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Research Article

Social Media for Science-Science and Science-Society Connects: Assessing the Readiness in Indian Context through an Analysis of Social Media Visibility of Research Papers

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ABSTRACT
The technological advancements and emergence of new kinds of communication mediums, especially social media and networks, have brought an era of unprecedented connectivity, which can be leveraged for better science communication. This paper explores social media activity around Indian research papers with the objective of evaluating if the quantum of activity is sufficient enough to indicate that social media can be an effective medium of science communication in India. In the absence of any existing survey of social media usage by scientists in India, the paper uses altmetrics as a proxy measure to capture; science communication activities around two major classes, namely, *science-science connect* and *science-society connect*. Results indicate that social media activity around Indian research papers is relatively low as compared to the developed countries and also the world average. There is a higher activity in *science-science connect* (Mendeley) whereas science-society connect is less pronounced (other social media and news). The paper argues that there is a need to expose Indian research community to the opportunities that social media presents and that an appropriate use can be helpful for improved science-science and science-society connects.

Keywords: Indian Science, Science Communication, Science and Society, Scientific Research, Social Media.

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INTRODUCTION

Science is considered to be one of the greatest collective endeavours, that creates new knowledge. Science not only helps in solving the needs of society and improve the quality of our lives, but it also improves our understanding of society. The science-society connect is therefore a very important aspect in the modern world, as also indicated in UNESCO's Science for Society section[1] which states that "*Science must respond to societal needs and global challenges*". The Scientific Social Responsibility Policy Guidelines 2022[2] released in public domain by the Department of Science and Technology (DST), Govt of India, in May 2022, is an important development in this regard. The policy guidelines propose to initiate activities to bridge the three kinds of gaps: "*science-society*", "*science-science*" and "*society-science*".

The "*science-society connects*" deals with "*transferring the benefits of scientific work to meet existing and emerging societal needs*". In other words, it talks about taking the science to the society so that the society can benefit from scientific research and scientific temper can be inculcated in citizens. The "*science-science connect*" refers to "*sharing of ideas and resources within the knowledge ecosystem*". This calls for increased interaction and resource sharing between scientific institutions and knowledge workers so that an optimal usage can be ensured. The "*society-science connect*" refers to "*collaborating with communities to identify problems and develop scientific and technological solutions*". This implies that scientists and researchers should interact more with society in a manner that they can understand the societal problems and needs, and work towards development of useful solutions. The interactions between scientists and society can facilitate two-way flow of facts, knowledge and ideas, which in turn can benefit both science and society.[1-5] The study of Science Communication

[1]https://en.unesco.org/themes/science-society
[2]https://dst.gov.in/sites/default/files/SSR%20

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(SC) underlines that it is an evolutionary process where scientists have the role of communicating their findings with the rest of the world by using different tools to not only disseminate knowledge but also to engage in dialogue and encourage participation of society in knowledge production.

Traditionally, scientists have used journals and magazines to report about various scientific discoveries. These journals and magazines are usually limited in their clientele and circulation. The language and style of reporting in these journals and magazines is also oriented towards a specific readership. Owing to these issues, science journalists have been trying to convey important scientific discoveries to the common public as easy to understand news articles. Though such communication practices continue to operate, the emergence of new social media platforms has brought in new avenues and opportunities for dissemination of science. Different kinds of social media platforms are now being used by researchers, scientists, institutions and science reporters for dissemination of scientific research and advancements. Many scientists are now sharing their new research outcomes/publications on different social media platforms. Institutions are also sharing scientific discoveries made by their labs and researchers in social media. Similarly, science journalists are also using social media platforms for sharing science-based news stories. In addition, many funding agencies and government projects place special importance on the dissemination of the project/program highlights on social media platforms. This has become even more pronounced in the post-COVID-19 World. It is in this context that studies are trying to explore the 'inreach' and 'outreach' potential of social media, and also the 'uptake' of social media by scientists in different countries.

The importance of social media in building research networks and in dissemination is now being underscored in different global surveys of scientists. Previous studies have assessed the prevalence of social media usage among the public and scientists. However, most of these have been conducted in developed countries namely U.S., Switzerland, Finland, and the UK etc. Brossard and Scheufele[6] through their study have shown that 60% of the U.S. public seeking information about specific scientific issues lists the Internet as their primary source of information. Based on this, they suggested that there is urgency for scientists to pay attention to communicating science in the new online world. A survey by Nature of 3000 scientists and engineers in 2014 identified scientist's active engagement with various academic social media platforms namely Research Gate, LinkedIn, Facebook, Twitter and Academia.edu. The study also drew attention to how these platforms have helped to overcome barriers such as geographical location and provided new opportunities for those who do not have access to peer group or resources.[7] Another survey-based study by Pew Research Centre in 2015 involved a survey of 3,748 U.S.-based members of the American Association for the Advancement of Science (AAAS) and found that 47% of them use social media to follow new discoveries and discuss science.[8] Lee and VanDyke[9] pointed out that science organizations continue to use social media largely for one-way communication and that the social media's potential for dialogue and engagement with public is underutilized. Collins, Shiffman and Rock[10] have shown that scientists perceive numerous potential advantages of using social media in the workplace but its usage has yet to be widely adopted. An editorial in Nature Cell Biology[11] noted that scientists are increasingly embracing social media in their professional lives and emphasized that social media engagement can positively influence their day-to-day work and scientific communication. Though, at the moment, social media is found to be more effective for science 'inreach' as compared to 'outreach', however, the popular use of such platforms is also opening up new possibilities for using social media for science 'outreach'. Besley *et al.*[12] in their study on scientists' willingness to engage with public also focused on online engagement through websites, blogs, and/or social networks (e.g., Facebook, Twitter), as a media for communicating science with adults who are not scientists. The research collaboration between countries and its connection with social media visibility has also been studied by recent studies.[13] Thus, the role of social media in facilitating the exchange of knowledge internally within and among scientific communities, as well as externally for outreach to engage the public, is now being recognized and explored.

There are, however, no such surveys or studies done in Indian context. It is not clearly understood how Indian scientists perceive and use social media for science communication/dissemination. How many Indian scientists are using social media platforms and for what kind of scientific communication, is also not clearly known. Therefore, there is a need for a detailed survey on use of social media by Indian scientists to understand the quantum and nature of its usage. In absence of such evidence, to be obtained from appropriate surveys, the paper attempts to explore if altmetric data can throw some light on use of social media for scientific discourse in Indian settings. Bibliometricians and scientometricians, having realized the importance of the science-related transactions in social media, have proposed 'altmetrics' as a new kind of alternative metrics to measure the different kind of impact.[14-16] Unlike the traditional measure of 'citations', the 'altmetrics' is very quick and has higher cascading effect.[17-19] Owing to wider reach of social media, some studies have also tried to explore if altmetrics could be useful for measuring societal impact of research.[20-23]

This study uses altmetrics as a proxy measure for the social media activity around Indian science. Several recent studies[24-26] have shown that while the social media activity around scientific articles are more phenomenal in the developed world, but in a country like India, it is yet to become a norm. For example, Banshal *et al.*[25] found that just about 28.5% of the total research output from India is covered on platforms like Facebook, Twitter,

Research Gate, Academia and Mendeley, which is 18% less than the global average. The paper, therefore, attempts to measure the current level of social media activity around Indian research papers and also compare it with some developed countries. The implications of the observed patterns on science-science and science-society connects are discussed. Finally, the article proposes some possible measures to improve the social media adoption by Indian scientists. The paper, therefore, attempts to measure the current level of social media activity around Indian research papers and also compare it with some developed countries. The implications of the observed patterns on science-science and science-society connects are discussed. Finally, the article proposes some possible measures to improve the social media adoption by Indian scientists.

DATA AND METHODOLOGY

We have taken worldwide scientific research output data for the year 2016 from Web of Science as reference data and tried to identify social media activity around these articles in different social media platforms. The publication records were downloaded in the month of Sep. 2019. The data for the year 2016 was taken for the reasons of stability of bibliometric records and also for availability of longer period (2016 to 2019) for the social media activity to accrue. The publication records comprised of 1,785,149 records with DOI. The social media activity around these articles is obtained from the popular social media aggregator- PlumX. PlumX is a major altmetric aggregator launched in 2016 by Plum Analytics, an Elsevier company. PlumX tracks altmetric activity around scholarly articles, books, book chapters, conference articlesetc. from a very wide variety of social platforms such as Twitter, Facebook, YouTube; online knowledge sharing mediums such as StackExchange, Wikipedia, Github; and bibliographical data-based sites such as Scopus, SciELO, RePEcetc. It organizes the captured data in five different types of metrics- usages, captures, mentions, citations, and social media.[3] PlumX provides end-user interfaces, widgets, and APIs for access of the captured data. We have accessed the PlumX data through a dashboard access updated till Nov. 2019.

Out of the 1,785,149 publication records, a total of 1,661,477 publication records were found covered in PlumX, which constitutes about 93.07% of the total data. For these records, we have obtained the online activity data for Twitter, Facebook, News, Blog and Mendeley platforms. The coverage percentage of the articles as well as average mentions per paper was obtained for data from different platforms. Coverage and average mentions per paper for India and three developed countries-the USA, UK and Germany along with the world average value are shown. The coverage variations across different subject areas were also obtained by grouping the publication into fourteen broad subject

Table 1: Coverage of scientific articles from India, developed countries and the world average in different platforms.

Platform		India	USA	UK	Germany	World Average
Twitter	Total no. of articles	63,959	476,939	126,554	109,225	1,785,149
	Articles covered in Twitter	14,165	211,601	63,758	47,639	600,051
	Coverage (%)	22.13%	44.37%	50.38%	43.63%	33.61%
	Avg. Mentions/ paper	5.868	9.308	13.151	7.497	7.457
Facebook (FB)	Total no. of articles	63,959	476,939	126,554	109,225	1,785,149
	Articles covered in FB	4,735	67,969	21,687	14,638	182,556
	Coverage (%)	7.40%	14.25%	17.14%	13.40%	10.23%
	Avg. Mentions/ paper	50.495	57.197	49.774	44.325	47.571
News Mediums	Total no. of articles	63,959	476,939	126,554	109,225	1,785,149
	Articles covered in News	957	30,438	8,729	5,760	60,901
	Coverage (%)	1.50%	6.38%	6.90%	5.27%	3.41%
	Avg. Mentions/ paper	3.978	4.421	3.949	3.612	3.749
Blog Platforms	Total no. of articles	63,959	476,939	126,554	109,225	1,785,149
	Articles covered in Blog	380	11,289	3,764	1,971	23,052
	Coverage (%)	0.59%	2.37%	2.97%	1.81%	1.29%
	Avg. Mentions/ paper	1.757	1.783	1.852	1.839	1.637
Mendeley	Total no. of articles	63,959	476,939	126,554	109,225	1,785,149
	Articles covered in Mendeley	56,410	420,050	112,160	99,061	1,540,214
	Coverage (%)	88.16%	88.07%	88.63%	90.69%	86.28%
	Avg. Mentions/ paper	28.097	48.089	61.507	49.492	35.079

areas as per the scheme proposed in Rupika *et al.*[27] These fourteen broad subject areas are: Agriculture (AGR), Art and Humanities (AH), Biology (BIO), Chemistry (CHE), Engineering (ENG), Environment Science (ENV), Geology (GEO), Information Sciences (INF), Material Science (MAR), Mathematics (MAT), Medical Science (MED), Multidisciplinary (MUL), Physics (PHY) and Social Science (SS).

ANALYTICAL RESULTS

Social Media Coverage of Articles

First of all, the level of social media coverage of scientific articles from India was computed in five platforms. The coverage levels of India were compared with the USA, UK, Germany and the world average values. Table 1 shows the coverage percentage and average mentions per paper in the five platforms for scientific articles from India and three developed countries. The world average values are also shown. It can be seen that in only 22.13% of Indian scientific papers get coverage in Twitter as compared to 44.37% in the USA, 50.38% in the UK, and 43.63% in Germany. The world average value for Twitter coverage is 33.61%. Thus, in Twitter platform, only about 1/5th of Indian scientific papers gets mentioned, which is even lower than the world average value. Similarly, the average tweet per paper for Indian scientific papers is 5.868, which is lower than the USA, UK, Germany and also the world average. The coverage percentage for Facebook platform also show similar patterns, with coverage of Indian scientific papers being 7.4% as compared to 14.25% in the USA, 17.14% in the UK, 13.40% in Germany and the world average value of 10.23%. However, the average mentions per paper for India is 50.495, which is higher than the world average as well as the UK and Germany. This may be seen in the light of the fact that India accounts for largest number of Facebook users in the world.[4]

In case of News mediums, only 1.50% of Indian scientific research output gets some kind of news coverage as compared to 6.38%

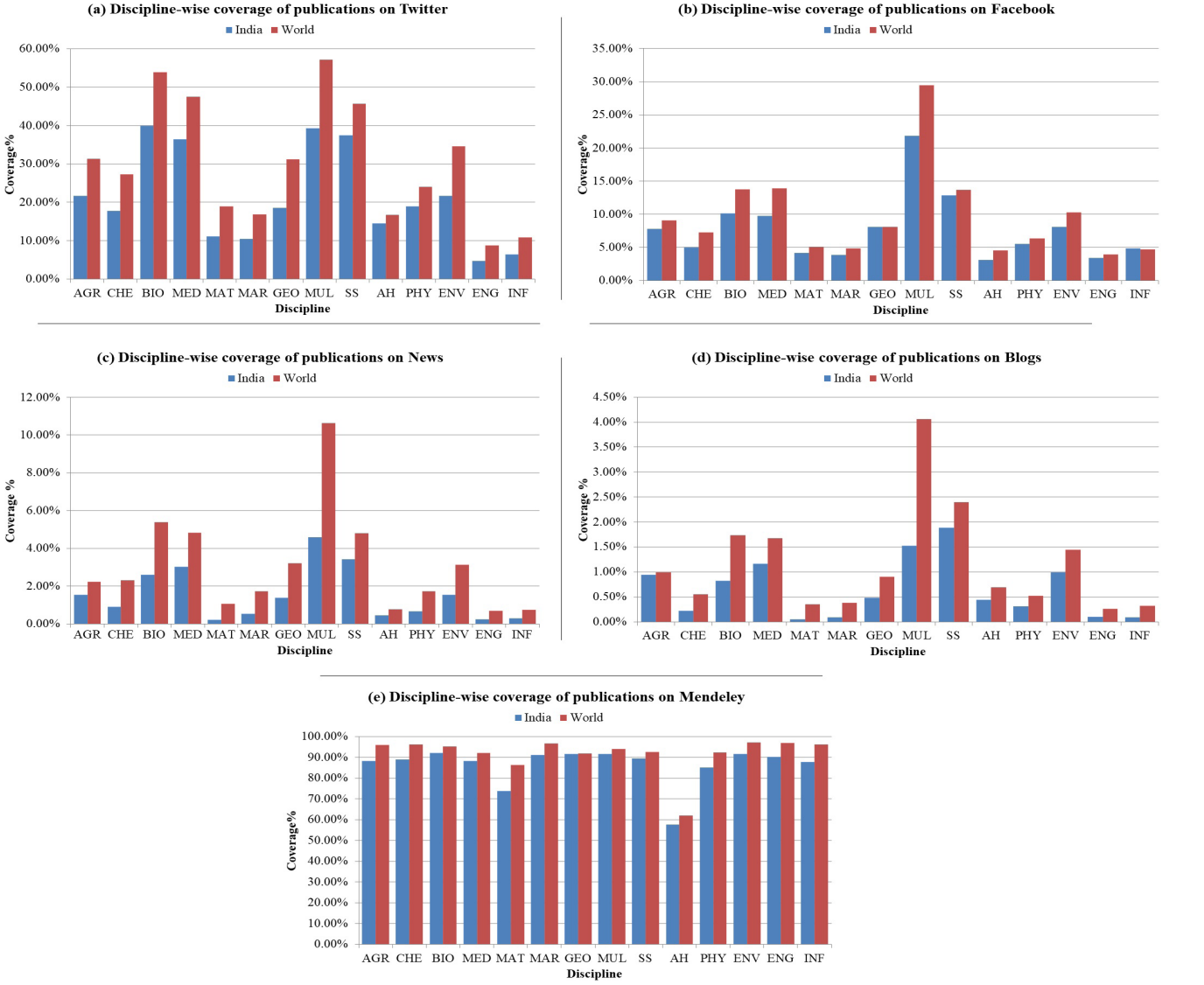

Figure 1: Subject-wise coverage levels of Indian research output and the World average values across different platforms.

in the USA, 6.90% in the UK, 5.27% in Germany and the world average value of 3.41%. However, in terms of average mentions per paper, the value for India (3.978) is above world average (3.749) and comparable to the UK (3.949) and Germany (3.612), lower only than the USA (4.421). In case of Blog platform, only 0.59% of Indian scientific papers get some blog coverage as compared to 2.37% of the USA, 2.97% of the UK, 1.81% of Germany and the world average value of 1.29%. The average blog mentions per paper for Indian scientific papers is, however, comparable to world average (1.637), though lower than the USA (1.783), UK (1.852) and Germany (1.839). In case of Mendeley platform, the coverage level of Indian output is similar to the other countries and also the world average. However, the average mention per paper is lower than the world average (35.079) as well as than the USA (48.089), UK (61.507), and Germany (49.492). Thus, from the values of coverage in different platforms, it is observed that Indian scientific output gets much less coverage than other developed countries as well as the world average (except in case of Mendeley platform). The average mentions per paper for Indian output is also quite low in Twitter and Mendeley as compared to developed countries and the world average values.

Subject-Area wise coverage of social media usage

The second step was to compute the differences in coverage for scientific output in different subject areas. Figure 1 shows the coverage percentage in different platforms for Indian scientific output as well as the world average values for each subject area. It can be observed (Figure 1(a)) that in Twitter, the coverage percentage for research output in all subject areas is less than the world average. Though, there are clearly visible variations in coverage level of research output from different subject areas (MUL, BIO, MED and SS accounting for higher Twitter coverage). In case of Facebook platform, the coverage percentage of Indian output is again lower than the world average for almost all subject areas (except for INF and GEO). Here too, variations are seen in coverage levels across different subject areas (with MUL, BIO, MED and SS having higher coverage than other subject areas). In case of News mediums, the coverage percentage of Indian research output in different subject areas is in general lower than the world average. The differential is higher in MUL, MED and BIO subject areas. Similar patterns of coverage difference are observed in case of Blog platform. In case of Mendeley platform, the differential of coverage percentage between Indian research output and world average is low; though Indian research output has slightly lower coverage percentage than the world average value. The results for coverage of research output from different subject areas thus indicate a significant gap between social media coverage of Indian research output vis-à-vis world average. Though the coverage patterns for different subject areas of Indian research output follow a similar subject differentiation as that of world average, but in almost all the cases, Indian research output gets lower coverage as compared to world average.

DISCUSSION AND CONCLUSION

The article analysed the coverage of Indian scientific research output in social media platforms. Analytical results show that, at present, the social media attention to Indian research output is not very significant, with only less than 1/4th of the Indian research output being mentioned in popular social media platforms like Twitter, Blog, and Facebook etc. These coverage levels are quite low as compared to the level in developed countries (like the USA, UK, Germany) and also lower than the world average value. The average mentions per paper in case of India are also in general lower as compared to developed countries. Analysis of social media coverage of research output for different subject areas also shows similar patterns.

Not only the social media coverage of research papers in developed countries is higher, but several surveys also indicate towards a wider use of social media by scientists in those countries. As clearly highlighted in global surveys, researchers now find social media as significantly useful for building research networks, and also in reaching out to a wider audience. Scientists can not only use social media to communicate and network with peers but also to promote the visibility of their research. In this sense, social media can be seen as having potential to facilitate science-science as well as science-society connects. However, in case of India, the social media activity around Indian research papers is very low, which poses serious challenges in evaluating its effectiveness for science communication and bridging the different connects (science-science and science-society connects). The level of social media activity around Indian research papers can thus be seen as an evidence of the its current usage for science 'inreach' and 'outreach' activities.

It is difficult to discern the factors that may be responsible for low social media activity around research papers in India. As such there are no surveys conducted in case of India to capture the perspective of Indian researchers towards use of social media. One can postulate that Indian researchers are not exposed to the importance of using social media for disseminating their research outputs. One may also like to partially attribute the lower social media coverage of Indian Science to the low Internet penetration. For example, the Digital Statistics 5https://datareportal.com/reports/digital-2021-global-overview-report for the Jan. 2021 shows that only 42% of Indian population has access to Internet as compared to more than 90% penetration in the US and European region and the world average of 59.5%. Similarly, the social media penetration in India is 31% as compared to more than 70% in US and European region and the world average of 53.6%. However, given the pace of growth of the penetration in India (from 14% in

[3]https://plumanalytics.com/learn/about-metrics/, accessed on 10 December, 2019
[4]https://www.statista.com/statistics/268136/top-15-countries-based-on-number-of-facebook-users/

2014 to 42% in 2021) and the large population, one would expect that technology access may not be the primary reason behind lower social media activity around Indian Science. A recent study by Dua *et al.*,[13] shows that the Indian papers published in collaboration with international authors have a higher visibility on social media in comparison to the papers published by Indian authors only. The lack of exposure to effectiveness of such platforms and the reluctance of scientists to use them for disseminating their work appears to be a more profound reason.

The importance of using social media for the different kinds of connects has now been explicitly underscored in the policy in India, as the Scientific Social Responsibility policy categorically suggests for improving the science-science, science-society and society-science connects and to utilize the different resources and tools for the purpose. However, given the current low social media activity around Indian research papers, it appears that a more systematic effort would be needed to motivate scientists and institutions to share their scientific outcomes in social media platforms. Institutional mechanisms and incentive structures may be created to promote sharing of scientific advancements in social media platforms so that they can reach to masses. For example, institutions may be encouraged to maintain social media pages and handles and to regularly share all their research outputs in different social media platforms. In addition, the scientific communication shared on social media platforms should be in a simple, easy to understand language so as to be easily understood by the common people. Social media no doubt has the potential to act as a cost-effective medium of wider science communication in India provided necessary steps are taken in this regard. In addition, caution must be exercised as social media may be manipulated to create misleading impressions.[28] As the Internet and social media penetration in India improves further, social media platforms are expected to become much more effective in this purpose.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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