Assessing the quality of university research – RT factor

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We discuss here the mechanisms to quantify the quality of research output of a university and highlight the pros and cons of evaluating and quantifying research quality. The concerns arising due to indiscriminate use of impact factors for assessing quality of research are pointed out. Nevertheless, the necessity of having metrics for determination of the research quality is acknowledged and we propose a new metric, Research Turnover (RT), which would aid in arriving at an assessment – by the university research administrators to provide incentives; by the academies of science and engineering to award fellowships; and by the funding agencies to award research grants. Typical examples are also elucidated which help in assessing individual researchers and award them accordingly, in consonance with performance-based incentive schemes.

Keywords: Assessment, publications, quantification, research quality, RT factors.

EVALUATING scientific and research quality is still a challenging issue and is bound to create ripples of controversies in the scientific and research fraternity. The Impact Factor (IF) is a measure of the citations to refereed journals in science, humanities and engineering, and is frequently used as a tool to gauge the relative importance of a research journal within its field. Originally devised by the Institute for Scientific Information's (ISI) founder Eugene Garfield, the IFs[1–5] and their derivatives[6–17] are generally believed to be robust quantitative measures of research quality.

However, many examples can be cited and reasons attributed as to why the IFs are not free from misuse and sometimes can be outright egregious[18–25]. There are a number of disturbing facts regarding the blind use of IFs in evaluating research quality; and some of the important concerns that are expressed by the fraternity are:

- The IFs could not be reproduced in an independent audit.
- The identification of the IF as an average is not quite correct. Because many journals publish non-substantive items such as letters or editorials, which are seldom cited.
- Journals dealing with review articles have substantially high IFs and need not necessarily reflect quality research.
- The temporal window for citation is too short. Some classic articles are often cited even decades after their first publication.
- The IF varies considerably among disciplines, thus introducing a bias into the evaluation process when making inter-comparison across disciplines.

Hence, time and again, pleas to use multiple methods to assess the quality of research have been made (see, for example, refs 8 and 13). One school of thought which is gaining many supporters of late, is that the quality of publications can be judged in many ways, *not only, by citations* but also, by using measures of esteem such as invitations, membership on editorial boards, and finally awards which often are the result of measuring quality. In some disciplines and in most countries, grant funding does play a role, and peer review – the judgement of fellow scientists – is an important component of assessment.

The aforementioned parameters constitute only a small sample of the multiple mechanisms in which assessment can be made. There are many other avenues for ascertaining quality assessment, and their relative importance varies among disciplines. In spite of this, 'objective' citation based statistics repeatedly become the preferred method for assessment, as the lure of a 'simple' process and simple numbers (preferably a single number) seems to overcome common sense and good judgement.

Although assessment of the quality of research and researchers has been ongoing for many years, the new premise is that good assessment must be 'simple and objective', and that this can be achieved only by relying primarily on metrics (statistics) derived from citation data rather than a variety of methods, including judgements by scientists themselves[26,27]. Against this background, it is important to realize that citation data provide only a limited and incomplete view of research quality, and the

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statistics derived from citation data are sometimes poorly understood and likely to be misused.

Research is complex in its manifestations and also too important to measure its value with only a single parameter. We need to recognize that assessment must be practical, and for this reason, easily derived citation statistics almost surely will be part of the process.

Though some in the scientific community would argue for dispensing with citation statistics altogether, doing so would necessarily mean discarding a valuable tool. It is therefore argued that citation-based statistics can play a role in the assessment of research, provided they are used judiciously, interpreted with caution, and make up only part of the process.

Citations provide information about journals, papers and people. We should therefore not hide the citation information but should strive to showcase it. Therefore it is suggested that we should not dismiss citation statistics completely as a tool for assessing the quality of research.

Thomson Reuters, a worldwide publisher which has taken over ISI, now indexes about 9000 journals in sciences and engineering, in its *Web of Knowledge* by indexing journals from about 60 countries[28–32]. Therefore, it is suggested that the Thomson Reuters database, whose temporal window for citation is five years, may be chosen as a reference for IFs and citations.

Based on this discussion, a new metric called as Research Turnover (RT) is defined to indicate the research value of the university. RT which may be assessed based on an empirical relation is proposed in this paper by considering the following parameters and criteria.

- Number and quality of publications in peer-reviewed and refereed journals
- Number of patents filed/published in national and international patent offices
- Number of sponsored research projects procured for the university
- Number of consultancy projects completed and revenue generated for the university
- Number of books published
- Number of Ph Ds supervised.

Research turnover – RT factor

The various parameters in arriving at RT are defined as follows.

RT_{pb} is the RT with respect to refereed paper publications. k is the number of authors in a particular publication, or the number of inventors in a particular patent, or the number of project investigators in a sponsored research project, or the number of authors in a book, or the number of research guides for a particular Ph D student. n is the number of journal papers having no IF. n_{if} is the number of journal papers with IFs in Thomson Reuters current database. a represents the journal papers with IFs in Thomson Reuters current database. b represents the journal papers having no IF.

IF_{norm} is the discipline-wise normalized IF of the individual publication. The reference document for arriving at the normalization factor is the current IF database from Thomson Reuters. For each journal's IF, the normalization is done by dividing the IF of the journal with the *maximum value of IF* for the journals in that particular discipline/field. An alternative for determining the normalization factor is to consensually arrive at the list of journals to be considered (instead of all available journals in the database) for fixing the maximum value of the IF to be used for normalization.

RT_{pt} is the research turnover with respect to patents. c represents the patents filed in international patent office; n_c is the number of the same. d represents the patents filed in the Indian patent office; n_d is the number of the same. RT_{sr} is the research turnover with respect to sponsored research projects. e represents the projects within band 1 (say, funding is $>X$); n_e is the number of the same. f represents the project within band 2 (say, $X >$ funding $> Y$); n_f is the number of the same. g represents the project within band 3 (say, $Y >$ funding $> Z$); n_g is the number of the same.

RT_{cp} is the research turnover with respect to consultancy projects. h_1 represents the projects within band I (say, funding is $>K$); n_{h1} is the number of the same. h_2 represents the projects within band II (say, funding is $<K$); n_{h2} is the number of the same. RT_{bk} is the research turnover with respect to books published. l represents the books published with international publisher; n_l is the number of the same. m represents the books published with national publisher; n_m is the number of the same.

RT_{ph} is the research turnover with respect to Ph Ds supervised. p represents the Ph Ds supervised; n_p is the number of the same. α, β and γ are the apportioned weights for different categories.

Based on the above parameters, we define RT in different categories as:

$$RT_{pb} = \left\{ \alpha_{pb} \sum_{i=1}^{n_{if}} \frac{a(i)}{k(i)} + \beta_{pb} \sum_{i=1}^{n} \frac{b(i)}{k(i)} + \gamma_{pb} \sum_{i=1}^{n_{if}} IF_{norm}(i) \right\}, \quad (1)$$

$$RT_{pt} = \left\{ \alpha_{pt} \sum_{i=1}^{n_c} \frac{c(i)}{k(i)} + \beta_{pt} \sum_{i=1}^{n_d} \frac{d(i)}{k(i)} \right\}, \quad (2)$$

$$RT_{sr} = \left\{ \alpha_{sr} \sum_{i=1}^{n_e} \frac{e(i)}{k(i)} + \beta_{sr} \sum_{i=1}^{n_f} \frac{f(i)}{k(i)} + \gamma_{sr} \sum_{i=1}^{n_g} \frac{g(i)}{k(i)} \right\}, \quad (3)$$

$$RT_{cp} = \left\{ \alpha_{cp} \sum_{i=1}^{n_{h1}} \frac{h_1(i)}{k(i)} + \beta_{cp} \sum_{i=1}^{n_{h2}} \frac{h_2(i)}{k(i)} \right\}, \quad (4)$$

$$\mathrm{RT_{bk}} = \left\{ \alpha_{\mathrm{bk}} \sum_{i=1}^{n_l} \frac{l(i)}{k(i)} + \beta_{\mathrm{bk}} \sum_{i=1}^{n_m} \frac{m(i)}{k(i)} \right\}, \quad (5)$$

$$\mathrm{RT_{ph}} = \left\{ \alpha_{\mathrm{ph}} \sum_{i=1}^{n_p} \frac{p(i)}{k(i)} \right\} \quad (6)$$

and, the comprehensive RT as

$$\mathrm{RT} = \mathrm{RT_{pb}} + \mathrm{RT_{pt}} + \mathrm{RT_{sr}} + \mathrm{RT_{cp}} + \mathrm{RT_{bk}} + \mathrm{RT_{ph}}. \quad (7)$$

Equation (1) ensures that due credits are given to the number of publications, publications with IF, publications without any IF and individual or multiple authorship. Higher credits (based on weights allotted) are given to single authors, more number of publications and publications with IFs. Similarly eqs (2)–(6) ensure that higher credit is given to individual accomplishments, international patents, larger sponsored projects and international book publications, in addition to the numbers in the respective categories. The computed RT value (eq. 7) will give a comprehensive metric for determining the quality of research. The higher the RT value, better the research quality. The comprehensive RT metric can be an effective tool for intercomparison of universities, or accreditation by agencies such as National Assessment and Accreditation Council (NAAC) and National Board of Accreditation (NBA).

The weights (α, β and γ) may be modified according to the requirements and priorities of the university or alternatively may also be specified as a national policy guideline by bodies like All India Council for Technical Education (AICTE) or University Grants Commission (UGC). The period of assessment can be based on the academic calendar year, starting from 1 July of the previous year and ending on 30 June of the current calendar year or the regular calendar year (1 January to 31 December) as per administrative convenience and requirements.

Awards based on RT factors – examples

It is suggested that in order to encourage the researchers and provide incentives, the period of assessment may also be monthly. Appropriate awards may be given to individuals as per pre-determined bands (categories) of RT values under each of the different categories discussed at the end of every month. In the following example for research paper publications, we divided the categories for incentives as A, B, C and D. Individuals who secure scores in category A will get maximum incentives and individuals with scores in category D will get minimum incentives. An example with typical weights (α, β and γ) and categories is elucidated here for better appreciation.

Research paper publications

For this example, we take typical weights as $\alpha_{\mathrm{pb}} = 3$ and $\beta_{\mathrm{pb}} = \gamma_{\mathrm{pb}} = 1$.

$$\mathrm{RT_{pb}} = \left\{ 3 \times \sum_{i=1}^{n_{if}} \frac{a(i)}{k(i)} + \sum_{i=1}^{n} \frac{b(i)}{k(i)} + \sum_{i=1}^{n_{if}} \mathrm{IF_{norm}}(i) \right\}$$

Category D: $0.0 < \mathrm{RT_{pb}} < 1.0$
Category C: $1.0 < \mathrm{RT_{pb}} < 2.0$
Category B: $2.0 < \mathrm{RT_{pb}} < 3.0$
Category A: $\mathrm{RT_{pb}} > 3.0$.

Case 1: An individual who publishes a paper in one journal having an IF of 1.5 as a single author has an $\mathrm{RT_{pb}}$ value of (3/1 + 0 + 1.5 = 4.5), whereas another individual who does the same, albeit with a co-author has an $\mathrm{RT_{pb}}$ value of (3/2 + 0 + 1.5 = 3). *Therefore, individuals who publish individually will naturally be more benefited.*

Case 2: An individual who publishes a paper in one journal having an IF of 0.1 with single authorship has an $\mathrm{RT_{pb}}$ value of (3/1 + 0 + 0.1 = 3.1), whereas another individual who does the same, albeit in a journal with no IF has an $\mathrm{RT_{pb}}$ value of (0 + 1 + 0 = 1.0). *Therefore, individuals who publish in good quality journals will naturally be more benefited.*

Case 3: An individual who publishes a paper in one journal having an IF of 0.1 as a solo author has an $\mathrm{RT_{pb}}$ value of (3/1 + 0 + 0.1 = 3.1), whereas another individual who individually publishes three papers in journals with no IF with single authorship has an $\mathrm{RT_{pb}}$ value of (0 + 3/1 + 0 = 3). *Therefore, individuals who publish in good quality journals will naturally be more benefited than individuals who publish in journals of no repute, even if their number of publications is higher.*

Case 4: An individual who publishes a paper in one journal having an IF of 0.1 with multiple (3) authorships has an $\mathrm{RT_{pb}}$ value of (3/3 + 0 + 0.1 = 1.1), whereas another individual who publishes two papers having no IF but with single authorship has an $\mathrm{RT_{pb}}$ value of (0 + 2/1 + 0 = 2). *Therefore, individuals who publish individually will naturally be more benefited.*

Case 5: An individual who publishes a paper in one journal having an IF of 0.1 with single authorship and also publishes a paper in a journal having no IF as a single author and therefore has an $\mathrm{RT_{pb}}$ value of (3/1 + 1/1 + 0.1 = 4.1), whereas another individual who publishes only one paper in a journal having an IF of 0.1 with single authorship has an $\mathrm{RT_{pb}}$ value of (3/1 + 0 + 0.1 = 3.1). *Therefore, individuals who publish more papers will naturally be more benefited.*

Similarly, one can apportion appropriate weights and incentive categories for other RT factors (pertaining to patents, sponsored projects, books and consultancy projects) based on the importance being given to various parameters as shown here.

Research patents

For this example, we take typical weights as $\alpha_{pt} = 5$ and $\beta_{pt} = 3$.

$$\mathrm{RT}_{pt} = \left\{ 5 \times \sum_{i=1}^{n_c} \frac{c(i)}{k(i)} + 3 \times \sum_{i=1}^{n_d} \frac{d(i)}{k(i)} \right\}.$$

Category C: $0 < \mathrm{RT}_{pt} < 3$
Category B: $3 < \mathrm{RT}_{pt} < 5$
Category A: $\mathrm{RT}_{pb} > 5.0$.

Sponsored research projects

For this example, we take typical weights as $\alpha_{sr} = 5$, $\beta_{sr} = 3$ and $\gamma_{sr} = 1$.

$$\mathrm{RT}_{sr} = \left\{ 5 \times \sum_{i=1}^{n_e} \frac{e(i)}{k(i)} + 3 \times \sum_{i=1}^{n_f} \frac{f(i)}{k(i)} + \sum_{i=1}^{n_g} \frac{g(i)}{k(i)} \right\}.$$

Here, e represents the projects with (say, funding > Rs 20 lakhs); n_e is the number of the same. f represents the project with (say, funding between Rs 10 and 20 lakhs); n_f is the number of the same. g represents the project with (say, funding < Rs 10 lakhs); n_g is the number of the same.

Category C: $1 < \mathrm{RT}_{sr} < 3$
Category B: $3 < \mathrm{RT}_{sr} < 5$
Category A: $\mathrm{RT}_{sr} > 5.0$.

Consultancy projects

For this example, we take typical weights as $\alpha_{cp} = 3$ and $\beta_{cp} = 1$.

$$\mathrm{RT}_{cp} = \left\{ 3 \times \sum_{i=1}^{n_{h1}} \frac{h_1(i)}{k(i)} + \sum_{i=1}^{n_{h2}} \frac{h_2(i)}{k(i)} \right\},$$

Category B: $1 < \mathrm{RT}_{cp} < 3$
Category A: $\mathrm{RT}_{cp} > 3$.

Book publications

For this example, we take typical weights as $\alpha_{bk} = 3$ and $\beta_{bk} = 1$.

$$\mathrm{RT}_{bk} = \left\{ 3 \times \sum_{i=1}^{n_l} \frac{l(i)}{k(i)} + \sum_{i=1}^{n_m} \frac{m(i)}{k(i)} \right\}.$$

Category B: $1 < \mathrm{RT}_{bk} < 3$
Category A: $\mathrm{RT}_{bk} > 3$.

Ph D supervision

For this example, we take typical weights as $\alpha_{ph} = 3$.

$$\mathrm{RT}_{bk} = \left\{ 3 \times \sum_{i=1}^{n_{ph}} \frac{p(i)}{k(i)} \right\}.$$

Category B: $1 < \mathrm{RT}_{ph} < 3$
Category A: $\mathrm{RT}_{ph} > 3$.

This example demonstrates that if more persons are involved in one activity, then the credits/incentives will be shared proportionately and the RT value comes down, compared to individual contributions.

Conclusions

A new metric for research turnover called the RT factor is presented, which takes into consideration the number and quality of research publications in refereed journals, books and patents, the number and extent of sponsored research projects and the number and extent of consultancy offered either individually or in collaboration with others. The metric can be a useful tool for research management. It is also envisaged that the proposed metric will be useful for recognizing and awarding talent and in comparing and ranking institutions and individuals based on their research contributions.

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