we chose 2021 as this is the same year as we use for Web of Science and Scopus). The table shows the total number of citations (resp. the number of citations since 2018), the h-index (resp. h-index since 2018) and the i10-index (resp. the i10-index since 2018). The i10-index is a Google innovation, which measures the number of articles published by an author that have at least 10 citations.

It is often difficult to find an author on Google Scholar, either because they do not have a profile or their name is the same, or similar, to other authors. Google Scholar uniquely identifies authors/journals using its own identifiers. This identifier can be found in the URL for a given author/journal (the IDs for the two Nobel prize winners are shown in Table 5). The URL for Benjamin List, for example, is https://scholar.google.com/citations?user=7OSgjtMAAAAJ.

Accessibility and Validation

The three sources mentioned above have some challenges around accessing the data. Web of Science is subscription based and provides limited access to its data, but you are unable to access JIFs. Scopus is also subscription based, but you can access CiteScores. Google Scholar does not show the number of publications it uses to calculate the h-index, so we must trust the figures for the h-index and i10-index that are presented.

Even if some of these resources were not behind paywalls, it is still problematic. The statistic(s) will change over time, so the data may (almost certainly will) have changed when the user tries to access the same information. It might be useful if there were easily accessible tools that enabled anybody to access the information, reported by a scholar/journal. This would remove the onus away from the scholar/journal, but this is not practical for a number of reasons. For example:

1. As mentioned above, some of the information is behind a paywall (in the case of Clarivate), so it cannot be freely/easily accessed by third-party products.

2. If tools were developed, they are likely to require an Application Programming Interface (API) to access the data. Google Scholar does not provide an API onto its platform. Indeed, as mentioned above, some of the information is not (reliably) available, even if you scraped the website, for example, how many papers have been published.
3. If such tools were developed, the entity that developed the tools would need to monetize it, if nothing else to support the development/support costs. It is difficult to imagine Elsevier, Clarivate and Google Scholar being supportive of a third party leveraging their data to provide this service, especially if it were a profit-orientated entity.
4. There are other entities that provide legitimate impact factors and h-indexes. It would be difficult to develop a product that encapsulates all the services.

It is not ideal, but the onus must be on the author/journal to provide enough information that an interested reader can validate that information. The only alternative is for the various (legitimate) providers to provide access to the underlying data so that tools could be developed to provide the necessary information. This is unlikely to happen, so the scholar/journal should provide the information necessary to enable us to check its validity more easily.

Illegitimate Sources

One of the reasons why it is important to be transparent in the way that these metrics are presented is to guard against unethical practices. This is not just concerned with authors misrepresenting figures—for example, just citing an h-index with no contextual information—but also to guard against the challenges posed by predatory publishers [20, 21, 23, 31, 35]. Predatory publishers/journals may also derive their own impact factors, or use those quoted by a third party, to persuade authors to submit to their journals.

Web of Science and Scopus provide details of how they calculate their impact factors, although there have been questions raised about reproducibility and external pressures to change the designation of some papers, which would affect the impact factor [27]. Illegitimate journals provide little, if any, details about how their impact factors are calculated. It is not uncommon to provide a figure and hope that the reader assumes that it is either Scopus or Web of Science.

If we were able to make it unacceptable, or at least obvious, when these metrics are not being cited correctly, this should be a warning flag in the fight against predatory publishers. That is, if a journal says that it has an impact factor from Web of Science and/or Scopus, it will be easy to validate this claim. If a journal is promoting an impact factor, but not providing the source, not providing any contextual information and/or not enabling the reader to validate the calculation, this would also be a warning that further due diligence is required.

Citing Journal Impact Factors, CiteScores and h-Indexes

It is important when citing the metrics discussed in this paper to make it clear what source is being used, that contextual information is provided, and that the reader(s) should be able to look up the information provided and be comfortable that it is correct. h-indexes, by their nature, change over time (as do the other metrics, but the history is largely preserved and they do not change as frequently). However, it should still be possible to look up the current h-index and infer from its context whether the h-index value given appears broadly correct.

Overarching Guidelines

The use of the following overarching guidelines is strongly encouraged. These are applicable to journals, publishers, individual researchers or a group of scholars, such as a university, a research institute or a research department.

1. A link should be provided to the source of the metric. This is particularly applicable when the citation is being made on a website, such as a journal's or scholar's home page, as this provides easy access for the reader who wishes to validate the entry.
2. If multiple items are being cited, for example on a CV, you should be consistent in the way you choose to cite metrics. For example, what year do you select for Web of Science's JIF or Scopus' Citescore? Do you always use the current year, the year the paper was submitted, the year it was accepted or some other year? Whichever year you choose, the same year selection criteria should be applied to all entries. We would encourage a statement about any selection criteria to be stated so that the reader is not left in any doubt.
3. If JIFs (or CiteScores) are being cited and are citing this paper in support of the way that you cite these measures, you are accepting that you recognize that impact factors are a measure of the journal and not a measure of the quality of the article and/or the author. It would be an even stronger statement if this was explicitly stated on (say) a CV, or wherever you are citing the metrics.

The following sections provide guidelines when citing from specific service providers.

Web of Science

Journal Impact Factor

If citing a JIF from Web of Science, you should present the following information.

1. The date when the details about the impact factor was accessed.

2. Journal details:

    (a) Journal name: If it is obvious from the context (e.g. below a CV entry), this can be omitted.
    (b) Journal ISSN: The ISSN is important as this can be used to uniquely identify the journal should there be any confusion over the name of the journal. Either the ISSN and/or the E-ISSN can be provided. This can be omitted if it can be inferred by the context (e.g. below a CV entry where there is a DOI link, which leads directly to the paper and, thus, the journal).
    (c) The source: In this case, "Clarivate Web of Science."

3. Journal Impact Factor details:

    (a) The impact factor of the journal: It is assumed that the impact factor is being given with self-citations. If you wish to give the impact without self-citations, this should be stated.
    (b) The year from which the impact factor is taken: If a number of impact factors are being cited at the same time, such as on a CV, when you are referring to the impact factor of a journal for each paper that has been published, the same methodology should be adopted for each entry; for example, the latest year available, the year when a given paper was published, the year a given paper was submitted etc.
    (c) The subject category
    (d) The core collection identifier from which you are quoting
    (e) How many journals are in the category, where the given journal is ranked, its journal impact factor percentile and its quartile: Some of this information may seem superfluous; however, in the interest of full disclosure, it is important to provide as much information as possible and which otherwise cannot be easily inferred.

Here is an example of how this data might be presented for the *Journal of Operational Research*:

- *Journal of the Operational Research Society* (ISSN: 1476-9360): 3.051 (2021): Operations Research & Management Science (SCIE) (163/228: 28.73%: Q3), from Clarivate Web of Science (accessed April 12, 2023).

For the sake of clarity, this information can be read as follows:

1. The name of the journal (*Journal of the Operational Research Society*)
2. The journal's ISSN (1476-9360)
3. The journal's impact Factor (3.051)
4. The year of that impact factor (2021)
5. The JCR category that the journal appears in: in this case, it is the Operations Research & Management Science category. It is noted that the *Journal of the*

Operational Research Society is also in the Management, but this entry states that it is more affiliated with the category as stated.
6. The JCR core collection to which the category is listed in (SCIE)
7. How many journals are in the category (228), the ranking of this journal (163), its percentile ranking (28.73%; see Section "Transparency Issues") and its quartile (Q3).

As mentioned earlier, the category is important, which is why it should be stated. If the Management category had been used, the entry would read (36/87: 59.20%: Q2), which would indicate a Q2 journal, rather than Q3 for the alternative category.

8. The source of this impact factor (Clarivate Web of Science)
9. The date when this data was collected (April 12, 2023).

A minimal entry, as the missing data can be inferred from the context in which the information is provided, could be:

- 3.051 (2021): Operations Research & Management Science (SCIE) (163/228), from Clarivate Web of Science (accessed April 12, 2023).

h-Index

If you are presenting an h-index for an author or journal from Web of Science, you should present the following information:

1. The date the h-index was calculated
2. The source: in this case, "Clarivate Web of Science"
3. The name of the author or journal
4. The search parameters from which the set of papers were derived
5. Once the citation analysis has been carried out, the following information will be available and should be presented:

    (a) The h-index
    (b) The number of articles from which the h-index is calculated
    (c) The number of citing articles
    (d) The number of times the articles were cited.

An example of the way to present an h-index is:

- April 16, 2023: Clarivate Web of Science: Benjamin List: Search term: Author Identifier = A-2121-2014. h-index = 78. Number of Articles = 134: Citing Articles = 13,499: Times Cited = 26,979.

Scopus

CiteScore

The information given for a Scopus CiteScore should be the same as for a Clarivate Web of Science, with minor modifications. We note the modifications here, rather than repeating the list from "Journal Impact Factor" section, as most of the information is the same.

1. The source should be given as "Scopus Elsevier."
2. "(Journal) Impact Factor" should be replaced with "CiteScore."
3. The core collection data can be omitted as Scopus does not have this, but the subject category should still be provided in full; for example, "Decision Sciences: Management Science and Operations Research", not just "Management Science and Operations Research."

As an example, this is how an entry for the Journal of Operational Research might be presented:

- *Journal of the Operational Research Society* (ISSN: 1476-9360): 4.8 (2021): Decision Sciences: Management Science and Operations Research (47/184: 74th percentile: Q2), from Elsevier Scopus (accessed April 12, 2023).

h-Index

If you are presenting an h-index for an author or journal from Scopus, you should present the same information as for Web of Science, but the source should be given as "Elsevier Scopus." The result could be presented as follows:

- April 16, 2023: Elsevier Scopus: Benjamin List: Search term: Searched for "List B" in the author search option. Chose author from the Max Planck Institute for Coal Research (Scopus Author Identifier = 7007013643) from list of authors returned by the search: h-index = 91. Number of articles = 273: Citing articles = 16,753: Times cited = 35,462.

Google Scholar

If you are presenting an h-index for an author or journal from Google Scholar, you should present the following information:

1. The date the h-index was calculated
2. The source: in this case, "Google Scholar"
3. The name of the author or journal

4. The person's/journal's Google Scholar ID
5. Once the Google Scholar home page is displayed, the following information will be available:

    (a) The h-index
    (b) The number of times the articles were cited

An example of the way to present an h-index is:

- April 16, 2023: Google Scholar: Benjamin List: ID = 7OSgjtMAAAAJ. h-index = 96. Times cited = 44,667.

If this information is displayed on a website, there should be a link to the given Google Scholar home page.

Other Sources

As mentioned in "Illegitimate Sources" section, there are many other resources available that provide JIFs. Many of these, such as Dadkhah et al. [4], Gutierrez et al. [13], Jalalian [18], Jalalian and Mahboobi [19], are fake, bogus or spurious (to use words from the article titles).

If it becomes the norm that JIFs and h-indexes are cited in the way proposed in this paper, then it will become apparent when the sources are illegitimate as they will be unable to provide transparent information.

Final Remarks

Journal impact measures and h-indexes are not without their problems, which is unsurprising given that impact factors were first mentioned almost 100 years ago [12], more formally almost 70 years ago [6], and the h-index was first proposed almost 20 years ago by [15]. While undergoing some changes, they are not that different to when they were first proposed,although they are used (and abused) in ways not envisaged at the time they were first proposed.

There have been suggestions as to how these metrics could be changed, developed or even scrapped; however, despite the many suggestions for change, they have been slow in coming. We would like to stress two things:

1. Authors, research groups and journals need to be clearer in the way that they use/cite JIFs and h-indexes. Ways in which this information should be presented have been proposed.
2. If new methodologies are introduced that develop or replace journal impact measures and/or h-indexes, part of their introduction should include how they should be used and cited.

Finally, we would like to think that this paper is a catalyst for change in the way that the scholarly community cites JIFs, CiteScores and h-indexes. We have provided some examples as to how this could be done, but we would encourage authors, universities, research institutes, research groups, libraries, journals, publishers etc. to develop their own guidelines. If these are not followed, then action should be taken that could (for example) be the rejection of a CV for promotion or a job application.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12109-024-09983-3.

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