



# Actual Researcher Contribution (ARC) Versus the Perceived Contribution to the Scientific Body of Knowledge

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**Abstract.** The aim of this paper is to propose a new quantitative metric that can be used to measure the total actual researcher contribution (ARC) to a body of knowledge. The proposed ARC metric is a fair measure that is needed to address the abuse of research collaboration and issues arising from honorary authorship, which both lead to the inflation of the total number of published articles by a researcher. This inflation can provide misleading information about a researcher's expertise and competence based on their perceived contribution. Research ranking agencies, database indexes, universities, and other decision makers can rely on the ARC metric to rank and evaluate university and researcher contributions to a body of knowledge and thus make more informed decisions and allocate research resources more efficiently.

**Keywords:** Actual researcher contribution · Publishing · Contribution · Metrics · Research collaboration · Honorary author

## 1 Introduction and Background

Writing and publishing academic research papers is one of the key activities that faculty members perform while working in the higher education environment. In fact, publications are one of the key areas considered when evaluating a faculty member's contribution to the scientific body of knowledge. They play an important role in the decision making for the hiring, funding, rewarding, or promoting of a faculty member. Research and publications are an important factor for evaluating an instructor's prestige, promotion, and pay (Borry, Schotsmans and Dierickx 2006 Mitcheson, Collings, and Siebers 2011). Increases in salary are dependent on the quantity and quality of the research papers produced by an instructor (Bergen and Bressler 2017). Furthermore, publishing in peer-reviewed journals is considered as prestigious because it provides proof of academic competence, and it is thus considered a key criterion for the ranking of top research universities and has become one of the main criteria for university accreditation by local and international agencies (Bergen and Bressler 2017). Therefore, it is essential for a faculty member to have many and high-quality publications. This sometimes pressures instructors to concentrate more on research rather than on teaching or other responsibilities (Bergen and Bressler 2017). More importantly, this pressure might encourage the publication of scientifically insignificant papers or raise

issues of gifted, guest, or honorary authorship (Bergen and Bressler 2017; Fong and Wilhite 2017; Kaushik 2013) where faculty members are listed as article authors even when they have not contributed significantly to the research. A critical need to publish research has created authorship abuse. This is evidenced by the many empirical studies that have provided surveys of past co-authors indicating that their names had been included on articles in which they did nothing or made only a minor contribution to the research work (Al-Herz, Haider, Al-Bahhar and Sadeq 2014; Bavdekar 2012; Borry et al. 2006; Seeman and House 2010). For example, Seeman and House (2010) surveyed 600 faculty members in the United States and found that 25% of them discovered their names listed on research papers only after they had already been submitted to a journal. Another survey study conducted by Al-Herz et al. (2014) also showed that 33.4% of 1246 corresponding authors admitted that they had added authors who did not deserve authorship credit. Empirical research has also shown that academic articles with more than five authors are more likely to have “honorary authors” than those with fewer than three authors (Bavdekar 2012). Undoubtedly, honorary authorship is a misrepresentation that leads to the perception of an extensive intellectual contribution that was not actually made by an author, making the publication record a less reliable measure of research productivity (Bergen and Bressler 2017). There are three reasons why honorary authorship should be considered as an unethical practice (Bergen and Bressler 2017):

- A publication credit that is not genuinely earned may falsely represent an individual’s expertise.
- Due to the gift authorship, the credited individual is perceived as being more skilled than colleagues who have not been published or published fewer times. This gives the individual an unfair advantage professionally over their colleagues when applying for jobs or promotion.
- Such individuals are also falsely perceived to have a higher level of competence and may be expected to accomplish tasks that are outside the range of their expertise.

Honorary authorship occurs for many reasons. For example, in some countries, cultural norms cause writers to show respect to department heads, senior researchers, or PhD supervisors or advisors by including their names on papers despite their not being involved. In other cases, scholars will sometimes perceive that adding more guest or honorary authors, especially if they have a reputation in the field, will increase the likelihood of a paper being accepted. Then sometimes, senior faculty members will help junior faculty members achieve tenure by adding their names to research papers (Bergen and Bressler 2017). In other cases, authors might cultivate a mutual relationship where they add an honorary author to their own paper with an agreement that the beneficiary will return the favour on their own paper in the future (Feaser and Simon 2008; Marusic, Bosnjak and Jeroncic 2011). In addition, at some universities, there is a research policy (i.e. cash-per-publication policies) that financially rewards faculty members who publish papers that included the university name. Some guest or honorary authors might abuse these policies by making agreements with friends or colleagues from other universities. If the friends include the guest author’s name on their work, the guest author will share the reward money with them, so it becomes a win-win relationship. In all of the above cases, there is an increase in the number of

faculty member publications without actually making real contribution to the body of knowledge. In fact, research collaboration has increased the number of publications for authors and the number of authors for each paper, which further opens the opportunity for honorary authorship. This leads to the question of what constitutes an author and what is an author's role, which has not yet been standardized across fields and is still unclear for many (Bergen and Bressler 2017; Papatheodorou, Trikalinos and Ioannidis 2008). Nevertheless, various scientific associations have indicated that an author needs to have provided substantial or significant contributions to the conception or design of a study, formulated its problems or hypothesis, analysed and/or interpreted its data, drafted the work, or revised it critically, and they be held accountable for all of the work's accuracy and integrity (International Committee of Medical Journal Editors (ICMJE) 2018; the Council of Science Editors (CSE) 2016; Publication Manual of the American Psychological Association 2001). Those who have only provided funding, general supervision, general administrative support, writing assistance, editing, or proofreading should not be considered as contributing authors but may be given acknowledgment in the article (ICMJE 2018).

Indeed, research collaboration raises the issue of the allocation of credit for scientific work (Ackerman and Brânzei 2014). Two specific problems emerge: first, exploiting the rationale for collaboration by adding guest or honorary authors who make no or trivial contributions to a research paper and this may not be known by the research community, and second, problems caused by the order of author names on a research paper (even for those who have made actual contributions). In this paper, we do not address the problems of research collaboration as there are many, but our focus is on the issue of authorship and the actual contributions and allocation of credit for authors. For example, counting an article as one paper for each co-author is too generous and unfair (Mesnard 2017) when compared to a paper written by only one author. In fact, there is no commonly accepted metric for assessing the actual contribution of an author to a particular article, and the standards for determining the order of author names vary from one field to another (Efthymoulou 2008; Lake 2010). In certain fields, researchers use alphabetical ordering, but this favours those whose last names start with letters that appear earlier in the alphabet. It is also common to assume that the more established authors deserve more credit even though their names appear last in the list (Efthymoulou 2008; Einav and Yariv 2006). Others list the authors' names according to their contribution in descending order where (the sequence determines the contribution) the first/leading author name indicates the author who has made the greatest contribution (Tscharntke et al. 2007). Nevertheless, if the second or last author listed is a well-known scholar, then there might be a perception in the research community that this author should receive more credit than the others despite the fact that others have made greater contributions. Sometimes research collaborators who work on big research project agree to rotate the first author on all resulted research papers regardless of their actual contributions (Ackerman and Brânzei 2014). Hence, the interpretation of author sequence seem like "a lottery" as one does not really know for sure if being the first or last author reflects whether the overall contribution was the most or least important (Tscharntke et al. 2007). As an alternative solution, some journals have a policy that requires authors to declare their contributions in a checklist form (i.e. a contribution statement, for an example, see the Author Contribution Form from the

European Endodontic Journal (2020) at [http://eurendodj.com/author\\_contribution.pdf](http://eurendodj.com/author_contribution.pdf)). However, these contribution statements are sometimes primarily descriptive and very subjective. In this regard, the American Mathematical Society (2004) has indicted that “Determining which person contributed which ideas is often meaningless because the ideas grow from complex discussions among all partners... mathematicians traditionally list authors on joint papers in alphabetical order.” This means that the authors have all made equal contributions, but again, those whose names are listed first will benefit, especially if the paper is written by a large number of authors. Dance (2012) has also pointed out that the credit allocation for collaborative works today is highly subjective, open to abuse, and often determined by the research centre’s politics or seniority rather than by actual effort or contribution. Recent studies (for examples, see Boyer et al. 2017; Mesnard 2017) have proposed metrics or indexes that quantify the actual contribution to each paper or per author, but these proposed metrics have a major limitation in that they depend mainly on data, such as contributions percentages and other variable values, provided by the authors themselves when submitting the paper to a journal, which are unavailable for articles and authors published in the past, so the metrics cannot be universal and generalized to evaluate the actual contributions made by all past authors. Kaushik (2013) also proposed a quantitative metric (formulae that calculates the total contribution per author) that basically gives weight to each paper written by an author depending on the position of the author’s name. For example, more weight (1 point) is given if the author is the first or corresponding author, while half a point is given to the authors who appear later in the list of authors. Although this measure can be used to calculate the total contribution of past and future authors, it is still subjective in assigning weight because it is unknown if the first author is actually the lead author or made the greatest contribution or if the authors’ names are sorted in alphabetically. In this case, the first author will perhaps gain an undeserved 1 point advantage over others. Furthermore, giving more weight to the corresponding author is also questionable. It is unknown to the research community or evaluation committees if the corresponding author really made the greatest contribution. In summary, as we have seen, no previous study has provided a fair generic and objective measure to calculate the total actual contribution made by a researcher, which is what this paper aims to propose.

## 2 Proposed Metric (ARC)

The proposed metric was developed with the following assumptions in mind:

1. There is a logical assumption that when a group of scholars have decided to collaborate on a research project, they understand from the start that each one of them will make a major contribution without which the work will be incomplete and unable or difficult to complete. Thus, the collaboration is seen as teamwork where one cannot claim to have contributed more than others, and it becomes a subjective matter as to which part is the most difficult and important, especially when research tasks are interdependent. For example, in a study, the person who gathers or provides the data might claim that this is the most important element, while another

might claim that analysing the data is the most crucial part. A third person might say that conceptualizing the basis of the paper is the most important element and without it, the paper would be impossible to publish. Therefore, it remains a subjective matter as to which task is the most important. In fact, performing research collaboratively is teamwork, like a football team working together in order to achieve the common goals of scoring and winning that cannot be claimed by only one player. In addition, we cannot always evaluate the exact level of contribution in terms of time and effort for each individual performing the research tasks. For example, a collaborator who is an expert at quantitative data analysis might be perceived to have made great expenditure of time and effort by an inexperienced contributor who has no idea what is required to perform the data analysis. In addition, the arrangements made between the contributors are unknown to the research community. Therefore, it is better to consider of the all contributors as equal. If certain authors have agreed to add honorary authors to their paper, then it should then be their choice and responsibility for reducing their own credit and share of the contribution as their accumulated points will be fewer when more author names are added to the paper. The advantage of this is that the honorary authors will get a percentage share (in any instance, it will be  $\leq 0.5$  assuming at least one honorary co-author name was added to a genuine author name) rather than a 100% authorship contribution for each paper carrying the honorary author name, thus this reduces free rider scores.

2. Most importantly, there is need for a universal generic metric that measures the actual total contribution of an individual author for past and future published research, not only for a particular paper, but collectively. Existing metrics have not developed a standard measure that tells us the total actual contributions per author including past articles. As we have unknown data (except when past authors did declare a contribution percentage) for millions of articles published in the past (in 2009, the estimated total scholarly research articles passed 50 million since the first journal articles appeared in 1665 (Jinha 2010), the fairer measure would be to consider the contribution of the collaborators as equal so that the measure can be applicable for future and past articles. The data showing the amount of input by each collaborator has sometimes been provided by the authors of past articles because of a request by the journal or provided voluntarily, but these are limited cases, and in some other instances, they were descriptive statements not quantitative measurable data.
3. For the reasons mentioned previously regarding the unethical and misleading information on the total number of publications produced by faculty members (perceived contribution through an honorary gift or having a minimal contribution), the number of publications should not be used as an criteria for promotions, hiring, or increases in salary. Rather, using the actual total contribution collectively for all articles would be a fairer measure. Although it might not be completely accurate, it is the best way to reflect actual contributions and minimize free rider scores. It is unfair to consider one paper written by one author the same as one written by two or n authors. Simply put, more credit should be given to a paper by a single author as more time and effort has been allocated than if two or more authors were collaborating. If two collaborate, the contribution share is reduced to half as the effort is

reduced by half. Furthermore, the work of authors who have published 10 papers as the fourth author should not be treated as equal to an author who has published 10 papers as a single author or with one co-author.

The following provides a clear definition for ARC:

**Actual Researcher Contribution (ARC)** is the total of the percentages of the contribution shares accumulated from each published paper that carries an author's name. The percentage share for each paper is calculated based on the assumption that all authors have made an equal contribution for the reasons mentioned above (i.e. teamwork, interdependent research work, need for an objective and not subjective metric, fair and applicable for past and future articles).

**Perceived Contribution (PC)** is the total number of published papers that carry the author's name regardless of the order in which the name appears or the exact level of contribution made by each author, including an honorary contribution.

ARC can be calculated using the following formula:

$$ARC \text{ for Author } X = \sum_{n=1}^T \frac{1}{Pn \# \text{ of Authors}} \quad (1)$$

**P:** Published refereed paper

**T:** Total number of papers that carry the author name

$$ARC \text{ for University } X = \frac{\sum_{n=1}^T ARCn}{\# \text{ of affiliated Authors}} \quad (2)$$

**T:** Total number of published authors affiliated with university X

Sharing credit among co-authors by percentage or by dividing by n ("1/n rule") is fairer, though it may be considered harsh (Mesnard 2017). However, knowing the percentage of one paper does not provide much information unless it is aggregated with the entire author's other publications, which is a new perspective addressed by this paper. The ARC value allows for comparisons between the total contributions of authors and universities.

Let us assume that we have three authors (A, B, C) who have published the number of papers shown in Table 1 and supposing that they have all published good papers with the same level of quality. According to PC, authors A and B are considered as the best as each has published three papers. However, ARC provides the actual contribution made in all papers collectively per author. Given the number of published papers carrying a particular author name and the number of authors who worked on each article, it can be found that authors B and C have made greater contributions than author A. In addition, both of them (B and C) have same level of ARC despite that

author B's name has appeared on three papers, while author C's name has appeared on only two.

$$ARC \text{ for Author A} = \frac{1}{3} + \frac{1}{2} + \frac{1}{3} = 1.16$$

$$ARC \text{ for Author B} = \frac{1}{2} + \frac{1}{2} + \frac{1}{1} = 2$$

$$ARC \text{ for Author C} = \frac{1}{1} + \frac{1}{1} = 2$$

**Table 1.** Calculating ARC

	# of Published papers	PC	# of authors for each paper (P)	Percentage of paper contribution	ARC	Rank as per ARC
Author A	3	3	P1: 3 authors P2: 2 authors P3: 3 authors	0.33 0.50 0.33	1.16	2
Author B	3	3	P1: 2 authors P2: 2 authors P3: 1 author	0.50 0.50 1	2	1
Author C	2	2	P1: 1 author P2: 1 author	1 1	2	1

### 3 Discussion and Implications

ARC reflects the actual aggregated contributions of an author as an alternative to the perceived contributions that focuses on counting the papers that carry the author name, which can be misleading or reflect unfairly on the competency and capability of authors and their contributions to the body of knowledge. Therefore, university administrators and the directors of research institutions should use this metric to make more effective and efficient decisions for allocating research resources and funding and for promotions and salary increases, and do so according to actual contributions made without giving credit to a person that does not deserve it.

We suggest that this metric be used as a standard practice for all journals, where authors should be asked to include the percentage of their contribution on the title page beside their names and affiliations (self-reported percentage). If a group of collaborators who have worked on a research project have decided not to include this percentage, they will by default be considered to have made an equal contribution.

ARC can also be used to calculate the total actual research contributions for each university by aggregating all ARC values for its researchers (past, present, and future), so it can be used for ranking a university's contribution to the body of knowledge. From the above example, if we assume that the three authors are all working at one university, then the ARC for that university will be 5.16 (1.16 + 2 + 2, the sum of the

ARC values for all of the published authors affiliated with the university). However, because the size of the universities (number of researchers/faculty members) is different from one to another (range from tens to thousands), the comparison and ranking becomes unfair (with regards the actual total contribution to the body of knowledge) as a large university might get a higher score than a small school. Therefore, we suggest adjusting that by dividing the value of  $\sum_{n=1}^T \text{ARC}_n$  by the number of affiliated authors (see above formula 2) in order to get the ratio of total actual contributions to the total number of university's authors, which provides a fair measure for rankings and comparisons with other universities. Back to the above example the ARC for the above university (has 3 three authors) should be 1.72 (5.16/3), taking into consideration the size of the university (i.e. only total number of authors not total number of the university's staff).

Adopting this ARC metric will make authors more responsible and accountable when working on a collaborative research project as they will know that adding gift or honorary authors to the paper will decrease their contribution percentage share for that paper, and thus, their ARC score will be lower, which will discourage accepting honorary authors.

Research ranking agencies and databases such as Scopus and Google Scholar can adopt this metric as the required data (i.e. the total number of papers that carry the author's name and the total number of co-authors for each paper) is available, and so it is easy to calculate for the past and future research of an author. This universal standard metric can also be used for comparing faculty member competence. Other measures, such as the total number of published papers or h-index, fail to address the issue of honorary authors, which is unfair. Honorary authorship leads to more publications being attributed to an author and more self-citations that increase when many authors are added to paper, so there will be more chances for manipulating and inflating the h-index value as well. ARC can give more reliable data about researcher productivity than the h-index.

We also suggest using ARC-5, which uses a time window of the previous five years to calculate ARC for authors and universities to avoid concerns regarding unfair comparisons between senior and junior researchers and scientists or newer and older universities. Thus, ARC-5 can inform research communities how active a researcher or university has been in the last five years in regard actual contributions to the literature.

As a limitation of ARC, it does not consider the quality of a paper when calculating the percentage share. For example, assume that author A has published two papers with a second author, and the first paper has been published in a highly ranked journal indexed by Scopus and the second has not yet been indexed or has been published in a low ranked journal. The contribution percentage share (0.50) from the first paper is considered as equivalent to the second paper (0.50). However, the issue of quality can be tackled depending on the database or agency doing the ranking. For example, Scopus might calculate ARC only based on the prestigious journals that are listed in Scopus database. However, this might create inconsistent values if used along with Google Scholar, which might consider any author published paper regardless of journal



rank or quality. In fact, this inconsistency is the same as with the h-index or total citation values, which are also not identical in Google Scholar and Scopus.

## 4 Conclusion

ARC is fair, universal, and standard metric that can be used to measure the actual intellectual contributions made by authors and universities. ARC can be calculated and used for any discipline, at any time, and for both past and new publications without any restrictions. The development of such a metric is very important as existing metrics are either inaccurate, unfair, or impractical and difficult to implement for academic and research universities and ranking agencies. ARC is easy to calculate because it relies on data that is readily available. It is easy to calculate, but it is also a powerful metric that can provide a great deal of information and assist in ranking and comparing between authors and universities to allow the more efficient use of research resources. It also discourages honorary authorship and provides the ability to give fair credit to collaborative authors and universities. In the case of unethical activities through guest or honorary authorships, ARC does not allow these authors to receive more than a percentage of the share of the contribution to a particular paper as it does not provide 100% authorship for each co-authored paper. Thus, it provides a more reliable measure for the total research contribution of a particular author or university.

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