

Altmetric and bibliometric indicators for academic social networks: Academia.edu & ResearchGate

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Background: E-visibility embodies the online presence of a researcher and their research, the researcher's discoverability, and the accessibility of the research. Academic social networking tools (ASNT) enable the creation of altmetrics for research within these academic online research communities.

Objectives: This article reports on the correlations between e-visibility and altmetric-bibliometric indicators on ASNTs (Academia.edu and ResearchGate) for the Environmental Sciences researchers at the University of South Africa.

Method: Altmetric and bibliometric indicators were collected from the ASNTs (Academia.edu and ResearchGate) and bibliometric data from the traditional citation resources (Scopus, Web of Science and Google Scholar), as part of a longitudinal study exploring research e-visibility and altmetric-bibliometric trends. Statistical analysis (using Spearman's rank coefficient) was conducted on the altmetric and bibliometric data to identify the altmetric-bibliometric correlations.

Results: The altmetric-bibliometric spearman correlation results show positive correlations that translates to increases in bibliometrics and altmetrics on ASNTs and citation resources.

Conclusion: This study is significant as it concludes that altmetric-bibliometric indicators correlate positively and translate to the increase in research e-visibility and it allows for the enhancement of research and societal impact for environmental researchers within a South African context.

Contribution: The findings of this study are beneficial to all researchers aiming at increasing their citation counts and enhancing their research- and societal impact. The main contribution of the study is the identification of altmetric-bibliometric correlations. Recommendations for researchers include well-maintained research profiles on ASNTs and citation resources for the increase of research e-visibility and the enhancement of research and societal impact.

Keywords: e-visibility; altmetrics; bibliometrics; altmetric-bibliometric correlations; academic social networking tools; ResearchGate; Academia.edu; Web of Science; Scopus; Google Scholar.

Introduction

Online research communities have become communication intermediaries creating efficient and effective knowledge-sharing channels, which in turn facilitate research e-visibility. The incorporation of Academic Social Networking Tools (ASNTs) into academia as online research communities has allowed the emergence of enhanced research activities in the research processes of researchers, including open publishing, evaluation of resources (Adriaanse & Rensleigh 2011), and collaboration (Taraborelli 2008). The social networking tools used by the researchers promote online Web activity and adapt to the research needs of researchers (Arda 2012; Mangan 2012). The researcher's profiles on these ASNTs reinforce the online research presence, which additionally enhances the concept of research e-visibility.

Furthermore, the research profiles on ASNTs act as the intermediaries for gathering of the bibliometric (citation data) and altmetrics (attention data). Bibliometrics are deemed necessary research metrics for the research performance measurement of researchers (Taylor 2013).

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Altmetrics have become instrumental to the societal impact measurement of a researcher, in an attempt to measure the reach of the attention research output is receiving in society and is used as a possible predictive indicator of citation trends and behaviour introducing additional performance measurement. Altmetrics propose to complement and supplement the limited usage of bibliometrics as research metrics for researcher performance measurement (Taylor 2013).

The premise is that there is a correlation between researcher e-visibility (online presence, discoverability of researchers and research output accessibility) and altmetric-bibliometric indicators. Discoverable and accessible research output becomes more retrievable, increasing the chances of being downloaded, utilised and cited. Equally, research output receiving attention in non-traditional research communities such as ASNTs increases the researcher's societal impact, and the associated attention leads to increased potential citation generation from previously uncharted research environments.

This article aims to highlight the e-visibility and the altmetric-bibliometric indicators statistical correlation, obtained from ASNTs, Academia.edu and ResearchGate, and the citation resources, Scopus, Web of Science and Google Scholar, for the Environmental Sciences researchers at the University of South Africa. The key contribution of this article is the statistically significant relationships between the bibliometrics and altmetrics of the participating researchers in the attempt to understand the effect of altmetrics as a measure of societal impact on the research metrics of researchers. Furthermore, the opportunity for identification of the most effective ASNTs in increasing the research e-visibility of researchers with citation performance and increasing research and societal impact.

Literature review

Research e-visibility

Research e-visibility, as a concept incorporates themes such as the researcher's online presence, the research output of the researcher, the researcher's discoverability and accessibility of the researcher's research output (Adriaanse & Rensleigh 2017a). The researcher's online presence is encapsulated in the inclusive research profile with accurate, relevant, and related information about the researcher for wider online audiences (Ale-Ebrahim et al. 2013; Arda 2012; Chung & Park 2012; Hoffman, Lutz & Meckel 2014). These online research profiles allow for increased research discoverability and research output accessibility with increased downloads (Ale-Ebrahim et al. 2013; Norman 2012), where researcher discoverability translates to the relative ease at which other researchers can discover a researcher and their research via the various online platforms (Norman 2012). Research accessibility implies that research output available online on these platforms, allows for increased retrievability and

downloadability for citing and translates to research being accessible (Czerniewicz & Wiens 2013; Norman 2012). Enhancing e-visibility for a researcher includes actively increasing and managing an online research identity via academic and research platforms. In addition, the increased citation counts attribute to higher research performance for the researcher and increased research impact on the field of study.

E-visibility and research impact measurement

The conventional research evaluations and research performance measurement exercises in academia have utilised the bibliometric indicators including citation counts and related bibliometrics of researchers to ascertain their research impact (Bornmann 2014a, 2014b; Hoffman et al. 2014; Naude, Rensleigh & Du Toit 2005; Roemer & Borchardt 2012). In terms of research e-visibility, more citations are generated by a researcher's research output when they are more discoverable, allowing for increased accessibility and downloadability. In turn, an increased citation count translates to enhanced research performance of a researcher and increased research impact for the academic discipline (Bornmann et al. 2016).

The introduction of ASNTs permeating research processes, brought new possibilities and variations to the research workflow, which include discovery, communicating, disseminating, and sharing of research. This in turn leads to new dimensions for measuring the scholarly research attention activity such as usage statistics and attention indicators, that is, views, reads, downloads, and the sharing of research output (Boudry & Durand-Barthez 2020; Kim & Abbas 2010). This brought about the realisation of the attention research output was receiving via social networking tools, which became known as altmetrics and were considered an alternative to bibliometrics. However, these are considered as complementary indicators to bibliometrics, allowing for a more inclusive measurement metrics, recording previously invisible impacts for the ascertaining of an inclusive research impact and the research performance for researchers (Kim & Abbas 2010; Konkiel 2013). An increased understanding appropriate to the association of altmetrics with bibliometrics, in the context of research e-visibility, encourages the investigation of the altmetrics-bibliometrics correlation, and redefining the terminology for bibliometrics and altmetrics for the measurement of research impact in academia.

Research has emphasised the evolving relationships between altmetrics and bibliometrics as indicators to measure the research performance of researchers for a more inclusive view of their research impact (Ortega 2015a; Torres-Salinas, Cabezas-Clavijo & Jimenez-Contreras 2013). Investigating research metrics to measure research impact involves unpacking the concepts of altmetrics and bibliometrics to acquire an outline of the nature and role of each research indicator within a research impact context.

The conventional research measurement uses bibliometric indicators to analyse and represent scholarly impact of published research and individual researchers (Bornmann 2014a, 2014b; Roemer & Borchardt 2012). Altmetric (alternative) indicators derived from the ASNTs, which includes views, downloads, readers and tweets, representing attention received by a research output outside of the traditional research environment, allow for the measurement of the societal impact of the research (Caberra, Roy & Chisolm 2017; Haustein & Siebenlist 2011; Hoffman et al. 2014; Kjellberg, Haider & Sundin 2016; Tattersall 2016). It is suggested that the recognition of altmetric indicators for representing a more inclusive view and complementary to the existing bibliometric indicators is gaining ground with a new generation of scientists and researchers seeking measurement of the more complete portrayal of research impact (Yeong & Abdullah 2012).

Relationship between altmetrics and bibliometrics

Previous research shows altmetric–bibliometric indicator relationships with positive correlations between the bibliometrics from Scopus, Web of Science and Google Scholar, and altmetrics from ResearchGate and Academia.edu. Strong positive correlations for bibliometric indicators were reported for Scopus, Web of Science and Google Scholar, with altmetric indicators from ResearchGate (Onyancha 2015; Orduña-Malea, Martín-Martín & López-Cózar 2016; Ortega 2015b; Shrivastava & Mahajan 2015), as well as with altmetric indicators from Academia.edu (Li & Thelwall 2012; Ortega 2015b; Thelwall & Kousha 2014).

Research methodology

Research design

This article is part of a larger PhD longitudinal (over a 2-year period) comparative e-visibility study, with the research design including a pragmatic view using a deductive approach, employing mixed methods to answer the research question and sub-questions. It involved micro-bibliometric analysis to establish research e-visibility trends of the Environmental Sciences researchers at the University of South Africa (UNISA). The e-visibility study developed an e-visibility strategy for enhancing e-visibility of the researchers by utilising the three e-visibility indicators: (1) online presence (the online representation of the researchers on the various websites and ASNTs), (2) discoverability (the presence of researcher profiles on the various websites and ASNTs); and (3) accessibility (the total amount of research output per researcher across these websites and ASNTs) (Adriaanse & Rensleigh 2017a).

Research sampling

The study used a non-random convenience sampling method with voluntary participation from 62 researchers (representing an 86.1% response rate) in the School of Environmental Sciences at the College of Agriculture and Environmental Sciences at UNISA.

Data collection

The data collection as reflected in this article involved gathering the altmetric data from ASNTs (Academia.edu and ResearchGate) and bibliometric data from traditional citation resources (Scopus, Web of Science and Google Scholar), between December 2014 and December 2016 as depicted in Figure 1. The altmetric-bibliometric indicator data included: name of researcher, total research output per ASNTs and citation resource, number of publications on ASNTs per researcher, number of ResearchGate views per researcher, number of ResearchGate downloads per researcher, number of Academia.edu views per researcher and citation count of researcher.

Data analysis

The altmetric and bibliometric data were statistically analysed to determine altmetric-bibliometric distribution trends via SPSS software, utilising the Kolmogorov–Smirnov (Lilliefors significance correction) normality tests with altmetric–bibliometric relationships determined using Spearman rank correlation. E-visibility indicators (online presence, discoverability, and accessibility) per researcher from each ASNT and citation resources were used to express the e-visibility status of the Environmental Science researchers (Adriaanse & Rensleigh 2017a, 2020).

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Johannesburg, College of Business & Economics Ethics Committee (No. IKM2018_017).

Results and discussion

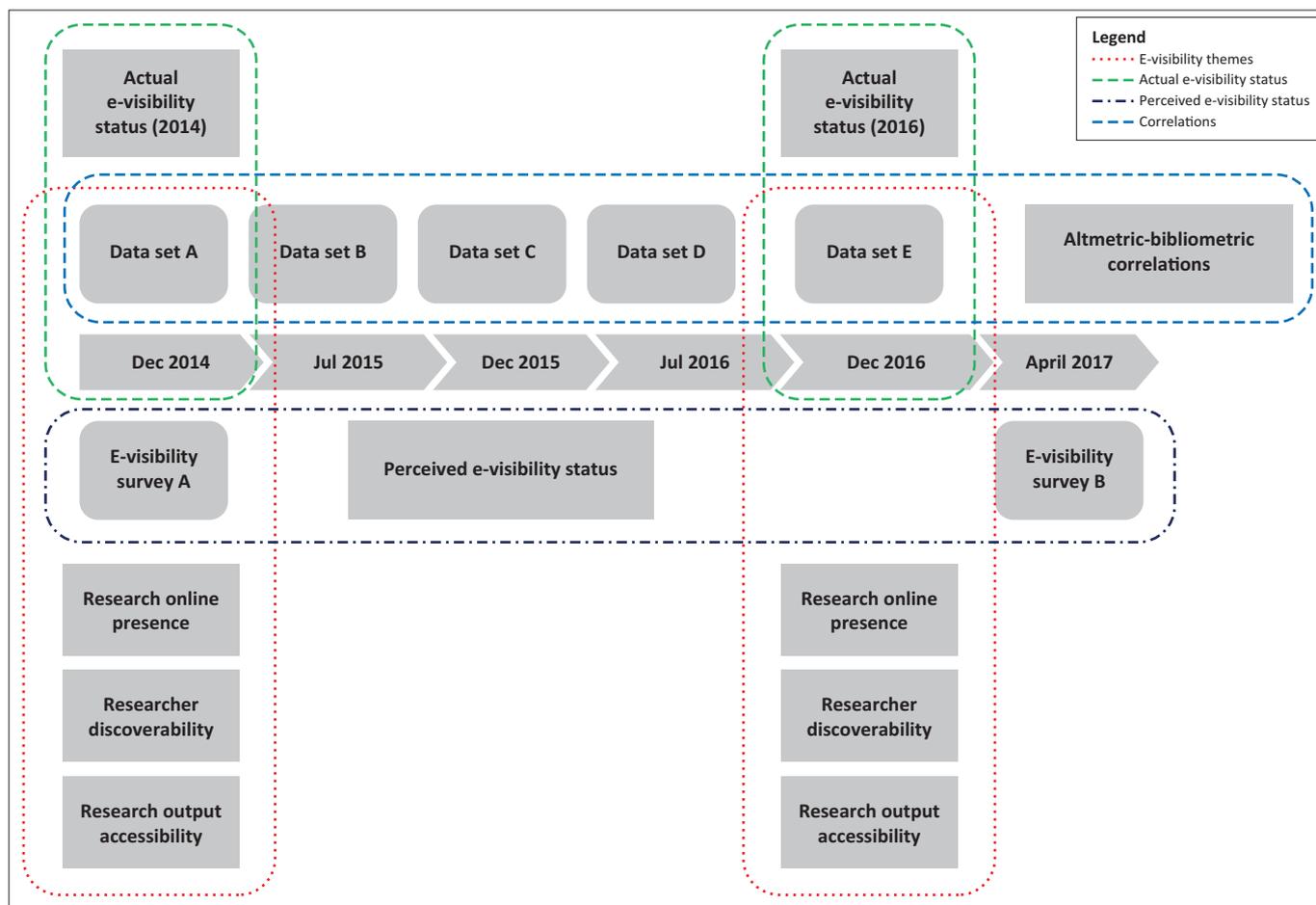
Bibliometric and altmetric indicators from 2014 to 2016

The results indicate an increase in bibliometrics (citations) for researchers across all three citation resources (Scopus, Web of Science and Google Scholar) as seen in Table 1 (Figure 2), with the highest increase in total number of citations, 170% for Google Scholar followed by Scopus with 99% and Web of Science with 69%.

In addition, the results show an increase in altmetrics across the ASNTs as seen in Table 2 (Figure 3). The highest increase in total number, 73% was recorded for Academia.edu. The increases in altmetrics for ResearchGate varied from 67% for downloads between December 2014 and July 2015, 54% for ResearchGate reads between December 2015 and December 2016, and 48% for views between December 2014 and July 2015.

Research e-visibility indicators: Online presence, discoverability, and accessibility

The largest increase for the online presence indicator was reflected by ResearchGate (27%) and Academia.edu (13%)



Source: Adriaanse, L.S. & Rensleigh, C., 2017b, 'E-visibility of environmental science researchers at the University of South Africa', *South African Journal of Libraries and Information Science* 83(2), 30–41. <https://doi.org/10.7553/83-2-1636>

FIGURE 1: Data collection for the longitudinal e-visibility study.

TABLE 1: Bibliometrics from citation resources: Scopus, Web of Science and Google Scholar.

Citation resources	Bibliometrics			
	Total number of citations	Mean	Normality	Increase in total number (%)
Web of Science 2014	685	11.05	0.396*	69
Web of Science 2016	1157	18.66	0.382*	
Scopus 2014	817	13.39	0.372*	99
Scopus 2016	1623	26.61	0.365*	
Google Scholar 2014	1308	21.10	0.342*	170
Google Scholar 2016	3536	57.03	0.333*	

*, Sig. (2-tailed).

representing the ASNTs, as seen in Table 3. The largest increase reported for the discoverability indicator was on the citation resource Google Scholar (35%), followed by Web of Science (34%) followed by the ASNTs ResearchGate (25%) and Academia.edu (21%), as seen in Table 4.

The largest increase for the indicator accessibility was reported on the ASNT Academia.edu (20%), closely followed by the citation resource Web of Science (19%), as seen in Table 5.

In general, research e-visibility on the ASNTs reflected a larger increase when compared with the citation resources during 2014 to 2016 as seen in Figure 4.

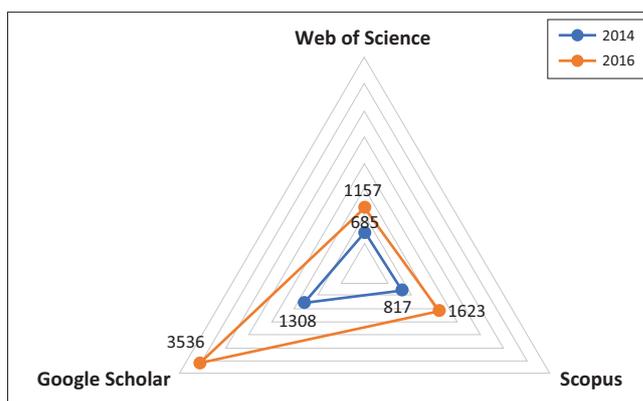


FIGURE 2: Bibliometrics from citation resources: Scopus, Web of Science and Google Scholar.

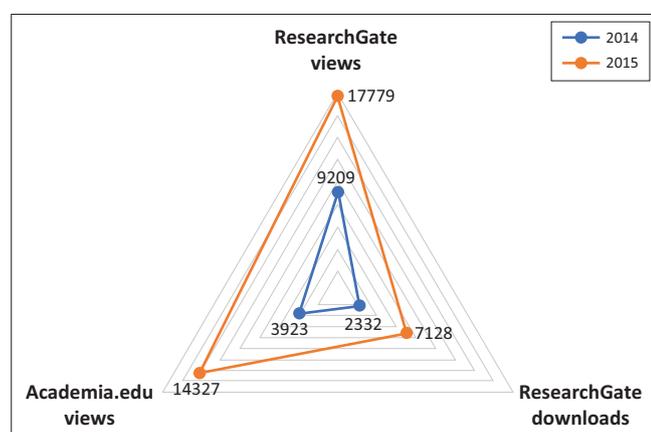
Altmetrics-bibliometrics correlations from 2014 to 2016

Table 6 shows the statistical correlations between the altmetrics, from the ASNTs: Academia.edu and ResearchGate, and the bibliometrics, from the citation resources: Scopus, Web of Science, and Google Scholar, as represented by the Spearman’s rank correlation coefficient. The correlations for the ResearchGate altmetrics and the three citation resources citations between 2014 and 2016 show an overall strong

TABLE 2: Altmetrics from academic social networking tools: Academia.edu and ResearchGate.

Academic social networking tool	Altmetrics			
	Total number for researchers	Mean	Normality	Increase in total number (%)
ResearchGate views Dec 2014**	9209	148.53	0.362*	48
ResearchGate views Jul 2015**	17 779	286.76	0.349*	
ResearchGate downloads Dec 2014**	2332	37.61	0.372*	67
ResearchGate downloads Jul 2015**	7128	260.42	0.365*	
ResearchGate reads Dec 2015**	16 146	260.42	0.330*	54
ResearchGate reads Dec 2016**	34 826	561.71	0.325*	
Academia.edu views Dec 2014	3923	63.27	0.454*	73
Academia.edu views Jul 2015	14 327	231.08	0.342*	

*, Sig. (2-tailed); **, ResearchGate changed their altmetric indicator profile from views and downloads in between July 2015 and December 2015, to reflect reads with the motivation that reads incorporate both views and downloads to be expressed as reads for a more accurate reflection of the altmetric indicator.

**FIGURE 3:** Altmetrics from academic social networking tools: Academia.edu and ResearchGate.**TABLE 3:** Distribution for research e-visibility indicator: Online presence.

Research e-visibility indicator: Online presence	Research online presence		Increase in research online presence (%)
	2014 (%)	2016 (%)	
Citation resources			
Web of Science	36	47	11
Scopus	45	52	7
Google Scholar	63	68	5
ASNTs			
ResearchGate	42	69	27
Academia.edu	42	55	13

ASNTs, academic social networking tools.

positive correlation. In addition, the correlations for the Academia.edu altmetrics and the three citation resources citations show overall positive (but weaker) correlations between December 2014 and December 2016.

Pertaining to the e-visibility themes online presence, discoverability and accessibility, the ASNTs represented the largest research online presence distribution. The largest researcher discoverability distribution was reflected on the citation resources. The largest research output accessibility was reflected on the ASNTs. Pertaining to the distribution of

TABLE 4: Distribution for research e-visibility indicator: Discoverability.

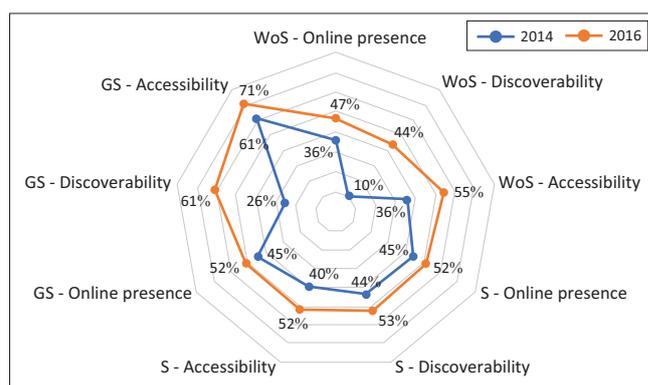
Research e-visibility indicator: Discoverability (Researcher online profiles)	Researcher discoverability		Increase in researcher discoverability (%)
	2014 (%)	2016 (%)	
Citation resources			
Web of Science	10	44	34
Scopus	44	53	9
Google Scholar	26	61	35
ASNTs			
ResearchGate	44	69	25
Academia.edu	37	58	21

ASNTs, academic social networking tools.

TABLE 5: Distribution for research e-visibility indicator: Accessibility.

Research e-visibility indicator: Accessibility (Research output)	Research output accessibility		Increase in research output accessibility (%)
	2014 (%)	2016 (%)	
Citation resources			
Web of Science	36	55	19
Scopus	40	52	12
Google Scholar	61	71	10
ASNTs			
ResearchGate	36	53	17
Academia.edu	16	36	20

ASNTs, academic social networking tools.



GS, Google Scholar; WoS, Web of Science; S, Scopus.

FIGURE 4: Change in research e-visibility indicators from 2014 to 2016.

bibliometric and altmetric indicators, the results clearly indicate an increase in total bibliometrics and altmetrics across the three ASNTs between December 2014 and December 2016.

The strong altmetric-bibliometric Spearman rank correlations reported for the altmetric indicators from ResearchGate and the bibliometrics from Scopus, Web of Science and Google Scholar advocate that altmetrics from ResearchGate have a strong positive relationship with the corresponding bibliometrics. The results therefore concur with the previous studies by Onyancha (2015), Orduña-Malea et al. (2016), Martín-Martín et al. (2016), Thelwall et al. (2013), Thelwall and Kousha (2017) on ResearchGate altmetric-bibliometric correlations from Scopus, Web of Science and Google Scholar, which reported medium to strong positive correlations and subsequently support the results from this study. The results obtained by the studies by Ortega (2015b) and Thelwall and Kousha (2014), found a weaker Spearman correlation below $r = \pm 0.2$ (significance not listed), which contrasts with the

TABLE 6: Correlation analysis of the Spearman rank values for altmetric and bibliometric indicators.

Altmetrics from academic social networking tools	Bibliometrics from citation resources					
	Web of Science 2014	Web of Science 2016	Scopus 2014	Scopus 2016	Google Scholar 2014	Google Scholar 2016
ResearchGate views December 2014	0.654 (0.000*)	0.708 (0.000*)	0.772 (0.000*)	0.770 (0.000*)	0.727 (0.000*)	0.765 (0.000*)
ResearchGate views July 2015	0.658 (0.000*)	0.750 (0.000*)	0.764 (0.000*)	0.828 (0.000*)	0.754 (0.000*)	0.822 (0.000)
ResearchGate downloads December 2014	0.623 (< 0.000*)	0.616 (< 0.000*)	0.705 (< 0.000*)	0.710 (< 0.000*)	0.667 (< 0.000*)	0.678 (< 0.000*)
ResearchGate downloads July 2015	0.600 (< 0.000*)	0.663 (< 0.000*)	0.734 (< 0.000*)	0.742 (< 0.000*)	0.680 (< 0.000*)	0.732 (< 0.000*)
ResearchGate reads December 2015	0.648 (0.000*)	0.732 (0.000*)	0.795 (0.000*)	0.852 (0.000*)	0.770 (0.000*)	0.840 (0.000)
ResearchGate reads December 2016	0.613 (0.000*)	0.707 (0.000*)	0.771 (0.000*)	0.830 (0.000*)	0.730 (0.000*)	0.804 (0.000*)
Academia.edu December 2014	0.204 (0.112*)	0.204 (0.112*)	0.366 (0.004*)	0.318 (0.125*)	0.363 (0.004*)	0.386 (0.002*)
Academia.edu December 2016	0.253 (0.047*)	0.313 (0.013*)	0.388 (0.002*)	0.451 (0.000*)	0.403 (0.001*)	0.490 (0.000*)

Note: bold values indicates the correlation strength.

*, 2-tailed significance.

stronger correlations for the Academia.edu correlation results found in this study.

The bibliometric indicators (collected from the citation resources Scopus, Web of Science and Google Scholar) represent the traditional research impact of the researchers, and the total number of altmetric indicators (collected from the ASNTs Academia.edu and ResearchGate) represents the societal and research impact of the researchers. The postulation is therefore that the combination of the total increases in the traditional research impact and the societal impact, combined with the positive altmetric-bibliometric correlations enhances the e-visibility of the participating researchers.

Conclusion

According to Thelwall et al. (2013), the determined correlations between altmetrics and bibliometrics point towards the assumption of relationships between altmetrics and bibliometrics and the influence on each other. The resulting correlations between altmetrics and bibliometrics indicators as shown in this study are supported by the findings of previous studies where strong positive Pearson and Spearman correlations are recorded, for the ASNTs and the citation resources Scopus, Web of Science and Google Scholar. Given the above it can therefore be suggested that the altmetrics from Academia.edu and ResearchGate have a possible influence on citations. The bibliometric trends indicating increases in altmetric and bibliometric indicators after participating researchers were introduced to research e-visibility initiatives, together with the positive correlations reflected in altmetrics and the bibliometrics, suggest an increase in research impact and societal impact.

The significant contribution of the e-visibility study lies in highlighting the relationship between increased research e-visibility via the online existence of research profiles on ASNTs, such as ResearchGate and Academic.edu, contributing to the researchers' increased research and societal impact. Centred on the premise that increased e-visibility exerts influence on the citation performances of

researchers and hence promotes increased research and societal impact, the altmetric-bibliometric indicator results were used to identify which ASNTs were recommended for maximising the citation counts of researchers. The study recommends researchers actively create and maintain a research presence on ResearchGate and Academia.edu.

Limitations

This study reported the altmetric-bibliometric correlations of researchers within the Environmental Sciences discipline at Unisa and the findings therefore cannot directly be generalised to researchers in all other disciplines and all other universities within South Africa and internationally. The recommendations serve as a guide on the creation and maintenance of research profiles on ASNTs for increased e-visibility to enhance citation counts and the research and societal impact of the researchers.

Future research

Based on the results, conclusions, limitations of the study, and literature discussed, there is scope for future research on the cross-altmetric relationships between the various altmetric indicators to establish cross-altmetric correlations for researchers in other disciplines.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

L.A. contributed towards the data collection and wrote up the research. C.J.P.N. contributed towards the conceptualisation, validation, writing and supervised the research. C.R. contributed towards the conceptualisation, methodology, validation, writing and supervised the research.

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Data availability

Data that support the findings of this research are available upon reasonable request from the corresponding author, C.J.P.N.

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