DESIDOC Journal of Library & Information Technology, Vol. 44, No. 5, September 2024, pp.307-313, DOI : 10.14429/djlit.44.05.19841

A Meta-Analysis on the Correlation Between Traditional Metric Indicators and X Metrics of Library and Information Science Articles

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ABSTRACT

Many researchers have examined citation-altmetric associations producing a wide range of observations. The negative and positive associations between these two metrics at various correlation levels create controversy in considering these metrics as replacements or complements for the research impact measurement. Very few studies tried to clarify this controversy by venturing into systematic analysis. Thus, the present study aims to find a solution by using meta-analysis to measure the Pooled Correlation Coefficient (PCOR) between the classic metric indicators and X metrics. Eligible articles for the analysis were chosen through Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines. Majorly Dimesions.ai, ResearchGate, Scopus and Google Scholar databases were searched and 10 articles were found eligible and selected for the analysis. The investigated articles showed positive and negative correlations between classic and X metrics ranging from -0.04 to 0.68. These articles were subjected to meta-analysis using the Random Effect Model (REM). The study found that the articles' PCOR was positive and measured at 0.18. Thus, the X metric complements the classic metrics for the quick Library and Information Science (LIS) research impact measurement.

Keywords: Traditional metrics; X metrics; Twitter; Twitter metrics; Altmetrics; Pooled correlation

1. INTRODUCTION

X, formerly and popularly "Twitter" ('X' and 'Twitter' are used interchangeably throughout the paper) is a powerful instrument for spreading comments, news and opinions across the globe[1]. Research has shown the wider usage of this microblogging platform by the faculties, researchers and scientists for scholarly communication[2-3]. They primarily use X to stay updated in their respective fields and disseminate their research works[4-5]. The quick dissemination of the scientific outputs through the X platform helps to measure their instantaneous impact by counting the number of Twitter activities[6]. According to a prior study, tweets within the first three days following an article's release can predict highly referenced publications[7]. Thus, tweets and retweets to scholarly outputs have been considered social impact measures and early indicators of citations[8].

Twitter has become a major altmetrics data source for scholarly output and many previous studies have reported its coverage and accumulation velocity of the tweetations to publications[9]. Since citation takes time to accrue, X metrics can be used as complementary metrics for assessing the societal influence of the investigation owing to the positive association between these two metrics as reported by various studies from different disciplines[10-12].

Received : 18 January 2024, Revised : 14 May 2024
Accepted : 21 May 2024, Online published : 24 September 2024

Limited information about the relationship between X metrics and traditional citation indicators is available regarding the LIS domain. Prior research revealed a favourable correlation between these two metrics at various correlation coefficient levels[13-14]. Research also revealed inverse relationships[15]. Thus, it is unsure whether X metrics can be used as a substitute or complementary indicator for classic indicators for impact measurement of LIS scholarly literature. The debate over this issue is still ongoing among the research community due to the positive and negative association between these two metrics. The possible solution to this conflict is to pool the correlation between these two metrics and report the final PCOR. Thus, the current investigation has been undertaken to find the PCOR by applying meta-analysis. A statistical method for combining different study findings, especially those with small sample sizes or opposing conclusions, is called a meta-analysis[16]. The present study is streamlined to answer the following research question.

What is the pooled correlation coefficient between the traditional metric indicators and X metrics?

2. METHODOLOGY

2.1 Search Strategy

Determining the PCOR between the conventional citation metrics and the X metrics is the goal of the

review question. To collect the eligible documents for carrying out the meta-analysis, a keyword search was carried out in major databases including Scopus, Google Scholar (GS), Dimensions.ai databases and ResearchGate in the last week of December 2023. The keywords used for searching the literature include "Altmetrics of LIS scholarly outputs", "Social media metrics of LIS articles", "Association between citation metrics and altmetrics for LIS outputs", "Correlation between citation metrics and altmetrics for LIS outputs", "Association between citation and Twitter for LIS outputs", "Correlation between citation and Twitter for LIS articles". The eligible article's 'references' were also examined to get new articles and can be considered an effective way of finding articles for this current investigation.

2.2 Inclusion and Exclusion Criteria

The study has adhered to systematic review method guidelines followed by PRISMA to identify, screen and select the eligible records (Fig. 1). Only peer-reviewed scholarly literature was considered for the study. Furthermore, outputs published in any language were taken into account. Another major inclusion parameter was that the study must have correlated traditional citation indicators like citation, Journal Impact Factor (JIF), eigenfactor, etc., with X metrics chosen when heterogeneity is acknowledged.

2.3 Meta-analysis

The meta-analysis was conducted using the free trial version of MedCalc (22.016). Two samples are required as a minimum to perform a meta-analysis.; to draw a valid conclusion, it is five25. The Fisher transformation of correlation was used to compute the effect size. The formula to convert r to a z score is z'=.5[ln(1+r)–ln(1-r)]. The REM was used for analysing the data since the study involved considerable heterogeneity (I2=>75, p<.05) (See Table 2). Heterogeneity is the difference in the results of various investigations. Cochran's Q was applied to find out the heterogeneity and it indicates the percentage of total variation among studies that can be attributable to real heterogeneity as opposed to random variation. The formula to calculate it is I2 = 100 % x (Q - df)/Q, where Q is Cochran's heterogeneity statistic and df is the degrees of freedom. Heterogeneity is categorized with values ranging from 0 % to 100 % as low at 25 %, medium at 50 %, and high at 75 %. The random effects model ought to be the one chosen when heterogeneity is acknowledged.

3. ANALYSIS AND INTERPRETATION

3.1 Features of the Investigated Studies

As per the data in Table 1, 10 studies were found eligible for the meta-analysis, and all were 'research

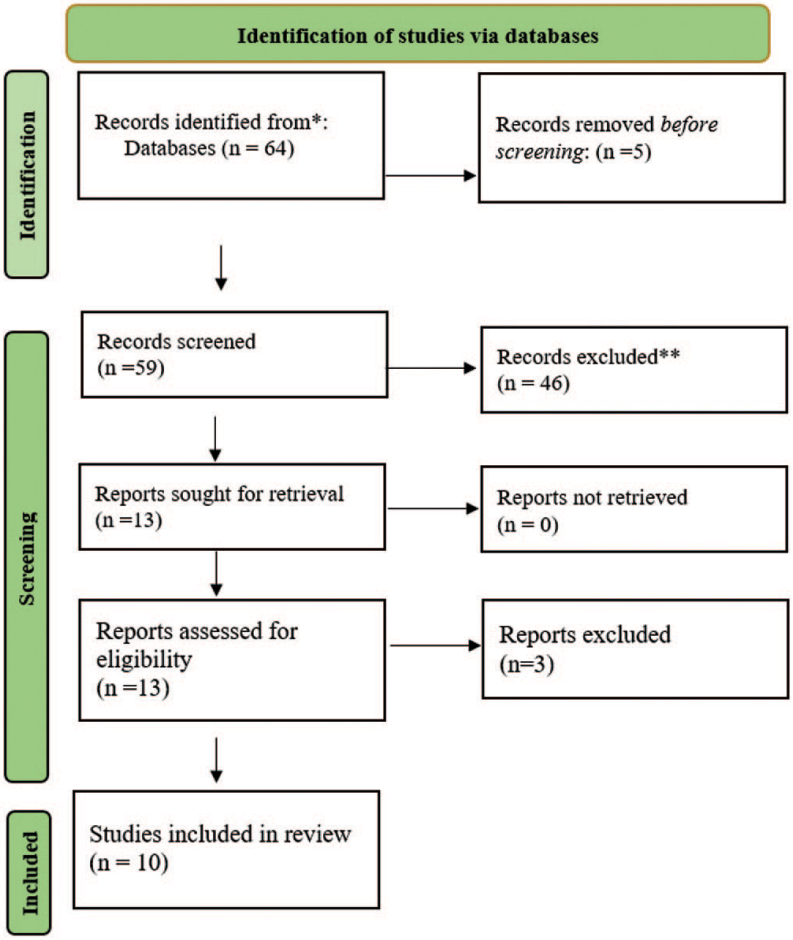

Figure 1. PRISMA flow diagram.

articles'. Of these, 9 articles were published in English and the remaining in Spanish. The articles were published between 2014 to 2023. As far as the source of citations was concerned, five studies i.e. Torres-Salinas[17], Zhao[13], Htoo[18] and Cho[14] correlated X metrics with citations and one study i.e. Yu[15], *et al.* associated X metrics with JIF from the Web of Science (WoS). 2 studies viz. Saberi[19] and Wang[20], *et al.*, carried out a correlation study by considering citations from GS. At the same time, Vysakh[21] and Vysakh[22] examined the degree to which Dimensions citations and Twitter metrics are related. Only one study i.e. Thelwall[23] tried to correlate Scopus citations with Twitter metrics. It is also seen from the Table that there are two major kinds of correlation tests ie. Spearman and Pearson were used to quantify the association between these indicators, and the choice between these two tests was made in light of the data's normalcy. Both positive and negative associations were reported. The correlation coefficient (r) value ranged from -0.04 to 0.68, i.e., from a low negative association to a strong positive association.

3.2 Meta-analysis for the Eligible Articles

Figure 2 depicts the forest plot of the meta-analysis which is conducted between the classic metrics with the X metrics. The Y axis shows the first author with the year of publication while the correlation coefficient value for each study under investigation is displayed on the X axis. The blue coloured box displays the number of samples of the investigated articles and a greater size indicates a larger sample size. The aggregate samples from all these 10 studies were 41474 (See Table 2). The blue colour diamond represents the fixed effects and random effects. It is evident from the Figure that, all the studies except two i.e., Torres-Salinas[17] (r=-0.09) and Cho[14] (r=-0.04) recorded a positive correlation. The study led by Thelwall[23] showed the strongest correlation, with a correlation coefficient of 0.68 (rho=0.68) (See Appendix 1).

3.3 Pooled Correlation and Heterogeneity

Table 2 shows that the PCOR is 0.18. (95 % Confidence Interval [CI] -0.0196 to 0.371) for the REM. For the papers, there is a great deal of overall heterogeneity which is measured by I^2 statistics. The I^2 value is 99.67 %. Heterogeneity can be classified as low at 25 %, medium at 50 %, and high at 75 %, with values ranging from 0 % to 100 %.

3.4 Publication Bias

The findings of Egger's (p=0.78) and Begg's (p=0.17) tests from Appendix 2 as well as the symmetry of the funnel plot in Figure 3 show that there was no publication bias because the p-value was greater than 0.05 (p>0.05).

4. DISCUSSION AND CONCLUSION

As fewer investigations have been conducted, the current investigation aimed to conduct a quantitative analysis between the traditional metric indicators and X metrics of selected LIS outputs to find the pooled correlation. Despite many researchers trying to compute the same in various domains, this is the first study to do so in LIS by considering Twitter metrics.

The meta-analysed finding of the investigation revealed that the pooled correlation between classic and Twitter metrics was positive (pooled r=0.18), validating that citation and Twitter metrics exhibit similar features. This finding is consistent with a previous meta-analysis investigation carried out by Bornmann[24].

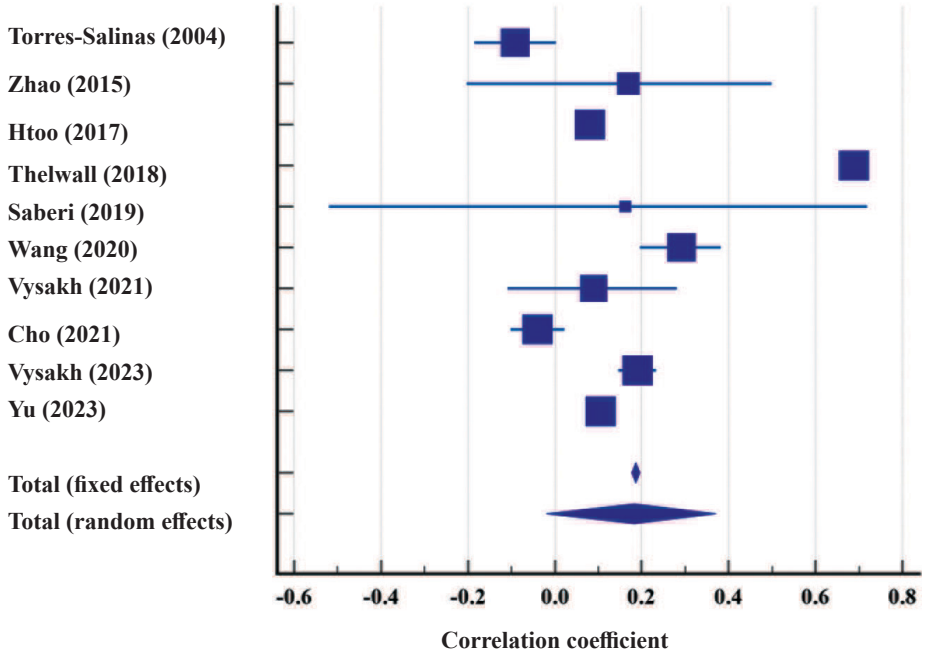

Figure 2. Forest plot for the meta-analysis.

Table 1. Features of the investigated articles

First author	Year	Title	Language	Source of classic metrics with indicator	Methodology	r
Torres-Salinas	2014	Presence on social networks and altmetrics of authors frequently published in the Journal EI Profesional de la Informacion	Spanish	WoS citations	Samples=426 LIS articles from EI professional de la informacion. Correlation=Spearman	-0.09
Zhao	2015	Assessing the popularity of the top-tier journals in the LIS field on Twitter	English	WoS citations	Samples=30 Top tier LIS journals as per JCR ranks published in 2013. Correlation=Spearman	0.16
Htoo	2017	Disciplinary differences in altmetrics for social sciences	English	WoS citations	Samples =19,580 LIS articles published from 2008 to 2013. Correlation= Pearson	0.08
Thelwall	2018	Altmetric Prevalence in the Social Sciences, Arts and Humanities: Where are the Online Discussions?	English	Scopus citations	Samples = Articles published and indexed in Scopus in 2013 from 35 social science and arts and humanities fields including LIS. Correlation=Pearson	0.68
Saberi	2019	Usage, captures, mentions, social media and citations of LIS highly cited papers: an altmetrics study	English	GS citations	Samples=10 LIS classic papers in Google Scholar. Correlation=Spearman	0.16
Wang	2020	The impact of preprints in Library and Information Science: an analysis of citations, usage and social attention indicators	English	GS citations	Samples = 371 LIS pre-print in Arxiv. Correlation=Spearman	0.29
Vysakh	2021	Altmetrics Linked Scholarly Information from Dimensions.ai Datasets for the Top 100 LIS Articles	English	Dimensions.ai citations	Samples = Top 100 LIS articles indexed in the Dimensions.ai database as of March 2021. Correlation-Spearman	0.09
Cho	2021	Altmetrics analysis of highly cited academic papers in the field of library and information science	English	WoS citations	Samples=Highly cited 1,000 articles in the LIS sub-domain. Correlation=Pearson	-0.04
Vysakh	2023	Examining the Association between Citations and Altmetric Indicators of LIS Articles indexed in the Dimensions database	English	Dimensions.ai citations	Samples=1951 LIS articles published in 2020. Correlation=Spearman	0.19
Yu	2023	Towards a better understanding of Facebook Altmetrics in LIS field: assessing the characteristics of involved paper, user and post	English	WoS JIF	Samples=86 journals and 12719 articles in the LIS domain published in 2019. Correlation=Spearman	0.10

Table 2. Pooled correlation and heterogeneity

Model	Aggregated samples	PCOR	95% CI	Fisher Z	p-value	Heterogeneity
Random effects	41474	**0.18**	-0.0196 to 0.371	1.772	0.076	I^2=99.67%

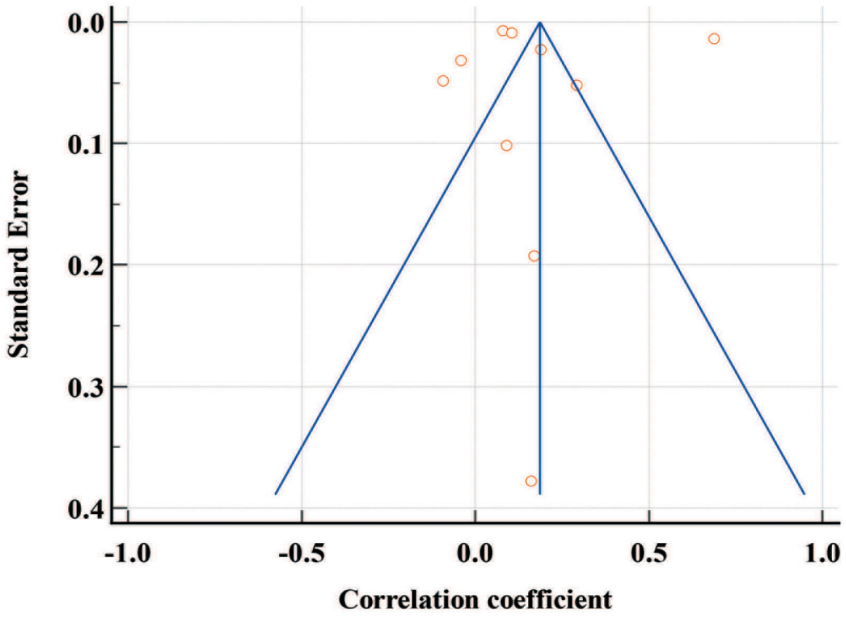

Figure 3. Funnel plot for publication bias.

Consequently, it is possible to use X posts and reposts of scientific publications as a reliable proxy for assessing the imperceptible impact of the LIS literature. Since citation takes time to accrue normally 2 to 3 years[26], the LIS scholarly community can use Twitter metrics as a substitute to show the broad and quick impact of their research. Consistent with this, it was endorsed from a previous study that 40 % of Twitter citations happen within the first week of publication[27]. Hence, it is advisable to use Twitter counts as an early impact indicator for less-cited research outputs from less-cited disciplines like LIS[28]. Furthermore, Twitter can predict future citations and it was discovered from a previous study that highly tweeted articles had an 11-fold increased likelihood of being highly cited[29]. Hence, Twitter metrics help researchers, especially early career researchers whose outputs are less cited or have no citations to find funding for their projects by showcasing the 'twimpact' factor as a parameter for funding applications. It was learnt that many funding agencies have started to consider the new gen metrics for funding decisions[30].

There are certain drawbacks to this study. Firstly, despite the considerable heterogeneity, the study has not tried to measure the pooled correlation by conducting a sub-group analysis by considering the source of citations. Thus, a future extended study can be conducted, which would help to ascertain articles indexed in which citation database shows higher correlation once pooled. The reason for this higher correlation and its relation with the difference in gaining greater social media attention by LIS journals indexed in specific citation databases can also be explored. As such, another sub-group analysis is possible by considering the sampling method and method of measuring correlation *i.e.*, Spearman and Pearson. Secondly, how the correlation pattern between classic metrics and Twitter metrics changes over time has not been assessed and can be considered for further investigation. Lastly, the present study is limited to the quantitative analysis of Twitter metrics with classic metrics. Other major altmetric indicators like Mendeley, news, blogs, policy mentions, Facebook etc. have not been studied. Thus, interested researchers can conduct an in-depth meta-analysis by considering the unstudied altmetric indicators and other classic metric indicators.

In closing, a scientific tweet is a new parameter that can measure the wider impact of research. Determining whether a scientific tweet is associated with traditional metrics can assist the research community in using Twitter metrics to complement traditional metrics. As per the findings of the current study, it is determined that for measuring the research impact of LIS research, Twitter metrics can be employed along with traditional metrics which helps to gauge the broader picture of the LIS research.

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His contributions to this paper include the topic selection, data collection, analysis & interpretation and overall drafting of the paper.

Appendix 1. Result of meta-analysis

Study	Sample size	r	95% CI	Weight (%)	
				fixed	Random
Torres Salinas, 2014	426	-0.0920	-0.185 to 0.00304	1.02	10.89
Zhao, 2015	30	0.169	-0.204 to 0.499	0.065	8.08
Htoo, 2017	19580	0.0800	0.0661 to 0.0939	47.24	11.15
Thelwall, 2018	5287	0.689	0.675 to 0.703	12.75	11.13
Saberi, 2019	10	0.162	-0.521 to 0.718	0.017	4.53
Wang, 2020	371	0.292	0.196 to 0.382	0.89	10.85
Vysakh, 2021	100	0.0900	-0.108 to 0.281	0.23	10.09
Cho, 2021	1000	-0.0400	-0.102 to 0.0220	2.41	11.04
Vysakh, 2023	1951	0.190	0.147 to 0.232	4.70	11.10
Yu, 2023	12719	0.106	0.0888 to 0.123	30.68	11.14

Appendix 2. Result of Egger's regression and Begg's rank correlation test for publication bias

Egger's test	
Intercept	2.3482
95% CI	-16.6097 to 21.3060
Significance level	p = 0.78
Begg's test	
Kendall's Tau	0.3333
Significance level	p = 0.17