

# Improving H-index using RA-index to Measure Researchers Impact, Case Study of Indonesian Researchers

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## Abstract

**Advantages** Advances in the information technology development provide convenience for researchers to read a paper directly after the publication of the manuscript. The number of citations of a paper can be obtained within one to two years after the paper is published. H-index uses the combination of the number of citation and the number of papers published by a researcher to measure his/her papers impact. H-index has some disadvantages, i.e. the H-index did not accommodate the group of the productive and perfectionist researchers. Since the year 2015, the Indonesian Government provided some incentives for Indonesian researchers in order to improve the number of publications. Most researchers profile is characterized by a large number of papers, with a few citations. This paper proposed an improvement to the H-index method to increase the sensitivity of the H-index calculation. The data source of 8,500 Indonesian researchers is from Scopus. The proposed method is based on Jain's Fairness Index and Lotka's Law, which we called the RA-index. This improved the RA-index used the weighting method mechanism based on " percent-contribution-indicated " (PCI) and " Equal 8Contribution (EC) method. Combination of the RA-index and the weighting method of author position is called RA-ma Index. It is expected that the proposed RA-ma index method can provide a positive contribution to measure the impact of Indonesian researchers.

**Keywords:** H-index, RA-index, Weighting Mechanism, Indonesian Researchers

## Introduction

Information technology provides easy access to academic literature sources for researchers. This access helps in finding references for researches and enabling more intensive mutual citation. The increase in the number of papers and the number of paper citation will boost the researcher's H-index value. In Indonesia, decision makers need to evaluate the H-index of Indonesian researcher. Indonesian government will give more research grants for researchers with H-index value of more than 3 in Indonesia. Indonesian Government policies use H-index value to evaluate research grant proposals.

In the past, the performance of a researcher was only measured by Nobel Prize achievement. Other researchers performance cannot be measured. In 2005, Hirsch proposed a H-index to measure the impact on all levels of researchers (Hirsch, 2005). Some advantages of H-index are 1) simple mathematical calculations, 2) can be applied to many things such as the profile of researchers, journal ranks, and ranking of research institutions or universities.

From the literature was found that the weaknesses of H-index, including 1) the productive and perfectionist researcher was not accommodated by the H-index (Mesiar, 2016), 2) self-citation was calculated, 3) the citation weight of the main researcher is considered equal to other researchers, and the frequency of citation in a paper has not been considered (Bai et al., 2018) (Mesiar, 2016) (Gagolewski, 2009) (Zhu, 2015). Many H-index improvement proposals have been made. This includes the proposal of Egghe in 2006, which accommodates the impact value of perfectionist researchers (Egghe, 2006). Bi Hui in 2007 proposed the impact evaluation of researchers based on the year of publication of papers (BiHui, 2007). A new method was proposed by Abramo in 2014 to measure the impact of researchers with a practical economic interpretation called the MNCS and FSS methods (Abramo, 2016). Improvement and new

indicator to measure the impact of researchers was needed for better indicator. Glanzel in 2014, stated that it is important to note the method and model to accommodate the needs (Glanzel, 2016).

This paper is divided into six sections. The next section discusses about methods. The third section presented the methods that will be used. The fourth section explains data source and methodology. The fifth section explains result and discussion. Finally, the conclusion is presented.

### Sinta Index Method

In 2017, the Indonesian Government released a researcher performance indicator named Sinta index, web source <http://sinta2.ristekdikti.go.id/authors> (Antara, 2017). The Sinta Index Calculation Method version 2.0 is used to measure the impact of Indonesian researchers. Data sources are from the the H-index calculation from two sources, i.e. Google Scholar and Scopus. The following is the Sinta Index calculation equation version 2.0 (Lukman et al., 2018):

$$\text{Sinta Index} = ((A * 40) + (B * 15) + (C * 1) C + (D * 4) + (E * 4) + (F * 16)) / \text{Divisor} \quad (1)$$

A: Number of article documents in Scopus

B: Number of non-article documents in Scopus

C: Number of citations on Google Scholar

D: Number of citations on Google Scholar

E: H-index value on Google Scholar

F: H-index value in Scopus

Divisor: 102 (Current divisor value used), 31 Januari 2017

Sinta index was used to measure the impact of Indonesian Researchers. The combination of H-index values of Google Scholar, Scopus, the number of paper in the Scopus and Google Scholar were weighted for each parameter to produce the value of Sinta Score (Lukman et al., 2018).

### Method of Calculating Credit Points in the Regulation of Lecturers' Promotion in Indonesia

The regulation for lecture's promotion for Indonesian researchers/lectures requires researchers to publish papers in reputable journal. The weighting factor for first author is higher than the other authors in the paper. The weighting factor for the first author is 60% of the maximum credit which is 40. The rest of the credit is divided by the number of co-authors (Dikti, 2014). Table 1 shows the maximum credit point for the paper based on the classification by the regulation of Ristekdikti (Dikti, 2014).

**Table 1. Classification of the maximum credit for the paper in the journal (Dikti, 2014).**

No.	Classification of Journals	Maximum Credit Point
1.	Reputable Journal (indexed by database indexes i.e. Web of Science, Scopus, and minimum Q3 in Scimagojr)	40
2.	Indexed Journal (indexed by database indexes i.e. Web of Science, Scopus, Microsoft Academic Search, and has no Impact Factor or Q4 in Scimagojr)	30
3.	Indexed Journal (indexed by database indexer i.e. DOAJ, Ebsco, Proquest)	20

The following is the equation for the calculation of the credit point in Indonesia:

$$\text{First Author Score} = 60\% \times M \quad (2)$$

$$\text{Other Authors Score} = (40\% \times M) / N \quad (3)$$

M = maximum score of assessment (quality of scientific publications based on table 1)

N = Number of other authors

### **Weighting Mechanism using SDC, EQ, FLAE and used Sequence-determining-credit PCI Methods**

Tscharntke in 2007 classified the weighting for each author in a publication text into four weighting methods groups. The four groups are: 1) Sequence-determining-credit (SDC), 2) Equal Contribution (EQ), 3) First-author-emphasis (FLAE) and 4) Percent-contributed-percentage (PCI) (Tscharntke, 2007).

The methods are as follows:

1. Sequence-determine-credit (SDC)  
The weighting method is basen on the model for the first author gets half of the maximum credit. The second author receive 1/3 of the maximum credit, the third author gets 1/4 of the maximum credit, up to ten authors.
2. Equal Contribution (EC)  
Weighting is calculated the same for all authors with a minimum score of 5%. The author's order corresponds to the alphabet.
3. First-last-author-emphasis (FLAE)  
The first author receives the full credit. The second author gets half of the maximum credit and the rest of authors receive the maximum credit divided by the number of authors minus two.
4. Percent-contributed-percentage (PCI)  
The credit distribution mechanism uses a combination of FLAE and EDC. The first author is given 60% of the maximum credit. The second author receives 20% of the maximum credit. The third author gets 10%, while the fourth and fifth author receive each 5% of the maximum credit.

### **The Advantages and Disadvantages of the H-index**

Currently, the H-index method is widely used to measure the impact of researchers (Bar-Ilan, 2008). The H-index method has been widely used by institutions for promotion of staff and distribution of research grant (Bornmann, 2011). Google Scholar, Scopus and Clarivate Analytics (Thomson Reuters) was used to display authors performance by using their H-index. The advantages of the H-index can be applied to many scientific disciplines (Hirsch et.al, 2014) (BiHui, 2007). One of the weakness of the H-index is that its less sensitive in measuring the impact on perfectionist and productive research groups (Mesiar et.al., 2016).

### **Improving the Sensitivity of H-index to Evaluate Indonesian Researchers**

Indonesia is a developing country and in the last few years, the Indonesian government tried to increase the productivity of scientific community based on the databases, i.e. Scopus and Clarivate Analytics. Currently, the number of citations obtained from Indonesian researchers is

still low. Based on Mesiar classification of researchers reference in 2016, Indonesian researchers can be classified as productive researchers (Mesiar et.al., 2016).

The research question is how to improve the sensitivity of H-index to measure Indonesian researchers based on the H-index.

### Data source

1. The source of data used is Scival (Scopus) July 2018. We collected the Scival data of 8,500 researchers from 15 universities, Indonesian Institute of Sciences (LIPI) and Ministry of Health, Indonesia on the top of 500 researchers in their institutions. The data was used to define the characteristic of Indonesian researchers.
2. Data from the Scopus of the top 100 researchers of developed countries such as Argentina, Israel, Spain and the top of 100 Indonesian researchers from the webometrics rank (July 2018). The number of papers, the number of citation and the number of uncited papers of a researcher from the data was used to get the reliability value of the RA-index.

### Research methodology

This research proposes a method to measure the impact of Indonesian researchers by considering the number of uncited papers, and the weighting factor of the author each publication.

We proposed a method called RA-ma index, which is an extended version of the RA-index method, which has been proposed in a previous work, with the addition of a weighting factor mechanisms for author and co-authors in an article.

**Table 2. Data distribution of H-index value of Indonesian Researchers of Top 500 Researchers from 17 Institutions in Indonesia Country (source: Scival July 2018)**

H-index	Number of Authors	Percentage	H-index	Number of Authors	Percentage	H-index	Number of Authors	Percentage
0	1029	12.11%	13	35	0.41%	26	6	0.07%
1	2680	31.53%	14	13	0.15%	28	2	0.02%
2	1729	20.34%	15	17	0.20%	29	2	0.02%
3	1079	12.69%	16	11	0.13%	30	1	0.01%
4	665	7.82%	17	7	0.08%	31	1	0.01%
5	427	5.02%	18	11	0.13%	34	1	0.01%
6	272	3.20%	19	9	0.11%	35	1	0.01%
7	146	1.72%	20	4	0.05%	43	1	0.01%
8	134	1.58%	21	3	0.04%	52	1	0.01%
9	77	0.91%	22	2	0.02%	54	1	0.01%
10	62	0.73%	23	3	0.04%	83	1	0.01%
11	35	0.41%	24	2	0.02%			
12	28	0.33%	25	2	0.02%			

The research methods are as follows:

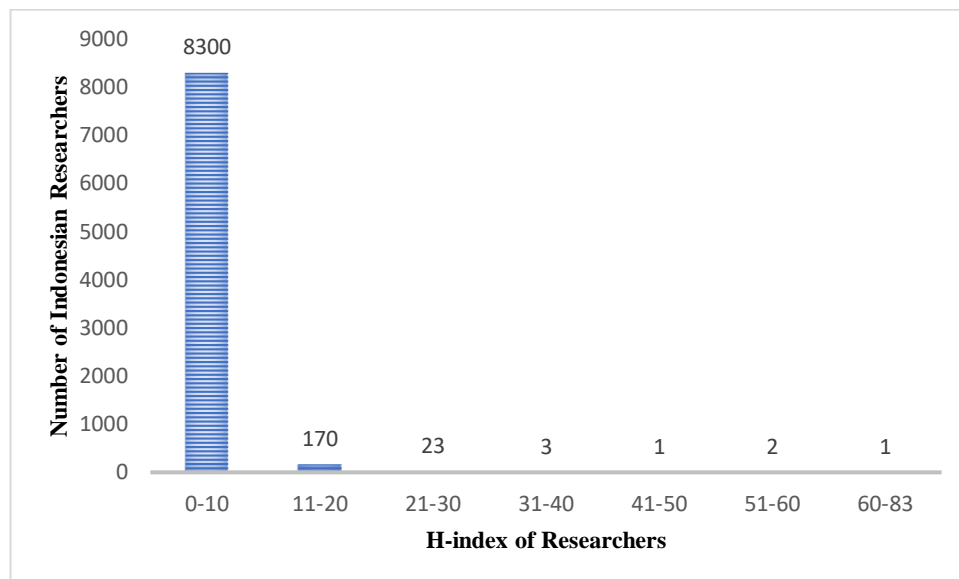
1. Collecting 500 top researchers from each of 17 Indonesia Institutions.
2. Recapitulating and representing data by the quartile table of characteristic of Indonesian researchers.
3. Analyzing data

4. Collecting 100 top cited researchers based on webometrics.
5. Calculating H-index, G-index and RA-index factor.
6. Calculating the correlation between of the number of indexed, cited and uncited papers with the H-index, G-index and RA-index values.
7. Calculating the reliability of the indices.
8. Analyzing the results of calculations.

## Results and discussion

Table 2 shows the H-index values of Indonesian researchers to illustrate the characteristic of the impact of the researchers based on the H-index. Indonesia has the ranked of 52<sup>rd</sup> based on scientific publication in the world version of Scimagojr version (Scimagojr, 2018). This shows the distribution of H-index values from researchers in Indonesia.

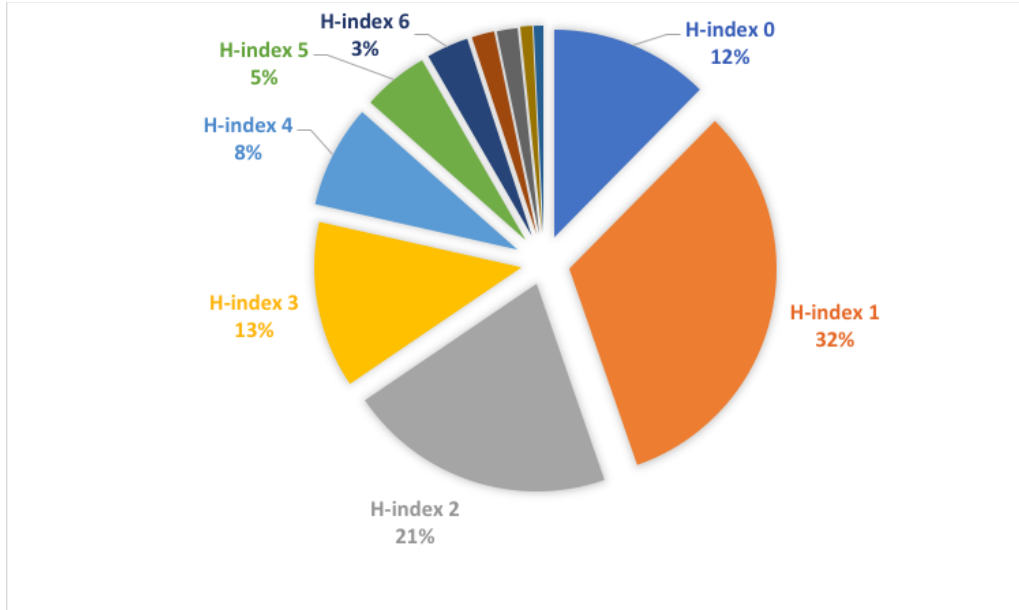
Figure 1 shows the data distribution H-index of the Indonesian researchers. 97.6% of the population have the H-index values in the range of 0 to 10. Figure 2 shows detail of H-index population of the Indonesian researchers.



**Figure 1. Data distribution of Indonesian Researchers with H-index value from 0 until 83.**

Figure 2 shows the distribution H-index of Indonesian researchers. 86% population is in the H-index values from 0 to 4. The highest percentage population of Indonesian researchers is the H-index value of 1. The averages of the publications of the researchers are one publication which have one citation.

We assume that the H-index is less sensitive to distinguish the performance of researchers in the largest population within the H-index range of 0 to 4. The growth of the Indonesian publications just started last two or three years along with the government policy, while the highest average of citation will be obtained in 2 of three years after the papers published (Noorden, 2017). So that, the citation activities of the papers are just begin. Figure 2 shows the representation of the H-index population, which was the result of the government policy two until three years ago.



**Figure 2. Pie Diagram composition of the percentage of Indonesian researchers with scores H-index 0 to 6**

### RA-index

In the previous work, a model for calculating the impact of researchers has been done using the RA-index method. The following is the RA-index equation:

The RA-index is composed of two values:  $index\_RA1$  and  $index\_RA2$ .

$$RA_1 = \sqrt{\sum_{i=1}^n c_i} \quad (4)$$

$$Indeks\_RA_1 = i \leq RA_1 \quad (5)$$

$i$  = number of the sequence of papers from the researcher based on the highest number of citations.

$RA_1$  is the value obtained from the root of the number of citations.

$Indeks\_RA_1$  is the value of  $i$  whose value is lower or equal to  $RA_1$ .

$$Indeks\_RA_2 = \sqrt{((a * (td - ts)) + (a * (td - tts - RA_1)))} \quad (6)$$

with  $td$  = the number of indexed papers,  $ts$  = the number of cited papers,  $tts$  = the number of uncited papers. The parameter  $a$  is the index-RA coefficient with a value of 0.5 as the initial value. These parameters are determined with the assumption that the uncited paper are weighted with half of the weighting value of the value of a cited paper.

A weighting of 0.5 is taken with the assumption of a requirement the appreciation of the number of published papers, even though they have not been cited. The weighting mechanism for the uncited papers is important to be carried out the increasing sensitivity of the researcher impact measurement, especially for the productive researcher group.

$$RA = Indeks\_RA_1 + Indeks\_RA_2 \quad (7)$$

$$RA - index \rightarrow i \leq RA \quad (8)$$

RA values are the sum of the index\_RA1 and index\_RA2 values. So that the value of the RA index is worth  $i$ , where the value  $i$ , is less than or equal to the value of RA.

For requiring the validation, the test method was used to the validity and reliability guarantee. The parameters were used to the tests i.e. the number of indexed, cited, non-cited papers and the RA-index value. Data samples of top 100 researchers from the developed countries and the largest number of researchers in the world also Indonesian researchers (based on webometrics ranking) (F. Aguillo, 2017).

**Table 3. Results of the Reliability-RA Test Method with three parameters.**

Item\Countries	Top World	Argentina	Israel	Meksiko	Portugal	Spain	Indonesia
Number of Indexed Papers	0.63	0.85	0.83	0.67	0.73	0.71	0.95
Number of Cited Papers	0.64	0.87	0.87	0.76	0.80	0.72	0.95
Number of Uncited Papers	0.40	0.44	0.31	0.33	0.31	0.45	0.52

The reliability test used the Pearson Correlation method. Table 3 shows that the parameters i.e. the number of indexed, the number of cited papers, the top world researchers, developed countries and Indonesia have strong correlation from the range of 0.63 to 0.95. However, the parameters of the number of uncited papers have weak correlation with the top world researchers and the developed country of 0.31 to 0.45. While, the number of uncited papers and Indonesian researchers have strong correlation of 0.52. So, it can be concluded that the RA index with additional parameters, uncited papers is valid to use as an alternative measurement for the impact of Indonesian researchers.

The next test is the reliability test of the RA-Index. The testing method uses the Cronbach Alpha method. Table 4 show the test result.

**Table 4. Results of index-RA testing with the Cronbach Alpha method**

Country	Cronbach Alpha Test
Top World	0,84
Argentina	0,88
Israel	0,86
Mexico	0,87
Portugal	0,84
Spain	0,83
Indonesia	0,87

Table 4 shows the results by the reliability test of the RA-index. Table 4 shows that the RA-index has a score of 0.85 by the method, which means the RA-index is reliable to be for measuring the impact of Indonesian researchers. Table 5 shows the standard interpretation of the reliability of the Cronbach Alpha method.

From the tests, it can be concluded that the RA-index method is feasible to be used as an alternative measurement of the impact of Indonesian researchers.

**Table 5. Standard interpretation of Cronbach Alpha Method test results**

<i>Cronbach's Alpha</i>	<b>Reliability</b>
<b>0.0 - 0.20</b>	Less reliable
<b>&gt;0.20 – 0.40</b>	Rather reliable
<b>&gt;0.40 – 0.60</b>	Fair
<b>&gt;0.60 – 0.80</b>	Reliable
<b>&gt;0.80 – 1.00</b>	Very reliable

Nowadays, we investigated some Indonesian researchers do “creating citation circles” activity to increase their H-index values. “Creating citation circle” is an activity that someone who cites the work of his friends, and instead they cite his work in the same way (Witold Kienc, 2015). This is a part of the “black hat” technique. The technique is not accepted or illegal for academics.

In order to prevent the activity of “creating citation circle”, we recommend the weighting mechanism for the citation data. The citation data is weighted before calculated by the RA-index method. This weighting mechanism proposed to give appreciation for the first author and correspondent author. The correspondence author referred is also a supervisor of the author. The proposed method accommodates the regulations of the Indonesia Government of the credit of scientific publications.

The method proposed of the citation data weighting mechanism uses a combination of PCI and EC methods. The calculation of the citation data weighting mechanism are as follows:

For example, one paper has citation 10, with four authors i.e. main author (1), correspondent (1) and other authors (2). So that, the citation calculation obtained by each author is different with proportions are as follows:

The main author and correspondent get maximum citation value of 100% of the number of citations (maximum value) obtained.

$$\text{author's citation value} = ma \times 100 \% \quad (9)$$

*ma* value = the number of total citations of a paper

Others author get a value of 50% of the maximum value divided by the number of other authors.

$$\text{others author's citation value of each} = (ma \times 50\%) / n \quad (10)$$

*n* = total number of the others author

The combination of the PCI and EC methods we called *maximization* or *ma* method for a weighting number of citations of author.

After weighting, is done, the data were calculated by the RA-index method. RA-index method has advantages in an accommodate for upper citation area, lower tail of H-index and uncited



paper. The combination method of the *ma* method and the RA-index method is namely RA<sub>ma</sub>-index method.

The RA-*ma* index method is expected to improve the sensitivity of the H-index for Indonesian Researchers characteristic and prevent the “creating citation circle” activity.

## Conclusion

The calculation of the impact of the researcher using the RA-*ma* index method yields a lower value for the impact of co-author. The RA-*ma* Index gives more appreciation for the first author and correspondent author. The results of the correlation calculation found a strong correlation of 0.52 between the RA-index value and the number of uncited papers. This correlation test is in accordance with characteristic of Indonesian researchers, which have many numbers of paper but have a few numbers of citation. The addition of the weighting method on the number of citation data for each researcher uses the *ma* method to filter the total number of citation of papers, which have many authors and citations from all of authors themselves.

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