Competence of Altmetrics in Building the Missing Features of Citation Metrics

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Abstract

Research output is multidimensional in nature and the existing bibliometric tools fail to cope up with the growing scope of the research output forms and also have citations as their sole base to evaluate research impact. Citations indicate the usage of a particular research work formally which reflect only the impact among the research community while societal impact is totally ignored. Altmetrics tracks heterogeneous research usages in the online environment which brings impact beyond academia in the picture. Bibliometrics and altmetrics complement each other in creating a more meaningful research evaluation metric. Thus, the missing parts of citations in evaluating research impact like time consuming and few others are expected to be compensated to an extent. With this aim, the paper discusses the limitations of the existing indicators and how altmetrics can be used to fill few gaps. Sample data from PLOS ONE journal was collected on Brain Damage during 2008-09 to prove that article downloads cannot be potentially used for predicting citations. It was also found that citations and altmetrics do not correlate as they measure different research impacts. The paper argues that citation counts highlights the work that was used to create knowledge and altmetrics reflects if the created knowledge was used for the betterment of the society. Therefore, this paper also strongly concludes that altmetrics cannot be used to predict citations and also states that either altmetrics or bibliometrics will remain unsolved puzzle in evaluating research output unless they are combined together as far as the evaluation metrics is concerned.

Keywords: Altmetrics, Research Impact, Research Evaluation, Citation Forecast

1 Introduction

Researches take place all over the world in all subjects. The main objective of research is to create new knowledge for the betterment of the society. Anything created have to be evaluated. Basically any system is not considered to be complete without feedback where feedbacks are used to evaluate the performance. In case of research, to evaluate the research output is to assess how far those research works are useful for the betterment of the society. Society is comprised of academic users and non-academic users. Intuitively it is believed that the (researcher community) academic users' feedbacks are reflected through citations and the existing bibliometrics tools and techniques are based on citations; thus research evaluation is done without considering the feedback of the other users of the society. There are usages that cannot be communicated in the form of citation. According to Beacham et al. (2005), different types of research use are Instrumental, Conceptual and Symbolic (Table 1).

Table 1: Types of Research Usage

Research Use	Characteristic	Result of research use/ research impact
Instrumental	Helps in decision making	Changes in policy &practice in clinical practice
Conceptual	Helps in non-decisional process	Changes the knowledge base
Symbolic	Helps in supporting the decisions made	Supports the decisions in arguments, in educa tional place etc.

Table 1 clearly explains the characteristics of each usage and their ways of impact. Altmetrics is a tool that captures all the activities that takes place around the published research work in online environment. By tracking these, we are able to capture the impacts created outside the formal communication channels of the research community. In 1944, Bernal stated that "Heart of Scholarly communication is visits, personal communication and letters" which clearly represent the concept of invisible college that are tracked by altmetrics. All existing statistically strong metrics to evaluate research output emphasis on tracking formal communication in spite of the importance of the informal communication. This was due to two reasons, i) no sophisticated communication platform for invisible college and ii) lack of technology to track the informal communication channel. Citation is the highest level of engagement with research articles and it was considered as the only way to communicate that a particular research was useful, ignoring the possibility for non – instrumental citations. As mentioned in Thompson Reuters (2008) , Garfield being one of the pioneers in the area commented on the quality of citation count as a measure as "People talk about citation counts being a measure of the 'importance,' or 'impact' of scientific work, but those who are knowledgeable about the subject use these words in a very pragmatic sense: what they really are talking about is utility." The term 'research impact' though widely used and has various definitions, no standard defi-

nition has been framed yet by bibliometricians. Research Impact can be used in synonym with usage as impact is measured based on the usage. Even the formal citations are a measure of usage of an article by a user in a way. Research Councils UK (RCUK) defines research impact as the demonstrable contribution that excellent research makes to society and the economy (http://www.esrc.ac.uk/funding-and-guidance/impact-toolkit/what-how-and-why/what-is-research-impact.aspx).

Research Exercise Framework (REF) defines research impact as an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia. REF's definition covers the impact beyond academia which is tracked by altmetrics unlike bibliometrics. Many studies are in progress to find the relationship between bibliometrics and altmetrics. The concept of altmetrics is in its very early stage and hence it is still a debate if they can be used for measuring research impact. The term 'research impact' has many inter related words like 'reach - influence – use' and there is no clear difference explained so far. Moreover while discussing the term 'impact' we all actually talk about 'usage' because not all research work creates impact in the society except a very few. Impactful research works are those that changes the current trend in the field which can otherwise called the classic works and all the other remaining research works are the effects

of the impact and are being used to develop or criticize or evaluating the new concept created by the impactful. Altmetrics had been criticized by many people, that it reflects neither influence nor use but the reach. In actual, altmetric data has different elements and each element reflects different types of output which can be used somehow for evaluating a research in different approaches. For example, one of the elements may reflect the 'reach' which can be used to evaluate if the research has actually reached the target users and likewise every element has its own potential. These elements are discussed detail later.

2. Exploring Different Levels of Engagements

Altmetric data tracks different types of scholarly activities around the research articles in the online environment. Though these data seem to be useful, there is no standard idea or study to interpret these data into useful information in respect to finding the research influence or impact. Generally we evaluate the quality of any online document based on the number of views. Even in libraries, a book is recommended based on the number of times it had been given to the users. Similarly it is obvious that more views to a document reflect it's quality. In Altmetrics, number of views is a cumulative count of full-text article views that includes HTML views and PDF downloads. Usually the users tend to read the abstract of the articles and then continues to read it only if they find useful information. This cumulative count reflects the usage on the publisher's platform as tracked by WebTrends tagging. This can be used to identify the number of users it reached. This count reflects that users found it relevant to their search but the mere number won't be able to give clear picture if they found it useful and doesn't say anything about if the work influenced their knowl-

edge base. This data has only the viewing count and no information about the users which gives more way for duplication and manipulation. Hence, this data can be used to identify the number of right users it has reached and tell not much about research impact. Unlike number of views, number of times saved by the users in online reference managers like Mendeley also collects data about the users and hence more easy to interpret it. The act of saving an article shows that the research work influences the users' knowledge base. Users may forget to put it to use in the mean course of time but sure it would have made influence on their knowledge base. In other case, the article may not be the core area of the user but may be their area of interest or curiosity. Intuitively, users save articles that influence them and have useful information.

Table 2: Different Levels of Engagements

Activity	Source	Interpretation
Views	Html views	Reach
	Pdf downloads	Influence/usage
Saves	Ref managers	Influence/usage
Discussions	Blogs, News, Comments, Other SNS	Influence/impact/ Quality
Recommend	F1000Prime	
Citations	Scopus, Web of Science, etc.,	Influence/impact/ Quality

Discussions about a particular article in the online environment are like post – peer reviewing. Blogs and comments; tweets; Facebook posts and others main stream Social Networking sites mentions add value to the quality of the article. Naturally recommendations also add value to the quality of the article.

▶▶ **Total views:** Shows the count of the users it reached which of no real use in finding the impact.

♦ **HTML views:** Users may assess the work in this this stage hence this reflects no impact

♦ **PDF views:** Most users save articles that are relevant or useful or that are interesting to them only after they recognize the essence of the work. Perhaps the users might not get back to the article in detail in few exceptional cases yet the work will have its own influence among the users. All the documents not necessarily have to be cited as citation reflects only the research impact. Citation reflects the usage of an article in building new knowledge and there are other uses that cannot be cited that reflects as the societal and service impacts.

▶▶ **Saving:** PDF downloads and saving count both are alike. Saving count in Altmetrics is generated by tracking the saving count of articles in online reference managers like Mendeley, CiteUlike etc. while

the saving of documents offline are tracked by considering the PDF downloads.

▶▶ **Discussing:** More the influence the article creates, more the discussions around that article. More the work is discussed, more the influence it had created. Ranging from tweets to blogs, it comes under discussion. Each and every platform is heterogeneous in nature; among them, Twitter citations for research assessment are also subject to criticism while blogs are more structured with references similar to citations in research article and henceforth blogs are even more reliable as it is less prone to manipulation or gaming. Hadas (2014) in her work also concluded that blogs are a promising altmetric source. Hence discussions around a particular article reflect its influence/impact and to an extent add points to the quality of the article.

▶▶ **Recommendation:** Users recommend articles that cart useful information that are worth reading. recommendations explicitly reflects both the impact and the quality of the article.
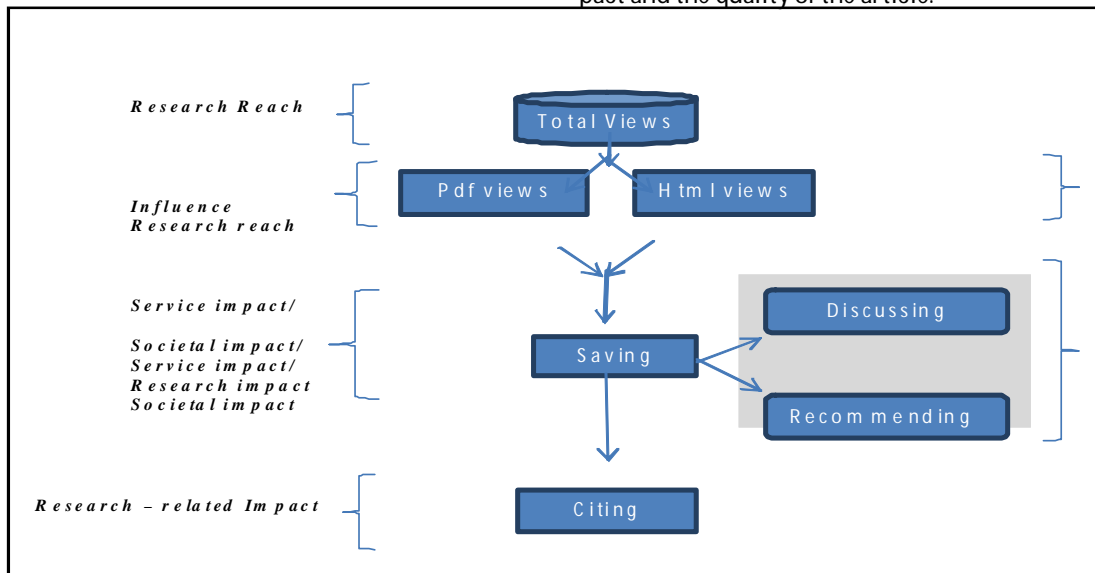

Figure 1: Overview of the Different Engagements with a Document

3. Missing Features of Citation Metrics as Quality Factor

There are different metrics to measure the impact of a research article like citation count, Journal impact factor, h-index, etc. While Journal impact factor is losing its importance these days, citation count is still strongly considered as an important factor for a high impactful article. Undoubtfully, an article with high citation count reflects the quality of the content but there are few other research articles with rich and quality content with lesser citations than expected. This is not due to the less importance of those works rather it is due to various reasons like where the right document is not provided to the right person in the right time etc. Recalling S.R Ranganathan's third law, "Every book its reader", every research work is useful and it gets acknowledged (cited) only if it reach the right user. There may be circumstances where the users are unable to cite or acknowledge it in their work. Citations fail to track the research impact for reasons like,

1.   Only the research community tends to cite articles to communicate its usage/importance.

2.   Not all the researchers in the same subject area will be able to cite it though they find it useful and applied it somewhere. For instance, there may be cases where the researchers will not be able to cite the relevant work due to page limitations and various other reasons where the every researcher would have faced.

3.   Research work in fields like Management studies, Food science technologies, etc., that can be applied more in the real life will be used more by the corporates or companies. These uses cannot be reflected in citations rather altmetric tools can track it.

4.   Authors are forced to publish in international journals due to the influence of impact factor and wrong understanding of creating more visibility via high IF journals. In such cases, the work does not reach the target users for whom the study will be beneficial. Articles like these will neither get cited nor reach the target users and hence remain unnoticed. Citations fail to reflect the significance of such research works.

To eliminate or minimize the barriers a mentioned above, alternative factors beyond citation counts are needed to evaluate research articles. Even after having strong place for bibliographic metrics, there are examples where the research impact was not clearly captured using citation metrics. For instance, according to Scopus "How to choose a good scientific problem" has only been cited 4 times (Alon, 2009), but has been shared on Mendeley nearly 42,000 times as of October 31, 2013. Another recent example is 'Cesium contamination in freshwater fish' published by Nature scientific reports. This is the article with the second top altmetric score of 7412 with 13944 tweets, yet this article has been cited only 4 times in Scopus. The website shows that 99% of the tweets are from Japan public people (the article is focusing on Japan fresh water fishes). Many such examples can be seen in Table 3 where Mendeley shares were found to be high while the Scopus citation was low. Thereby this case shows a vivid picture of bibliometrics indicator failing to track the impact created among the target end users of the research. Altmetric data are heterogeneous and multidimensional in nature which helps in both tracking the research reach and in evaluating the research output. According to Lin and Fenner (2013), the levels of engagement are as follows where 1 is the lowest level of engagement and 5 is the maximum.

1. Viewing: the activity of accessing the article online.

2. Saving: storing and referencing of articles (or references) in online tools such as Mendeley or Citeulike.

3. Discussing: Ranging from tweeting to blogging.

4. Recommending: formal endorsement of a paper, e.g. F1000Prime.

5. Citing: formal citation of an article in another article.

Mode of communication and the platform used varies according to the field of research. Based on that, we can identify if a particular research work has reached the target users and to take necessary steps further if needed. This has also been foretold in a working paper of Scholarly Communication in Africa Programme (Neylon, Willmers, & King ,2014) that "Altmetrics will be possible to proactively identify target audiences, which might be geographical, disciplinary or demographic and to ask whether they are being reached and how distribution might be modified to maximize. The purpose of the research work is fulfilled only when it reaches the target users and they find it useful. Target users of research can be of two types: Academic and Non – academic users. While academic users are the people who mostly acknowledge a research article by citing it in their work, the acknowledgements of the non- academicians like members of the public, Practioners, etc. are visible in the invisible college as they hardly do write scholarly research articles. With the advancement of technology, a sophisticated platform is possible for the invisible college communication. Hence, the research usages where the citation is not necessary or possible are tracked and used for research evaluation. No system can show 100% performance, hence there are few limitations in

altmetrics as it is informal and it can be manipulated. Altmetrics data is available only for years after 2011 which is considerably insufficient data to conclude positive or negative about this altmetrics. Citation itself took nearly 20 years to be accepted by the society and hence this new concept altmetrics will take a few years of refinement to be accepted widely. Few researches have stated that the altmetrics count is low and it has less opportunity to be used while measuring research impact yet there are strong signs that altmetrics have the potential to fill the missing pieces of the research impact (Jean and Euan, 2013).

4. Relationship between Altmetrics and Bibliometrics

Researches take place for the betterment and development of the society. In this case, evaluating a research work based only on the acceptance among the fellow researchers (citations) and ignoring the end users' views or feedback may not show us the whole picture. The major difference between bibliometrics and altmetrics is that the bibliometric tools and techniques tracks and visualize the usage and the impact only among the research community whereas the altmetrics tools give us a wider and important option of tracking the usage and impact among the society or the end user community (whose major communications are informal) Hence, altmetrics when combined with bibliometrics (citations) can be defined as "A potential and meaningful metrics for evaluating research impact based on influences created among both the academia (formal) and societal world (informal)."

Altmetric data are widely considered to be a great but the real problem lies in interpreting it. Debates take place far and wide if altmetrics can be used to predict the future citation or if it can be used as an alternative metrics to the existing metrics. Accord-

ing to an earlier study (Kuruvilla et al., 2006) the research impact falls into four categories such as research – related impact, policy impact, service impact and societal impact. There are various reasons for citing a particular work and citation only reflects the research – related impact. There are no ways to track the other impacts like service impact and societal impact using bibliometrics. Rather altmetrics can be used to track societal impact and service impact. Meanwhile, Altmetric.com (Kwok, 2013) plans soon to start flagging up citations by agencies such as the World Health Organization and the Inter¬governmental Panel on Climate Change,

both based in Geneva, Switzerland which can be an added advantage. To understand the relationship between altmetrics and bibliometrics, an analysis was done by collecting data from PLOS ONE journal. Altmetric and bibliographic data of Articles for 2008 and 2009 on Brain disease were collected and analyzed in Table 3. As interpreted in Table 1, number of saves and number of pdf views (downloads) reflect the influence or impact hence, the count of views, saves and citation were considered. The number of views gives both pdf views and html views. Html views reflect the reach and the pdf views/downloads/saves reflect the influence created.

Table 3: Altmetric data for research articles from PLOS ONE database for the year 2008 – 2009

Sl. No.	Title	Published Date	PDF views (downloads)	Total Citation	Saves	% of Citation
1.	Neonatal Oral Imitation in Patients with Severe Brain Damage	2008	373	1	12	0.25
2.	Spillway-Induced Salmon Head Injury Triggers the Generation of Brain aII-Spectrin Breakdown Product Biomarkers Similar to Mammalian Traumatic Brain Injury	2009	404	3	11	0.72
3.	Variants of ST8SIA1 Are Associated with Risk of Developing Multiple Sclerosis	2008	546	4	7	0.72
4.	Morphological and Glucose Metabolism Abnormalities in Alcoholic Korsakoff's Syndrome: Group Comparisons and Individual Analyses	2009	483	6	12	1.21
5.	Perfusion Imaging in Pusher Syndrome to Investigate the Neural Substrates Involved in Controlling Upright Body Position	2009	1748	7	19	0.4
6.	Dimethylarginine Dimethylaminohydrolase-1 Transgenic Mice Are Not Protected from Ischemic Stroke	2009	468	10	6	2.1
7.	Arterially Perfused Neurosphere-Derived Cells Distribute Outside the Ischemic	2008	692	11	6	1.58

	Core in a Model of Transient Focal Ischemia and Reperfusion In Vitro				
8.	Hippocampal Volume Reduction in Congenital Central Hypoventilation Syndrome	2009	399	11	14	2.66
9.	Diagnostic Accuracy of S100B Urinary Testing at Birth in Full-Term Asphyxiated Newborns to Predict Neonatal Death	2009	902	16	10	1.75
10.	Both Functional LTß Receptor and TNF Receptor 2 Are Required for the Development of Experimental Cerebral Malaria	2008	736	21	1	2.85
11.	Methamphetamine Preconditioning Alters Midbrain Transcriptional Responses to Methamphetamine-Induced Injury in the Rat Striatum	2009	700	21	9	2.96
12.	Impact of Growth Hormone (GH) Deficiency and GH Replacement upon Thymus Function in Adult Patients	2009	794	22	4	2.76
13.	HIV-1 Tat Co-Operates with IFN-? and TNF-a to Increase CXCL10 in Human Astrocytes	2009	836	22	10	2.6
14.	Functional Status of Peripheral Blood T-Cells in Ischemic Stroke Patients	2009	1126	22	12	1.94
15.	Regulation of Adipose Tissue Stromal Cells Behaviors by Endogenic Oct4 Expression Control	2009	1527	23	20	1.48
16.	T Cells' Immunological Synapses Induce Polarization of Brain Astrocytes In Vivo and In Vitro: A Novel Astrocyte Response Mechanism to Cellular Injury	2008	1089	27	23	2.48
17.	Regional Brain Stem Atrophy in Idiopathic Parkinson's Disease Detected by Anatomical MRI	2009	1229	27	23	2.15
18.	Melatonin Promotes Oligodendroglial Maturation of Injured White Matter in Neonatal Rats	2009	865	30	14	3.41
19.	Damage to the Fronto-Polar Cortex Is Associated with Impaired Multitasking	2008	1162	32	77	2.52

20.	Methamphetamine Self-Administration Is Associated with Persistent Biochemical Alterations in Striatal and Cortical Dopaminergic Terminals in the Rat	2009	877	32	14	3.6
21.	Mitochondrial Mislocalization Underlies Aß42-Induced Neuronal Dysfunction in a Drosophila Model of Alzheimer's Disease	2009	1357	39	1	2.87
22.	Seropositivity to Herpes Simplex Virus Antibodies and Risk of Alzheimer's Disease: A Population-Based Cohort Study	2008	1288	41	16	3.14
23.	Microglial Involvement in Neuroplastic Changes Following Focal Brain Ischemia in Rats	2009	1817	46	23	2.5
24.	Delayed Postconditioning Protects against Focal Ischemic Brain Injury in Rats	2008 2009	1489 1559	51 53	14 96	3.39 3.2
25.	Resting Network Plasticity Following Brain Injury					
26.	The Recently Identified P2Y-Like Receptor GPR17 Is a Sensor of Brain Damage and a New Target for Brain Repair	2008	2501	69	30	2.73
27.	Abeta42-Induced Neurodegeneration via an Age-Dependent Autophagic-Lysosomal Injury in Drosophila	2009	2025	70	41	3.38
28.	Uncovering Intrinsic Modular Organization of Spontaneous Brain Activity in Humans	2009	2887	156	188	5.07

5. Discussions

The findings as reported in Table 3 lead to the following discussions It was found that majority of the published online research articles fall in the pattern "TOTAL VIEWS > DOWNLOAD COUNT > CITATION COUNT". It's quite surprising that less than 5% of total document views were found to be cited and hence other usages are yet to be traced. Here the role of altmetrics in culling the citation data from various sources supplement citation metrics to make the data (to be processed) complete. However altmetrics cannot be used to predict citations, as the different levels of engagement with articles reflect heterogeneous impacts. There may be cases where articles that have high citation count will have fewer engagements like sharing or saving etc., and vice – versa. No specific proportional ratio can be found among altmetrics elements that can aid us in predicting citations. Bornmann (2014) in his study found that "Twitter counts and traditional citation counts are not correlated with one another. It seems that the two measure different aspects of research impact. Pertinent evidence was observed on comparison of total citation metrics (bibliometics) with num-

ber of saves (altmetrics). There was a lot of inconsistency observed in terms of numbers. For instance, when the number of saves was found to be higher (12) the citation was merely 1 (Ref. Sl. No. 1 of Table 3). Contrastingly when the number of citations witnessed 39 times, the number of saves was just 1 (Ref. Sl. No. 21 of Table 3). This clearly indicates that saves and citations cannot be equated because of mismatch in the number of times used. However, the combination of citation metrics and altmetrics may bring out a clear picture of research impact. Still there is a long way to make it viable and acceptable widely.

6. The Myth of Predicting Citation using Download Counts

Both altmetrics curve and bibliometric curve have their own growth and obsolescence stage. Altmetric curve starts as soon as an article is published while it takes a minimum of two to three months for the bibliometric curve to begin. To put in other words, altmetrics deals with early stages of engagements with documents whereas bibliometrics deals only with the end stage of the same, therefore altmetrics and bibliometric data can never go closely together. Articles once published will be downloaded by all types of users and slowly the download count will decrease and reach obsolescence. Even though there might not be any particular pattern of document views. Among these all types of users who downloaded the article, not necessarily everyone will cite the paper to communicate the usage of that article (which cannot be tracked specifically). A very few percentage of the users cite and communicate that the particular article was useful in creating new knowledge and then gradually the citation gets accumulated which takes quite a long time due to various reasons. In this scenario, downloads cannot be used to predict citations for a research articles.

Guerrero-Bote and Moya-Anegón (2014) in their recent investigation revealed download counts and the citation counts do not correlate in the early stages of the articles published but strong correlations were found in the seventh year after publications. Whereas one of the major advantages of altmetrics is to evaluate the research impact in lesser period of time, strong correlations found after seven years of publications does not give high hopes towards using download counts for predicting the citations. Even from the data available in Table 3, it is obvious that there is no correlation or a specific pattern between downloads and citation. Hence, article downloads cannot be potentially used for predicting citations.

7. Conclusion

Bibliometric tools and techniques are in use for years. If we care to evaluate the research output in wider view, we need to accept the limitations of citations and start to work on it. A recent press release of John Wiley & Sons (2014) states that the addition of altmetric data to its journal as Altmetric helps authors better understand the impact of their articles. Both altmetrics (informal) and bibliometrics (formal) tracks data from different channels thus reflect different outputs. At times one may lead to other and vice versa. Either of them when considered separately and unaccompanied cannot give a whole picture of the research impact or research influence but will remain an unsolved puzzle with missing parts. With all the above discussed findings this paper concludes that altmetrics and bibliometrics compliments each other and when combined will result in a better meaningful research evaluation metric. Taylor (2013) in his work argued though altmetrics has the potential to be the valuable element in calculating social reach (thus understanding social impact) but it has to undergo numerous steps before

placing this in the same place as bibliometrics. Rather than sticking to traditional metrics, we need to mine deeper with the available new techniques for the betterment of the system. Also altmetrics will help in self-motivation among researchers and indirectly helps in the betterment of research. Like Einstein once said "Everything that can be counted does not count and all that counts cannot be counted." Further investigation on altmetrics to obtain very specific answers on the impact of research (publications and other products of research) is to identify which activities should be counted and which reflects what. It is also important that interpreting altmetric data has to be done cautiously. Altmetrics cannot be put into a meaningful single score that can be used to evaluate the research article as each different level of engagements reflects heterogeneous usage. Altmetrics and bibliometrics when combined together can form a new meaningful research evaluation metrics. To add more weightage to this argument, a work by Taylor (2013) has already initiated the idea of combining these two to form a common metrics.

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