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Original Research

A Bibliometric Review of Academic Social Networking Sites (ASNSs) in Scholarly Communication: A Scientific Mapping based on Scopus Database

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Abstract

This study aimed to investigate the current state of published literature on Academic Social Networking Sites (ASNSs) in scholarly communication using bibliometric techniques. Social Networking Sites have revolutionized social interaction and scholarly communication by making it easier for researchers to collaborate and share their work. Researchers used selected keywords to gather data from Scopus. Fourteen years from 2007 to 2020 were considered for the analysis of research publications. Additionally, this research employed a Biblioshiny to provide a graphical representation of bibliometric indicators. the VOSviewer, CorTex, and Citespace software packages were employed to evaluate the keyword analysis and explore the research theme of social networking sites in research communication. A total of 751 publications were retrieved from 381 journals. In terms of publication, positive growth was seen. In scholarly communication, the United States is the most productive country in SNSs research. Regarding institutional affiliation, Wuhan University in China is the most prolific. In addition, it outlined the "5 Ps" for implementing ASNSs. Hopefully, the information provided by this bibliometric analysis of scholarly communication on social networking sites will be helpful to scholars in the future and contribute to the growth of knowledge in this area.

Keywords: Academic Social Networking Sites (ASNSs), Social Networking Sites, Scholarly Communication, Research Communication, Scientific Mapping, Bibliometric Study.

Introduction

In the last two decades, many online tools emerged for social communication, For example, Social Networking Sites (SNSs), Facebook, Twitter, Academic Social Networking Sites (ASNSs), Academia.edu, ResearchGate, Mendeley, Google Scholar Citation, and Zotero (Williams & Woodacre, 2016) has entirely changed social interaction and research communication (Mason & Sakurai, 2020). Popular ASNSs, namely Academi.edu, ResearchGate, and Mendeley, were developed in 2008 and 2012, respectively. Academic Social

Networking Sites (ASNSs) underpin several online tools that befit academicians, scientists, and scholars in particular due to the multiple features that attract them (Jordan, 2019). These tools refer to Web 2.0 platforms that permit users to create profiles, provide links to published articles, share scholarly articles, and exchange thoughts with subject experts worldwide (Asmi & Margam, 2018). The focus audiences of ASNSs are students, research scholars, scientists, professionals, and other educational stakeholders.

Further, Jordan (2019) divided Academic Social Networking Sites into two groups based on their features. Those online platforms are predominantly used to create profiles and build networks on one side (such as Academia.edu and ResearchGate). In contrast, online tools featured posting research activities, sharing, discussions, and references cum citation assistant (Mendeley) on the other side.

ASNSs in Scholarly Communication

Scholarly communication or research communication is a systematic mechanism in which every researcher, scholar, or scientist is involved, and how scholars exchange information communication formally or informally (Bardakcı, Arslan & Ünver, 2018; Lee, Yoon, Smith, Park , & Park, 2017). In a real sense, scholarly communication is "…the process by which scholars communicate with one another as they create new knowledge and by which they measure its worth with colleagues before making a formal article available to the broader community" (Thorin, 2006, p.1).

The use of ASNSs is increasing rapidly for "accessing e-scholarly contents" among academia and, therefore, acts as a data source (Asmi & Margam, 2018). Scholars adopt numerous ICT-based tools to widespread and consume a massive amount of information produced or required. Moreover, ASNSs are considered prominent tools in research communication to help researchers interact and collaborate with peers and promote research work among the masses (Bardakcı et al., 2018; Koranteng & Wiafe, 2019). These online networking tools have made a new horizon of scholarly communication, acknowledged as a prominent means of acquiring scientific knowledge (Lee et al., 2017). Nonetheless, "these sites allow users to upload academic articles, abstracts, and links to published articles; track demand for their published articles; and engage in professional interaction, discussion, and exchange of questions and answers with other users" (Asmi & Margam, 2018). As Ortega (2015) mentioned, ResearchGate and Academia.edu are significantly used for collaboration and networking, while Mendeley is for browsing new papers. Another study reported that Google Scholar Citation is used for citation status, while ResearchGate and Academia.edu share scholarly works (Haustein, Sugimoto & Larivière, 2015).

Bibliometric Study

According to OECD Glossary (2021 cited in IOWA State University), "the statistical analysis of books, articles, or other publications... to measure the output of individuals/research teams, institutions, and countries, to identify national and international networks, and to map the development of new (mult-idisciplinary) fields of science and technology."

Thus, a bibliometric study is a scientific mapping technique introduced in quantitative research (Lopes, Faria, Fidalgo-Neto & Mota, 2017)**.** It helps to figure out the disciplinary differences between scholarly works (Soós & Kiss, 2020; Zhang, Estoque, Xie, Murayama & Ranagalage, 2019), highly productive authors (Wang, Li & Ho, 2011), top-ranked countries, languages, journals, and the maximum number of cited articles as well (Ardito, Scuotto, Del Giudice & Petruzzelli, 2019). The Bibliometric study also reports any particular area's growth trends over

time (Barbosa & Schneck, 2015; Ellegaard & Wallin, 2015).

Aims and Scope of the Study

Publication output on Academic SNSs in scholarly communication has increased over the years. Most prior studies in this field have focused on the topic from inside a specific academic field or with the end user in mind. However, no comprehensive study on academic social networking sites in scholarly communication has been discussed in detail. This study paints a comprehensive picture by highlighting the scholarly articles indexed in the SCOPUS database for 14 years that discuss academic SN websites and their role in scholarly communication. Titles, countries, authors of the most frequent sources of the publications, trends, and collaboration patterns have been discussed in detail.

1. Who are the most productive authors, countries, and universities?
2. Which are the top authors' keywords used in ASNSs and scholar communication?
3. What are the growth trend and citation impact on ASNSs in scholarly communication?
4. What is the most critical scenario of international collaboration in scholarly communication to ASNSs?
5. What are the essential research themes on academic SNS in scholarly communication?

Literature Review

The growth rate of ASNSs is faster (Ortega, 2015; Skeels & Grudin, 2009)**,** showing popularity among the users. Professionals use these ASNSs for their professional work. The prominent ASNSs are ResearchGate, Academia.edu, Mendeley, and Google Scholar Citation (Asmi & Margam, 2018; Ortega, 2015). Social Networking Sites have entirely changed the sphere of informal scholarly communication by facilitating a new web service (Lee et al., 2017)**.** These sites "accommodate traditional social-network elements such as constructing personal profiles and interactivity with peers, uploading and tagging articles, and tracking citations" (Meishar-Tal & Pieterse, 2017, p.2). In addition to the above social networking sites, LinkedIn is a bit different platform where business stakeholders can communicate regarding their job search, career management, and working relations in a better way (Skeels & Grudin, 2009)**.** Moreover, ASNSs have speed up the publication process to meet the readers' demand at no charge (Thelwall & Kousha, 2015). Simultaneously these sites "encourage authors to upload full-text articles that appeared in academic journals, lectures presented at conferences, and even drafts, making them accessible to the public" (Meishar-Tal & Pieterse, 2017). Ortega (2015) found a significant disciplinary difference in terms of using ASNSs, concluding that Academia.edu is a widely used tool for the humanities and social sciences (HSS), whereas biologists prefer ResearchGate (RG).

After a comprehensive literature review, we identified the 5 Ps (Figure 1) as the reasons why professionals make use ASNSs and what are their natural, fundamental features such as:

Profile Creation: This is one of the first and foremost points that ASNS tools allow users to create an account of their own. Creating an account is more or less the same for all means. An email id, contact number, profession, profile picture, and work experience are the important elements need to create an account on these platforms. In this way, users can make his/her own unique identity in the ocean of Social Networking Sites.

Publicity of Works: Here, users can upload full documents of their scholarly works, only abstracts, or provide the link. It also alerts interested users whenever a new research work in their defined sphere is published. As Meishar-Tal and Pieterse (2017, P.4) mentioned:

"*Two mechanisms exist for this purpose. One is active: members of the network choose to follow authors of their acquaintance or those whose research topics are of interest to them. The other is passive: the network itself proposes (via the site and the user's email address) new articles for the user to follow, either by authors associated with the user's area of interest or those who belong to a circle of direct contacts such as a shared institution or department".*

Professional Collaboration: Academic Social Networking Sites facilitate clients to build endless professional networks worldwide. In addition, users can collaborate with their respective disciplines' experts beyond any geographical boundaries. Therefore, ASNSs help users nurture and enhance their expertise by collaborating with various fields. Because of this value-added feature, ASNSs are regarded as "Collaborative Information Management Tools" (Hoffmann, Lutz & Meckel, 2014)**.**

Peer Discussion: They also have a window of discussion where the users can put forward their difficulties over these networks, and interested ones can appropriately help them.

Personal Metrics mean users can measure their own and others' impact. How many citations have they obtained, or have the authors cited them? Besides this, online ASNSs provide the number of reads and downloads of each uploaded research work (Meishar-Tal & Pieterse, 2017).

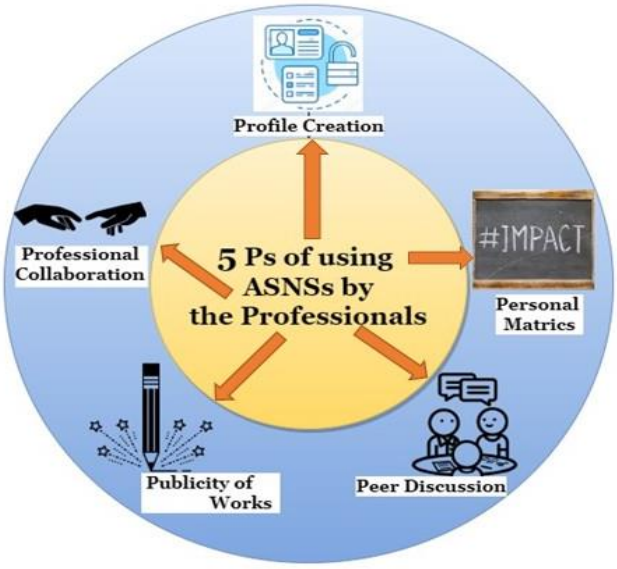

Figure 1: Proposed 5 Ps as the Striving Reasons for Using ASNSs by the Professionals

Materials and Methods

Keyword analysis and scoping review approaches have been used to analyze the comprehensive literature in the field. The framework comprised four interrelated phases: identification, selection, screening, and analysis. The strategy adopted by Hailu and Wu (2021) is utilized with some modifications.

Identification

The data were retrieved from Scopus using the following search strategy: (("Academic Social Networking Sites") OR ("Social Networking Sites") OR ("Social media") OR ("Web 2.0") AND ("Scholarly Communication") OR ("Research Communication") OR ("Science Communication")) AND (LIMIT TO (LANGUAGE , "English")) AND (

LIMIT-TO (DOCTYPE , "ar") OR LIMIT TO (DOCTYPE , "re")) AND (LIMIT-TO (EXACTKEYWORD , "Social Media") OR LIMIT-TO (EXACTKEYWORD , "Scholarly Communication")). Boolean operators are also used to initiate the relationship between the keywords.

Selection

Elsevier's Scopus database was considered as a data source for the present study because Scopus has a more extensive journal coverage than Thomson Reuter's Web of Science (Abdullah & Othman, 2022; Abd Aziz, Abdullah, Harith & Sofyan, 2022; Harsh, Bal, Weryha, Whatley, Onu & Negro, 2020). Neither restricted our search results with the period nor applied any filtration regarding the regions. The study selected only the English language, research, and review articles, among many other documents.

Screening

A total 980 results were retrieved with the initial search. The researchers have manually gone through with the abstracts of those results. Duplicate, ambiguous, and irrelevant articles to our keywords were excluded from the study. After careful and rigorous screening, only 751 results were included in the study for further analysis.

Analysis

In recent years, many software programs like VOSviewer, SciMAT, Citespace, and Publish or Perish (PoP) have been developed to aggregate scientific publications and associated data (Abd Azizet al., 2022). The CSV and RIS data sheet, consisting of years, authors, fields of study, article sources, nations, and languages, were exported to VOSviewer for additional analysis. In contrast, the BibTex data sheet was used by R-Studio (Biblioshiny) for other graphical presentations. In this research, visual aspects of keyword analysis were mapped with the help of VOSviewer, and the research theme of co-citation of cited references was generated using Citespace, a piece of software that use to give a better representation of scientific mapping (Abdullah & Othman, 2022). The author's keyword is discovered through co-occurrence analysis. The metadata files for the dataset of papers were then examined, and their content was determined using Cortext Manager. An online tool for bibliometric analysis is called CorText Manager. It can be utilized for statistical network analysis in many different fields of study.

Results

Information on ASNSs

In this study, the research articles were analyzed for 14 years, from 2007 to 2020, on academic social networking sites (ASNSs) in scholarly communication from the Scopus database. As shown in Table 1, 751 relevant documents (688 research articles and 63 review papers) were found in 381 journals. The study identified by the R tool that the average citation per document with 18.55, while the average citation per year per document was 2.795. A total of 1782 authors were found in 751 documents at an average rate of 2.3 per document, whereas 152 articles were single-authored, and the collaboration index was 2.94.

Table 1
Primary Information about Literature on Academic Social Networking Sites (ASNSs) In Scholarly Communication

Description	Results	Description	Results
Timespan	2007:2020	**Authors**	**1782**
Sources (Journals)	381	**Authors Collaboration**	
Documents	751	Authors of single-authored documents	143
Average citations per document	18.55	Authors of multi-authored documents	1639
Document Types		Single-authored documents	152
Article, Review	751	Documents per Author	0.4
Document Contents		Authors per Document	2.3
Author's Keywords (DE)	1758	Co-Authors per Documents	2.99

Yearly research growth and citation impact

A total of 751 documents were retrieved from the Scopus database (Table 2). The growth of articles published on ASNSs fluctuated between 2007 and 2020. However, the growth of documents published showed a noticeable increase when data on ASNSs was presented from 2008 to 2020, except in 2015. It was noticed in Table 2 that in the initial year (2007) of the study, only three (3) documents were published, while in 2020, the total number of documents was 148. 2020 was the most productive year, with a total of 148 documents. The data showed a growth trend during this study period. The reason may be that several social networking sites have been launched and used from 2008 onwards. Awareness among users is also increased over time, and researchers have started paying attention to these areas. The highest mean citation per article and mean citation per year were found in 2011.

Table 2
Yearly Research Growth and Citation Impact on ASNSs in Scholarly Communication

Year	Publications	Mean Citation/Article	Mean Citation/ Year	Citable Years
2007	3	17.67	1.26	14
2008	2	16	1.23	13
2009	6	19.33	1.61	12
2010	13	29.46	2.68	11
2011	21	60.9	6.09	10
2012	27	36.89	4.1	9
2013	38	40.5	5.06	8
2014	51	33.14	4.73	7
2015	86	30.78	5.13	6
2016	61	24.51	4.9	5
2017	74	16.77	4.19	4
2018	94	9.03	3.01	3
2019	127	3.89	1.94	2
2020	148	1.03	1.03	1

Most Productive affiliation

The top productive institutions on ASNSs are shown in Table 3. Regarding publication, Wuhan University of China was the most productive organization holding 22 documents, followed by the University of Wisconsin-Madison and the University of Wolverhampton, with 16 and 14 publications, respectively. On the other side, among the top ten universities, Indiana University Bloomington (USA) was the least productive university with ten publications. Simultaneously, the result also showcased the United States country has the highest number of articles contributed regarding ASNSs.

Table 3

Most Productive Affiliation and Country on ASNSs in Scholarly Communication

Rank	Affiliations	Publications	Country
1	Wuhan University	22	China
2	University of Wisconsin-Madison	16	USA
3	University of Wolverhampton	14	UK
4	Nanyang Technological University	13	Malaysia
5	Universit De Montral	13	Canada
6	Leiden University	12	Netherlands
7	University of British Columbia	12	Canada
8	University of California	12	USA
9	Yeungnam University	11	South Korea
10	Indiana University Bloomington	10	USA

Productive sources

The top journals in publishing documents ASNSs are listed in Table 4. Regarding most productive sources, Scientometrics holds the top position with 22 publications, followed by PLoS One and JASIS&T with 21 and 19 publications, respectively. Whereas in terms of total citation (TC), JASIS&T ranked first, and in terms of cites core, Computers in Human Behavior left the others behind. Two of the ten journals identified (ASLIB Journal of Information Management and Journal of Documentation) are from Q3. Out of the top ten most productive sources, Emerald Group shares 30% (n=3), followed by Sage Publication 20% (n=2). Among the sources on the quartile, there were four high-impact journals. According to the h-index, Plos One and the Journal of the Association for Information Science and Technology were the highest impact journals.

Table 4

Top 10 Most Productive Sources on ASNSs in Scholarly Communication

Rank	Source	Publication	Citations	Impact Factor	Quartile	Cite Score	h-index	Year of Publication	Publisher	Country
1	Scientometrics	22	643	3.23	Q2	5.6	11	2014	Springer	Netherland
2	Plos One	21	700	3.24	Q2	5.6	12	2013	Public Library Science	USA
3	Journal of the Association for Information Science and Technology	19	1101	2.68	Q2	5.9	12	2014	Wiley	USA
4	Public Understanding of Science	16	309	2.97	Q1	5.3	10	2013	Sage Publication	England
5	Computers in Human Behavior	14	774	6.82	Q1	14.9	11	2011	Pergamon-Elsevier	USA
6	Journal of Informetrics	14	540	5.1	Q1	9	10	2012	Elsevier	Netherland
7	Online Information Review	14	232	2.32	Q2	4.3	8	2013	Emerald Group	England
8	Science communication	12	248	4.18	Q1	7.9	8	2013	Sage Publication	USA
9	ASLIB Journal of Information Management	10	254	1.9	Q3	3.6	8	2014	Emerald Group	England
10	Journal of Documentation	9	393	1.81	Q3	3.1	7	2009	Emerald Group	England

Most productive authors

Table 5 portrays the most productive authors in the domain of ASNSs in scholarly communication. It was identified that Thelwall M from the University of Wolverhampton, the UK published the highest number of documents (np=12) with the highest 1038 citations, followed by Brossard D from the University of Wisconsin-Madison, the USA, and Costas R from Leiden University Netherland by publishing 10 and 9 documents respectively. In terms of h-index, the highest h-index was received by Thelwall M, followed by Brossard D, Costas R, Haustein S, Bowman TD, and Larivire V, respectively.

Table 5

Top 10 Most Productive Authors on ASNSs in Scholarly Communication

Rank	Authors	Affiliation	Department/School	Country	Publication	Citations	h-index	Year of Publication
1	Thelwall M	University of Wolverhampton	Data Science	UK	12	1038	12	2012
2	Brossard D	University of Wisconsin-Madison	Life Science Communication	USA	10	410	8	2012
3	Costas R	Leiden University	Centre for Science & Technology Studies	Netherland	9	337	8	2015
4	Haustein S	Université de Montréal	Information Studies	Canada	9	671	8	2014
5	Bowman Td	Université de Montréal	Library & Information Science	Canada	8	207	6	2014
6	Larivire V	Université du Québec à Montréal	École de bibliothéconomie et sciences de l'information	Canada	8	637	6	2014
7	Park HW	Yeungnam University	Media & Communication	Republic of Korea	8	122	7	2011
8	Holmberg K	University of Wolverhampton	Economic Sociology	UK	7	459	7	2009
9	Nicholas D	CIBER Research Ltd	CIBER Research Ltd	UK	7	105	5	2014
10	Scheufele DA	University of Wisconsin-Madison	Life Science Communication	USA	7	200	6	2012

The study was identified regarding authors belonging to countries (see Figure 2); the figure shows that most authors belong to the United Kingdom, Canada, and the United States.

Figure 2: Authors belong to the Country's Collaboration

Most cited research papers

Table 6 illustrates the top ten most cited research papers on ASNSs, where 'Imagining Twitter as an Imagined Community' by Gruzd A is the top-cited paper in the list with 296 total citations. 'Business impact of Web 2.0 technologies' authored by Andriole SJ, and 'Insights from hashtag #supplychain and Twitter Analytics: Considering Twitter and Twitter data for supply chain practice and research' authored by Chae B, are the second and third most cited papers in the list respectively with 211 and 200 total citations. However, the paper of Brossard D was found to be the least, with 165 citations among the top ten most cited papers.

Table 6
Top 10 Most Cited Research Papers on ASNSs

Rank	Citations	Title	Author	Year	Source	Citation/Year
1	296	Imagining Twitter as an Imagined Community	Gruzd A	2011	American Behavioral Scientist	26.91
2	211	The business impact of Web 2.0 technologies	Andriole SJ	2010	Communications of the ACM	17.58
3	200	Insights from hashtag #supplychain and Twitter Analytics: Considering Twitter and Twitter data for supply chain practice and research	Chae B	2015	International Journal of Production Economics	28.57
4	200	Tweeting biomedicine: An analysis of tweets and citations in the biomedical literature	Haustein S	2014	Journal of the Association for Information Science and Technology	25.00
5	199	Factors Affecting Bloggers' Knowledge Sharing: An Investigation Across Gender	Chai S	2011	Journal of Management Information Systems	18.09
6	194	Do altmetrics point to the broader impact of research? An overview of benefits and disadvantages of altmetrics	Bornmann L	2014	Journal of Informetrics	24.25
7	183	An Introduction to social media for Scientists	Bik HM	2013	Plos Biology	20.33
8	178	If you love something, let it go mobile: Mobile marketing and mobile social media 4x4	Kaplan AM	2012	Business Horizons	17.80
9	168	Social networking site or social surveillance site? Understanding the use of interpersonal electronic surveillance in romantic relationships	Tokunaga RS	2011	Computers in Human Behavior	15.27
10	165	New media landscapes and the science information consumer	Brossard D	2013	Proceedings of the National Academy of Sciences of the United States of America	18.33

Mapping of all keywords

The software of VOS viewer was used in conjunction with the network analysis, which used keywords to identify a wide variety of areas and information regarding the investigation of sustainability and dangers that generally affect the firms. It resulted from analyzing the co-occurrence of the author's and the index's keywords. Figure 3 identifies the top fifty authors'

keywords where social media stand in the first position, followed by Twitter, scholarly communication, altmetrics, science communication, and web 2.0, respectively, with a frequency of 268, 121, 92, 79, 72, and 49 times.

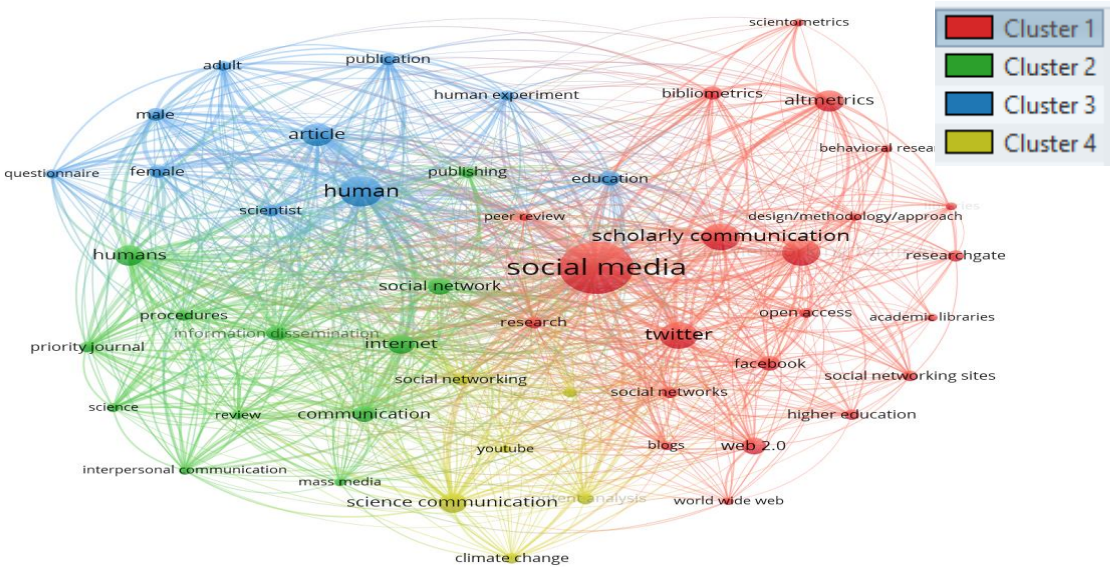

Figure3: Mapping of all Keywords through VOS viewer

Co-occurrence selected from "types of analysis" and all keywords selected from a "unit of analysis", Full counting method with Minimum (15) occurrence of keywords considered for analysis. Of the (3236) keywords, (50) meet the thresholds. For each of the (50) keywords, the total strength of the co-occurrence links with the other keywords will be calculated. The keywords with the greatest total link strength will be selected. The selected 50 keywords were grouped into four clusters with links (899) and total link strength (5541), as shown in Figure 3.

Cluster # 1 represents 22 keywords, namely academic libraries, altmetrics, behavioral research, bibliometric, blogs, design/methodology/approach, Facebook, higher education, libraries, open access, peer review, research, ResearchGate, scholarly communication, Scientometrics, social media, social, networking (online), social networking sites, social networks, Twitter, web 2.0, and world wide web

Cluster # 2 comprises 12 keywords: communication, humans, information dissemination, internet, interpersonal communication, mass media, priority journal, procedures, publishing, review, science, and social network.

Cluster # 3 comprises ten keywords: adult, article, education, female, human, human experiment, male, publication, questionnaire, and scientist)

Cluster # 4 includes 06 keywords: climate change, content analysis, science communication, social network analysis, social networking, and YouTube)

Thematic Map of ASNSs

In Figure 4, Clusters and Key Words Plus from the co-occurrence network are highlighted on a thematic map for 2007 through 2020. Information about how significant a topic is is displayed along the X-axis, reflecting centrality (the extent to which one cluster interacts with other clusters). The Y-axis represents density (i.e., the strength of an internal cluster network),

which can be taken as a proxy for the evolution of the subject (Di Cosmo, Pinelli, Scandurra, Aria & D'Aniello, 2021).

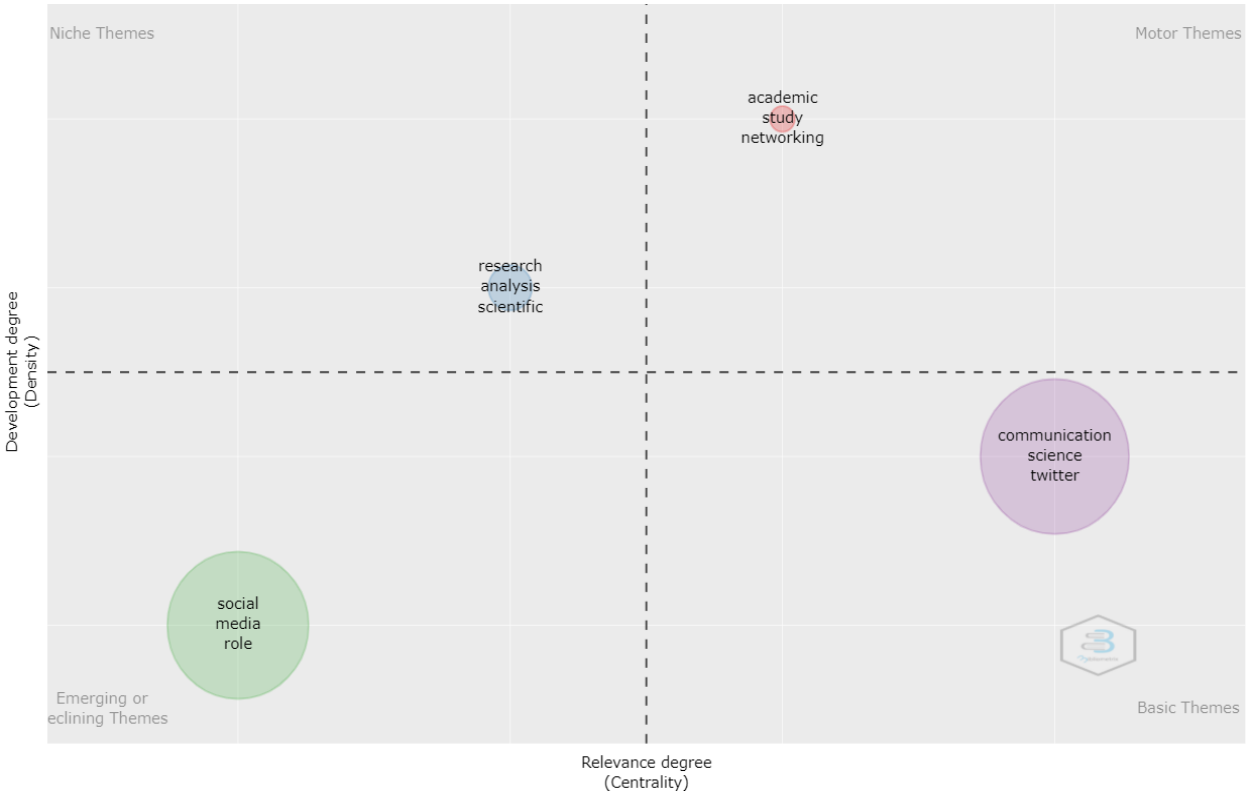

Figure 4: Thematic map of ASNSs Using Biblioshiny Software

Exploring the research theme by analyzing of co-citation of cited references

The cluster's label is derived from the noun phrases used in each cluster. Words and phrases referring to nouns are taken from a document's title, keywords, and abstract, with the most prominent of these phrases being used as labels for groups. The log-likelihood ratio (LLR) test, Term Frequency-Inverse Document Frequency (TF IDF), LSI (Latent Semantic Indexing), and Mutual Information (MI) test are the few cluster labeling extraction procedures offered by CiteSpace. This paper applied the LLR and LSI test, the default approach in CiteSpace, to get the labels out of the clusters. A likelihood ratio test contrasts the two statistical models (the null and alternative models) regarding how well they match the data. A likelihood ratio test compares two models depending on which one is more likely to explain the data. After calculating a p-value from this probability ratio (or its logarithm), one can decide whether or not to reject the null model by comparing it to a predetermined threshold value (Shi & Liu, 2019). The summary highlights major clusters first, including citing articles and cited references. The importance of nodes will be summarized in terms of citation-based metrics, such as citation counts and citation bursts, and network-based metrics, such as degree centrality and betweenness centrality. Sigma combines both types, i.e., burst and betweenness centrality. Other features are not included in the current summary, for example, structural variation analysis and analysis of uncertainties, concept trees, and dual-map overlays.

Figure 5 represents the mapping of major research theme-based co-citation of cited references, and a particular cluster represents each theme. It found 12 significant clusters. The

largest cluster (#0) has 75 members and a silhouette value 0.826. It is labeled scientometric analysis by LLR, social media by LSI, and unbearable emptiness (1.86) by MI. This hotspot focused on the metric analysis of articles related to social media. The major citing article of the cluster is M, THELWALL (2015.0) Web indicators for research evaluation. Part 2: social media metrics. Profesional de la Informacion, V24, P14 DOI 10.3145/epi.2015. The most cited author in this cluster is Holmberg K, 2014, DISCIPLINARY DIFFERENCES IN TWITTER SCHOLARLY COMMUNICATION @ SCIENTOMETRICS, V101(2).

The second largest cluster (#1) has 64 members and a silhouette value 0.874. It is labeled as a web indicator by both LLR and LSI and as a graduate student (0.61) by MI. The main citing article of the cluster is: L, BORNMANN (2014.0) Do altmetrics point to the broader impact of

research? An overview of benefits and disadvantages of altmetrics. Journal of Informetrics. DOI:

10.1016/j.joi.2014.09.005. The most cited author in this cluster is: Thelwall M, 2013, DO ALTMETRICS WORK? V 8(5),

The third largest cluster (#2) has 63 members and a silhouette value 0.859. It is labeled as an academic social networking site by both LLR and LSI and as social networking service (1.91) by MI. This hotspot focused on several social networking tools related to academia. The main citing article of the cluster is W, YAN (2018.0). Research universities on the ResearchGate social networking site: an examination of institutional differences, research activity level, and social networks formed. Journal of Informetrics, V12, P16 DOI: 10.1016/j.joi.2017.08.002. The most cited author in this cluster is Thelwall M, 2014, ACADEMIA, V 65(4). Other clusters: Cluster #3 Academic Library, Cluster #4 Mendeley Readership, Cluster #5 The Role, Cluster #6 Information Science, and Cluster #7 New Media Landscape.

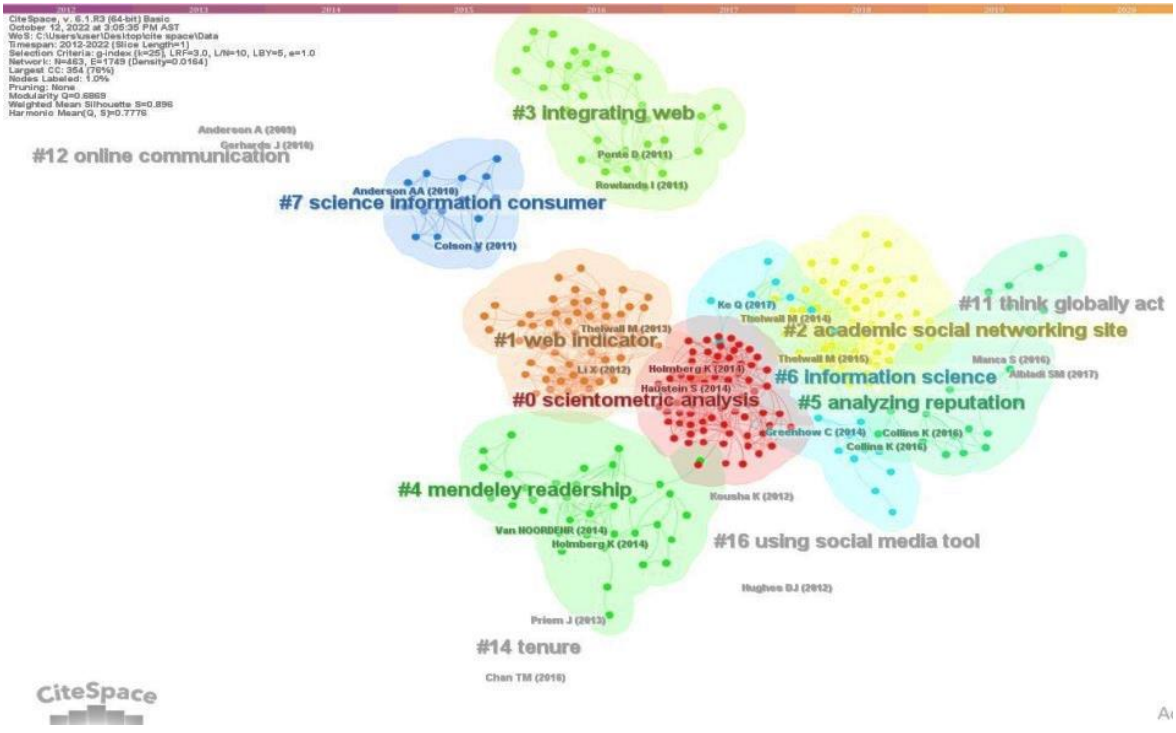

Figure 5: Exploring Research Theme by CiteSpace

Indicators of the centrality of countries on ASNSs

The United States (461 papers) was the country that published more articles in collaboration with other countries (Table 7). The country with the most significant number of collaborative papers was the UK (134 papers), followed by Canada (109 papers), China (77 papers), and Germany (74 papers).

Table 7
Indicators of the Centrality of Countries on ASNSs in Scholarly Communication

Rank	Country	Publications	Country	Cluster	Closeness	Country	Betweenness
1	USA	461	USA	2	0.02	USA	321.45
2	UK	134	UK	2	0.017	UK	107.66
3	Canada	109	Portugal	1	0.016	Spain	53.85
4	China	77	Spain	1	0.016	Canada	49.19
5	Germany	74	Japan	5	0.015	Japan	38
6	Spain	69	Sweden	1	0.015	Portugal	38
7	Australia	65	New Zealand	1	0.014	Netherlands	26.13
8	India	64	Canada	2	0.014	Australia	21.44
9	South Korea	40	Netherlands	2	0.014	China	13.21
10	Italy	35	Iran	1	0.013	Germany	12.64

The United Kingdom is more intense at the European level, followed by the Netherlands, Germany, and Australia. Based on centrality indicators of ASNSs in scholarly communication, the most prolific countries with the highest closeness in the network are the United States (0.02), the United Kingdom (0.017), and Spain (0.016). However, the countries that bridge the gap with other countries with the highest betweenness were the United States (321.45), the United Kingdom (107.66), and Spain (53.85). According to clusters, Japan has the most significant number of clusters, followed by the USA and the UK.

Figure 6 highlights the country-wise collaboration map where it is found that the USA, in collaboration with Canada, published the highest number of documents (27), followed by the USA with China and the USA with the UK reporting 21 and 19 documents, respectively.

Rank	From	To	NP	Rank	From	To	NP
1	USA	CANADA	27	6	UNITED KINGDOM	AUSTRALIA	10
2	USA	CHINA	21	7	USA	NETHERLANDS	10
3	USA	UNITED KINGDOM	19	8	UNITED KINGDOM	GERMANY	9
4	USA	GERMANY	11	9	USA	AUSTRALIA	9
5	USA	KOREA	11	10	UNITED KINGDOM	NETHERLANDS	7

Figure 6: Country Collaboration Map

Authorship Pattern on ASNSs

Table 8 exhibits the authorship pattern of literature on ASNSs in scholarly communication. It was found that two-authored publications were found to be on the top, sharing 203 documents, followed by three authored publications (157 documents). The single-authored publications ranked third place reporting 152 publications. It is worth discussing that the number of citations received by the single-authored publications was higher (3343) than the two and three-authored publications. However, the number of publications exceeds that of the single-authored contribution. However, the research on ASNSs in scholarly communication is pretty collaborative.

Table 8
Authorship Pattern on ASNSs

Authorship pattern	Publications	Times Cited
1	152	3343
2	203	3331
3	157	2583
4	75	1597
5	49	1032
6	21	362
7	12	185
8	10	229
9	4	66
10	3	44
11	2	41
12	3	59
13	1	4
14	1	1
15	1	30
16	1	2

Bradford's Law

"Bradford's Law is used to estimate the exponentially diminishing returns of extending a search for references in journals (Table 9). Bradford's Law specifies that if journals in a field are divided by the number of articles into three zones, the number of journals in each zone will be proportional to 1: n: n²" (Su, Lin, Chen & Lai, 2020). According to Bradford's Law of Scattering, if the journals in a particular field are arranged in descending order based on the number of articles they hold, there will be three different groups or zones. Bradford called the first zone the "nucleus of the journal particularly given to that subject." Zone 1 is called the Core, zone 2 is called the Middle zone, and Zone 3 is known as the tail zone.

Table 9
Bradford's Law of Scattering on ASNSs

Sr. No.	No. of Journals	No. of Articles	Total Articles	Cum. Articles
1	1	22	22	22
2	1	21	21	43
3	1	19	19	62

Sr. No.	No. of Journals	No. of Articles	Total Articles	Cum. Articles
4	1	16	16	78
5	3	14	42	120
6	1	13	13	133
7	1	12	12	145
8	1	10	10	155
9	3	9	27	182
10	2	8	16	198
11	4	7	28	226
12	**4 (12)**	**6**	**24 (250)**	**250**
13	9	5	45	295
14	16	4	64	359
15	24	3	72	431
16	**36 (85)**	**2**	**72 (253)**	**503**
17	**248**	**1**	**248**	**751**
Total	**345**		**751**	

In the current study, out of 345 journals, in the Core zone, 12 journals constituted 250 articles; in the middle zone, 85 journals held 253 articles; and in the tail zone, 248 journals contained 248 (Table 10 and Figure 7). Therefore, the data of ASNSs in scholarly communication does not conform to Bradford's distribution.

Table 10
Bradford's Zone of Source Journals on ASNSs

Zone	Number of Journals	Number of Articles	Multiplier factors
Zone-1	12	250	
Zone-2	85	253	7.08
Zone-3	248	248	2.92
Total	345	751	10.00 (mean 5.00)

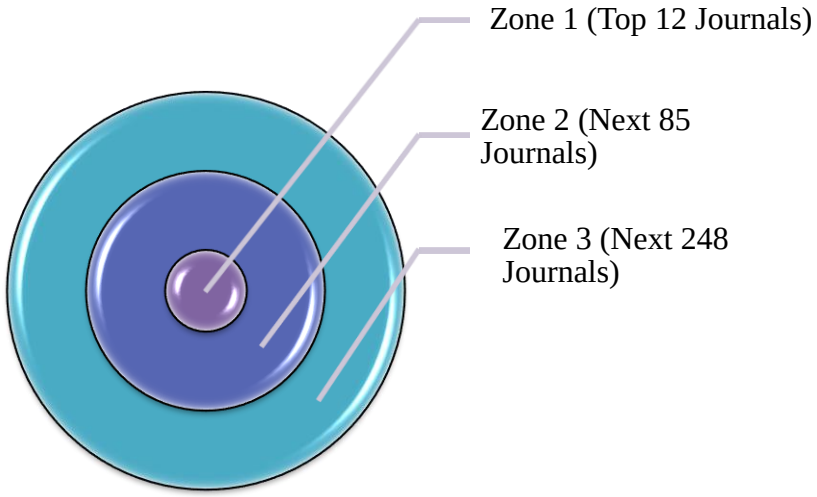

Figure 7: Bradford's Law of Scattering

Discussion

This study presented a bibliometric assessment of the use of academic and social networking sites in scholarly communication to get a clear idea regarding the countries, institutions, authors, publications, citations, and most frequently occurring words. Regarding types of documents, research articles mainly were in numbers, and similar results were found (Zyoud, Sweileh, Awang & Al-Jabi, 2018; Aparicio-Martinez, Perea-Moreno, Martinez-Jimenez, Redel-Macías, Vaquero-Abellan & Pagliari, 2019). It was found that the average number of citations per document is 4.51. In the context of the core journals devoted to ASNSs in scholarly communication, Scientometrics was the leading journal, followed by PLOS One, and the results are similar (Su, 2020). Regarding the yearly growth of literature, it is inferred that from 2007 to 2020, an overall positive growth trend was observed, and the result is consistent with (Abdullah & Othman, 2022; Zyoud et al., 2018).

As the name implies, a hotspot is a cluster of related documents exploring a specific scientific topic or issue over a specific period (Liang, Faria, Fidalgo-Neto & Mota, 2018). Broad characterizations of the subject matter in the literature serve as the keywords. To zero in on the most active areas of study related to social networking sites in scholarly communication, one need only examine the most frequently used terms. Keywords were also grouped for this research. In total, the study uncovered 12 clusters. Cluster analysis showed that research articles on Scientometrics analysis, web analysis, and social networking sites are the major hotspot. It means these are the emerging areas, with articles coming on them comparatively more.

The collaborative network has grown significantly over the previous decade, with the United States, Canada, China, and the United Kingdom taking the top spots. In general, more opportunities for scientists to collaborate might help spread information at all levels of the discipline. It has been proven that the growth rate and the number of citations of articles from international partnerships are higher than those from national collaborations (Di Cosmo, 2021). As could be seen in many bibliometric studies (Abdullah & Othman, 2022; Aparicio-Martinez et al., 2019; SeyyedHosseini, & BasirianJahromi, 2021; Su et al., 2020), the USA is the most productive country on ASNSs in scholarly communication, followed by UK and Canada. Regarding affiliation, Wuhan University, China, is the most productive institution. In addition, the research showed that the leading research institutions in the United States, Canada, and China produce the majority of the country's scientific output. There is a large amount of scientific production in the United States from the University of California at Berkeley, followed by the University of Wisconsin-Madison and Indiana University. The University of Montreal and British Columbia account for most Canadian scientific communications on ASNs. Like the United States, Wuhan University is China's most active participant in scientific publishing. These countries and organizations strongly associate with Thelwall M, Brossard D, Costas R, Haustein S, and Bowman TD.

The first three most productive sources (journals) were found in the category of Q2. The journal *Annals of Library and Information Studies* published by NISCAIR, India, was found to be the only Indian source among the most productive sources in this field. Surprisingly, no Indian or Malaysian authors were among the top twenty most productive authors. *Most of the publications from the Scientometrics journal (n=22) were* the most productive source.

In fig-4 depicts a thematic map where the four themes were detected. In the first theme (Motor), "academic," “study” and “networking" were found. This theme is considered an established, significant themes that help to organize a field of study (Di Cosmo et al., 2021).

Similarly, "Niche theme" is a highly developed plot but not relevant to the subject (Abd Aziz, et al., 2022). In this theme, "research," "analysis," and "scientific" was identified. The third (emerging or declining theme) is considered a weak and marginal quadrant. Keywords - "Social media role" is found. The fourth theme, "basic and transversal," deals with overarching themes that cut beyond specific subfields of study (Abd Aziz et al., 2022; Di Cosmo et al., 2021). In this quadrant, "Communication," "science," and "Twitter" was noticed.

Bradford's Law of Scattering does not fit well with the data of ASNSs in scholarly communication.

Conclusion

It is essential to highlight a few key conclusions from our bibliometric study of an emerging multidisciplinary field: the use of social networking sites in scholarly communication. The titles of these works (Social Networking Sites, Scholarly Communication) and the keywords (Academic Social networking Sites and Scholarly Communication, Social networking Sites, Scholarly Communication, Researcher Communication, and Science Communication) that the researchers have selected showed convergences and linkages between titles and keywords. This demonstrates that the articles published on social networking sites in scholarly communication are consistent with the description of the study.

Using bibliometrics as an assessment tool, the study on ASNSs in scholarly communication identifies various performing areas and other parameters besides mapping the pattern of authorship as well as the communication behavior of researchers in the field of social networking. Positive growth was observed in research productivity, and the single-authored publications were dominated by multi-authored. Interestingly, single-authored publications dominated the multi-authored papers in terms of citations. The research on ASNSs in scholarly communication is fairly collaborative, but the collaboration trend, in the case of developing countries like India, is not encouraging. Contrarily, not even a single institution from a developing country was found to be among the top-performing institutions globally. Therefore, it is suggested that developing countries must enhance research productivity and collaborative research for better visibility and more significant impact. The current study was limited to the SCOPUS database only. Other databases, including Web of Science, may produce better results with exhaustive coverage. Given the findings, it is concluded that the present study on ASNSs in scholarly communication is a milestone. It is worth conducting since social media play a catalyst role in disseminating scholarly communication accessible to the academic fraternity. The findings will benefit the teaching community, researchers, research scholars, and budding professionals in any field to use the ASNSs to a large extent.

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