

RC-index: A New Measure to Quantify Researchers' Contribution

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ABSTRACT

There are many methods (tools) available to identify the research output of a researcher, primarily based on the number of published papers, where they published, their citations, etc. But still no methods are available to determine the contributions of a researcher. This paper proposes *rc*-index of a research paper as well as *RC*-index of a researcher for determining researcher's contribution by balancing percentage contributions of a researcher, impact factor of the journals and the number of citations. Some comparisons are also made with *h*-index and *r*-index.

Keywords: Percentage contribution, Impact factor, Citation, *h*-index, *rc*-index, *RC*-index.

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INTRODUCTION

For evaluation and comparison purposes of different researchers/authors of the same or parallel field (for example - in the process of recruitment, career advancement, project grant allocation, rewards, awards, etc.), there is a need of quantifying researcher's contribution. Many authors (American Society for Cell Biology (ASCB), 2012; Bihari and Tripathi, 2017; Egghe, 2006; Egghe, 2007; García-Pérez, 2012; Hicks *et al.*, 2015; Hirsch, 2005; Jin *et al.*, 2007; Liu and Sun, 2020; Rahul, 2013; Schreiber, 2008; Schubert, 2011; Seglen, 1997) worked in these directions from different viewpoints. Also, many methods (tools) are available for these purposes such as *h*-index, *g*-index, *r*-index, *S*-index, *i10*-index, etc. (Egghe, 2006; Hirsch, 2005; Liu and Sun, 2020; Rahul, 2013).

The advantages and disadvantages of various outputs (like total number of papers, total number of citations, citations per paper, number of significant papers, number of citations to each of the *q* most-cited papers) of a researcher are given in (Hirsch, 2005) with the suggestion of *h*-index, defined as the number of papers with citation number $\geq h$ for characterizing the output of a researcher. But later (Egghe, 2006; Egghe, 2007; Schreiber, 2008; Schubert, 2011) shown some limitations in this index due to information loss and low resolution. To overcome these limitations, several

other indices were proposed (Bihari and Tripathi, 2017; Egghe, 2006; García-Pérez, 2012; Jin *et al.*, 2007).

This paper proposes *rc*-index of a research paper as well as *RC*-index of a researcher for determining contributions of a researcher of the same or parallel field, in general. It is dependent on the researcher's percentage contribution, impact factor (IF) of the journals and total number of citations. This index is a very useful tool for comparison even if two researchers have written the same number of papers, same number of citations and even in same journals. This index can be considered as new beginning for evaluation.

METHODOLOGY

Before proceeding further for defining formula for *rc*-index and *RC*-index, following requirements are necessary.

1. Percentage contributions from all researchers
(This is to be furnished at the time of submission),
2. Citations on each paper,
3. IF of each journal.

Now, *rc*-index of the i^{th} -paper can be determined by the formula

$$(rc)_i = \frac{P_i \times (JIF)_i \times C_i}{100}; 0 < P_i \leq 100, \quad (1)$$

$$\sum \frac{P_i}{100} = 1, \quad (2)$$

Decimal value of the
percentage contributions of
researchers in a paper

whereas *RC*-index of a researcher is determined by the formula

$$RC = \sum_{i=1}^n \frac{P_i \times (JIF)_i \times C_i}{100} \text{ or } RC = \sum_{i=1}^n (rc)_i, \quad (3)$$



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where P_i indicates percentage (%) contributions of a researcher in an i^{th} -paper, $(JIF)_i$ indicates journal impact factor in which i^{th} -paper is published, C_i indicates number of citation of that i^{th} -paper, and the summation extends over all n publications of a researcher.

It should be noted that JIF should be upgraded subsequently in defining the RC-index calculation for its higher value (but not for lower value); that means, suppose at the time of publication, a journal having IF 2.50 and for the next year that journal having IF 2.40, then for calculating RC-index for the next year, JIF should be considered as 2.50 without upgradation with new JIF 2.40. But if for the next year JIF is 2.60, then RC-index can be upgraded with new JIF 2.60. Of course, increase of citations can be upgraded automatically.

RESULTS AND DISCUSSION

Consider the following hypothetical model illustrations.

Example 1 Assuming the situation as shown in Table 1, where five authors (X_1, X_2, X_3, X_4, X_5) worked together for four papers and published all papers in journals having IF with different percentage contributions. Moreover, no authors have more than these four papers.

From Table 1, it is observed that all researchers have the same h -index (4), r -index (508.8), h_1 -index (0.8) and h_m -index (0.8). Thus, looking only to these indices, all researchers are observed to be equally potential and there is no any distinction, but are it true? To filter best out of them RC-index is useful here. As per RC-index, contributions of all researchers (refer Figure 1) are different and researcher X_4 has more contributions than others.

Table 1: Calculation of rc -index, RC -index, h -index, r -index of five authors (X_1, X_2, X_3, X_4, X_5) who worked together for four papers with different percentage contributions.

Papers	IF of a journal	Number of citations	Percentage contributions by each author					rc -index of each paper using formula (1)				
			X_1	X_2	X_3	X_4	X_5	X_1	X_2	X_3	X_4	X_5
Paper 1	0.5	28	10% =0.10	26% =0.26	35% =0.35	14% =0.14	15% =0.15	1.4	3.64	4.9	1.96	2.1
Paper 2	1.8	16	15% =0.15	20% =0.20	18% =0.18	30% =0.30	17% =0.17	4.32	5.76	5.184	8.64	4.896
Paper 3	3.6	35	25% =0.25	16% =0.16	17% =0.17	24% =0.24	18% =0.18	31.5	20.16	21.42	30.24	22.68
Paper 4	5.0	68	20% =0.20	25% =0.25	14% =0.14	25% =0.25	16% =0.16	68	85	47.6	85	54.4
RC-index of each researcher using formula (3)								105.22	114.56	79.104	125.84	84.076
h -index by (Hirsch, 2005)								4	4	4	4	4
r -index by (Rahul, 2013)								508.8	508.8	508.8	508.8	508.8
h_1 -index by (Schreiber, 2008)								0.8	0.8	0.8	0.8	0.8
h_m -index by (Schreiber, 2008)								0.8	0.8	0.8	0.8	0.8

Table 2: Calculation of rc -index, RC -index, h -index, r -index of a researcher (X_6) who published seven papers independently as well as in collaboration with others with different percentage contributions.

Papers	IF of a journal	Number of citations	Percentage contributions	rc -index of each paper
Paper 1	0.5	15	12%=0.12	0.9
Paper 2	1.4	22	14%=0.14	4.312
Paper 3	3.5	30	25%=0.25	26.25
Paper 4	4.0	27	30%=0.30	32.4
Paper 5	2.3	32	100%=1.00	73.6
Paper 6	0.8	5	45%=0.45	1.8
Paper 7	1.9	13	70%=0.70	17.29
RC-index of X_6				156.552
h -index of X_6				6
r -index of X_6				349.6

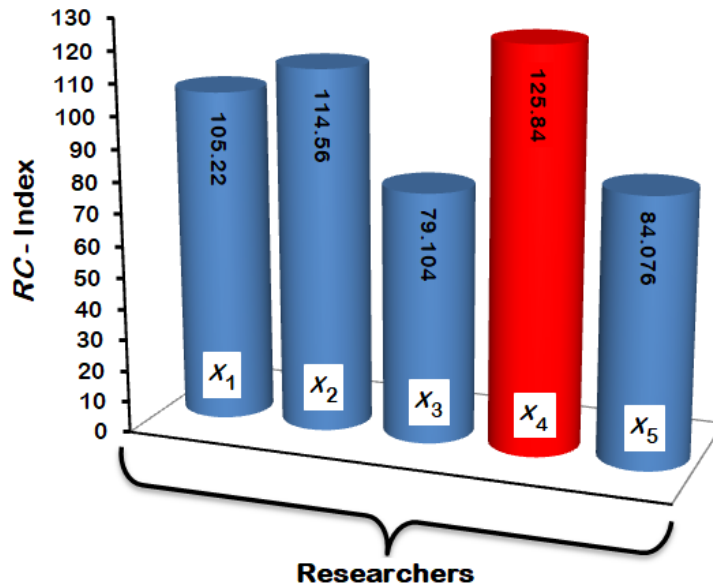


Figure 1: Contributions of researchers (X_1, X_2, X_3, X_4, X_5) with their RC-index.

Table 3: Calculation of *rc*-index, *RC*-index, *h*-index, *r*-index of a researcher (X_7) who published seven papers with the same data as in Table 2 with different JIF.

Papers	IF of a journal	Number of citations	Percentage contributions	<i>rc</i> -index of each paper
Paper 1	0.4	15	12%=0.12	0.72
Paper 2	1.5	22	14%=0.14	4.62
Paper 3	3.0	30	25%=0.25	22.5
Paper 4	5.5	27	30%=0.30	44.55
Paper 5	2.4	32	100%=1.00	76.8
Paper 6	0.7	5	45%=0.45	1.575
Paper 7	2.0	13	70%=0.70	18.2
RC-index of X_7				168.965
<i>h</i> -index of X_7				6
<i>r</i> -index of X_7				380.3

Table 4: Calculation of *rc*-index, *RC*-index, *h*-index, *r*-index of a researcher (X_8) who published seven papers with the same data as in Table 2 with different number of citations.

Papers	IF of a journal	Number of citations	Percentage contributions	<i>rc</i> -index of each paper
Paper 1	0.5	24	12%=0.12	1.44
Paper 2	1.4	20	14%=0.14	3.92
Paper 3	3.5	13	25%=0.25	11.375
Paper 4	4.0	12	30%=0.30	14.4
Paper 5	2.3	6	100%=1.0	13.8
Paper 6	0.8	15	45%=0.45	5.4
Paper 7	1.9	12	70%=0.70	15.96
RC-index of X_8				66.295
<i>h</i> -index of X_8				6
<i>r</i> -index of X_8				168.3

Consider other examples 2-4.

Example 2 Suppose a researcher X_6 has published seven papers independently as well as in collaboration with others, and having situation as shown in Table 2 for the published papers.

Example 3 Suppose a researcher X_7 has published seven papers independently as well as in collaboration with others, and having situation as shown in Table 3 for the published papers.

Example 4 Suppose a researcher X_8 has published seven papers independently as well as in collaboration with others, and having situation as shown in Table 4 for the published papers.

In above examples 2-4,

- (a) Example 3 differ from example 2 by IF of the journals.
- (b) Example 4 differ from example 2 by number of citations.
- (c) Example 4 differs from example 3 by both IF of the journals as well as number of citations.

It is observed from Tables 2-4 that all researchers (X_6 , X_7 , X_8) have the same h -index (6) with different r -index 349.6, 380.3 and 168.3, respectively, as well as different RC -index 156.552, 168.965 and 66.295, respectively. According to situation of r -index and RC -index, researcher X_7 has more contribution than others.

CONCLUSION

A new rc -index of a paper and RC -index of a researcher are proposed (can be considered as new beginning for evaluation) for determining contributions of a researcher of the same or parallel field by balancing all available information such as percentage contributions, IF of journals and number of citations. These indices provide effective insight to evaluators or to judges in the selection procedure for the process of recruitment, career advancement, project grant allocation, rewards, awards, etc. RC -index can also work in the situation when both h -index and r -index are same. The following are some salient features of RC -index.

1. This index balances all available information such as percentage contributions, IF of journals and number of citations to determine researcher's contribution.
2. This index attempts to give nearer to exact view (up to certain extent) about researcher's contribution.
3. Because of this index, researchers are motivated to impart more contributions independently and to send a paper in a journal having IF.
4. The papers which have no citation or JIF are excluded from this index. But once citation and JIF are assigned to

that paper and journal, respectively, this index upgraded automatically.

5. Using this index, same or parallel field of researchers are suggested to compare.
6. For the situation where percentage contributions of researchers are not available, it is suggested to calculate this index by considering equal percentage contributions by all researchers.

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ABBREVIATIONS

ASCB: American Society for Cell Biology; **DORA:** San Francisco Declaration on Research Assessment; **IF:** Impact Factor; **JIF:** Journal Impact Factor; **ORCID:** Open Researcher and Contributor ID; **RC-index:** A new measure proposed to quantify researchers' contribution.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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