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Mapping the Landscape of Open Science Research in Africa: A Bibliometric Analysis

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Abstract

This study conducted a comprehensive bibliometric analysis to map the landscape of open science research in Africa. Open science practices, including open-access publishing, open data sharing, open educational resources, open source, and open collaboration, have the potential to enhance scientific transparency, innovation, and collaboration. However, the adoption and implementation of open science principles vary across regions, and there is a need to understand the current state of open science research within the African context. A total of 302 datasets of documents from Scopus (Elsevier), from inception to 2023, were extracted, analysed, and visualised using software like MS Excel, Harzing's Publish or Perish and VOSviewer. A team of information specialists crafted the requisite keywords and verified the final search strategy. The results showed an increasing trend in new documents in open science in Africa. The most active source titles were Library Philosophy and Practice with 17 (7.02%), followed by Open Access Implication for Sustainable Social, Political, and Economic Development, and the African Journal of Library, Archives, and Information Science with 8 (3.31%). South Africa and Nigeria were the most influential countries contributing 59 (19.54%) and 56 (18.54%) publications in the subject area, respectively. The most productive authors were Ezema, I. J., and Nwagwu, W.E. with four documents each. The University of South Africa and the University of Nigeria were the most influential institutions with a total of publications 17 and 13, respectively. The citation analysis of highly cited articles pointed out that Mentis et al. (2017) and Duan et al. (2019) were the most cited articles in the subject area with 140 and 100 cites, respectively. The keywords analysis showed that open access, Africa, and open data were the most frequently used author keywords with 49 (20.25%), 35 (14.46%), and 34 (14.05%) total publications, respectively. The co-occurrence of research terms revealed four clusters of interconnected concepts, thematically organised around open access, human, Africa, and open-source software. The research will enhance comprehension within the field and is anticipated to assist researchers, students, and educators in pinpointing research areas, developments, high-quality scientific literature, and suitable journals for disseminating their findings related to open science. Furthermore, the study gives insights into the present state of open science research in Africa, which will guide policies, financing strategies, and capacity-building programmes targeted at supporting open science practices and furthering scientific research and innovation across the continent.

Keywords: Open Science; Africa; Bibliometric Analysis; Citation Analysis; Research Impact

1. Introduction

Open science is a movement that seeks to make scientific research, data, and dissemination available for all aspects of society, novice and professional (Chiware & Lockhart, 2024). It encompasses a range of practices, including open-access publishing, open data sharing, open educational resources, open-source software, and open collaboration. These practices have the potential to significantly enhance scientific transparency, innovation, and collaboration on a global scale. In recent years, open science has gained considerable momentum, driven by technological advancements and the growing recognition of the benefits of openness in research (Thibault et al., 2023). Open science is closely aligned with the United Nations Sustainable Development Goals (SDGs), particularly SDG 9 (Industry, Innovation, and Infrastructure), SDG 4 (Quality Education), and SDG 17 (Partnerships for the Goals), as it fosters inclusive and equitable access to knowledge, promotes innovation, and enhances global partnerships (United Nations, 2024).

Open science holds promise for resource-limited countries, especially research and academic institutions in African countries with fewer resources to support world-class impactful research and compete globally. By providing open access to scientific literature, open science reduces the financial barriers many African institutions face, allowing practitioners, researchers and students to access a wealth of information that would otherwise be out of reach (Strydom et al., 2022). Open data sharing enables African researchers to collaborate more effectively with their peers around the world, leveraging shared data sets to enhance the quality and impact of their work (Skelly & Chiware, 2022). Open educational resources and open-source software also play a crucial role in building local capacity, offering tools and learning materials that can be freely used and adapted to meet local needs (Mishra, 2017; Tella, 2020).

Despite the global push towards open science, its adoption and implementation vary widely across different regions. Africa faces unique challenges and opportunities in the realm of open science. The African research landscape is characterised by a diverse array of institutions, languages, and research priorities. Historically, African researchers have faced numerous barriers, including limited access to funding, inadequate infrastructure, and restricted access to scientific literature (Mishra, 2017; Skelly & Chiware, 2022; Strydom et al., 2022). Open science practices offer a pathway to overcoming some of these challenges

by providing broader access to research outputs and facilitating collaboration both within Africa and with the global research community. Understanding the current state of open science research in Africa is crucial for identifying gaps, fostering collaboration, and formulating strategies to promote open science on the continent.

Ideally, the open science movement makes scientific research and its dissemination accessible to all without paywalls or barriers, making science more impactful, reproducible, and transparent. However, open science research's growth and patterns are poorly understood or unclear, particularly in Africa (Okafor et al., 2022). Moreover, the impact of open science research on Africa, as measured by citations received, is limited (Huang et al., 2024).

Bibliometric analysis is a powerful tool for mapping the landscape of research activities and trends (Rejeb et al., 2020). By analysing publication data, patterns, and keyword usage, bibliometric studies can provide valuable insights into the development and dissemination of scientific knowledge. Thus, this study aims to conduct a comprehensive bibliometric analysis of open science research in Africa, utilising data from the Scopus database. By examining patterns of publication, authorship, institutional affiliation, and keyword co-occurrence, this study seeks to map the current landscape of open science research in Africa and identify key trends and influential contributors.

Additionally, the study employed the theory of citation analysis to explain the impact of open science research in Africa, which mainly assumes that a relationship exists between the number of citations and the document's quality, significance, and impact (Rejeb et al., 2022). Thus, incorporating this theory in this study facilitated assessing the impact of open science research in Africa.

This study not only contributes to the body of knowledge on open science but also supports the achievement of the SDGs by promoting inclusive and equitable access to scientific knowledge and fostering innovation and global partnerships.

Objectives of the study

This study was conducted to measure the following:

- the trends and growth of open science research in Africa and
- its impact based on citations received

2. Literature Review

Since the mid-2010s, the open science movement has grown rapidly, with research conducted across various disciplines and published primarily in information science, computer science, and multidisciplinary journals (Lee et al., 2022). Open science practices have gained prominence across disciplines such as public health, medicine, education, and computer science (Lee et al., 2022). Moreover, the field is evolving rapidly, with emerging areas like artificial intelligence, metadata, and ethics in open science (Ahmed et al., 2024). For instance, Whyte and Pryor (2011) reported that open science practices span various disciplines, including astronomy, bioinformatics, chemistry, epidemiology, language technology, and neuroimaging.

Open science research in Africa has gained momentum in recent years, with studies examining its status, challenges, and potential benefits. Publications on this topic have been emerging since at least 2017 (Bezuidenhout et al., 2017; Ezema & Onyancha, 2017), with ongoing research continuing through 2022 (Okafor et al., 2022). These studies highlight the slow but increasing adoption of open-access publishing in Africa, with South Africa and Egypt leading in repository contributions (Ezema & Onyancha, 2017). For instance, Ezema and Onyancha (2017) noted that the number of open-access journal articles from Africa increased from 2,019 in 2005 to 24,997 in 2014. However, researchers face significant barriers, including limited digital infrastructure, linguistic diversity, and economic constraints (Bezuidenhout et al., 2017; Mwelwa et al., 2020). Despite these challenges, open science presents opportunities for enhancing research visibility, fostering collaboration, and addressing complex societal issues (Mwelwa et al., 2020; Okafor et al., 2022). To fully realise the benefits of open science, African countries need to address funding and leadership challenges, develop compatible policies and practices, and create a well-coordinated, federated multi-state open science system (Mwelwa et al., 2020; Okafor et al., 2022).

Furthermore, research on open science in Africa reveals that South Africa and Egypt are leading contributors to scientific publications, alongside other top African countries (Waleed & Elbadawy, 2021). Additionally, Onyancha (2020) noted that the USA and England are the most influential countries in open science research collaboration with five sub-Saharan African countries.

Finally, Duzyol et al. (2011) reported that the

most cited open-access papers are by Lawrence, Antelman, and Swan & Brown, as identified through co-citation analysis. This highlights the impact and recognition of certain key works within the open science domain.

3. Methodology

This study employs a bibliometric analysis to map the landscape of open science research in Africa, involving data collection, analysis, and visualisation to systematically capture and analyse relevant bibliographic data. Data collection began with selecting Scopus (Elsevier) as the primary database, due to its comprehensive coverage of peer-reviewed literature across various disciplines (Schotten et al., 2017), and a team of information specialists developed a search strategy tailored to open science research in Africa, using keywords related to open science practices and geographical terms specific to Africa. The search covered publications from the inception of the database up to 2023, ensuring a comprehensive longitudinal analysis, and only documents explicitly focusing on open science within the African context were included, resulting in a total of 302 datasets extracted from Scopus, including information on authors, titles, source journals, publication years, affiliations, and citations as illustrated in Figure 1.

For data analysis, several software tools were employed: MS Excel for initial data cleaning, sorting, and basic statistical analysis; Harzing's Publish or Perish for gathering citation metrics and analysing author and institutional impact; and VOSviewer for creating visualisations of bibliometric networks, including co-authorship, co-citation, and keyword co-occurrence networks. Descriptive statistics summarised the distribution of publications across different categories, temporal trends in publication were analysed to identify growth patterns, and the most prolific authors and their contributions were identified along with their institutional affiliations. Citation metrics identified highly cited articles and influential authors, while keyword analysis revealed prominent themes and research focus areas through co-occurrence analysis.

Visualisation of the data used various tools and techniques: line charts to visualise temporal trends in the number of publications, maps and charts to display the geographical distribution of research output, and VOSviewer to generate network maps representing relationships between authors, institutions, and keywords. These visualisations included co-authorship

networks showing collaborations between researchers and institutions, co-citation networks illustrating interconnections between frequently cited articles, and keyword co-occurrence networks depicting thematic clusters within the research.

By systematically collecting, analysing, and visualising bibliometric data, this study provides a comprehensive overview of the landscape of open science research in Africa. The findings are expected to inform researchers, policymakers, and educators about the current state of open science practices and guide future initiatives aimed at promoting openness and collaboration in scientific research across the continent.

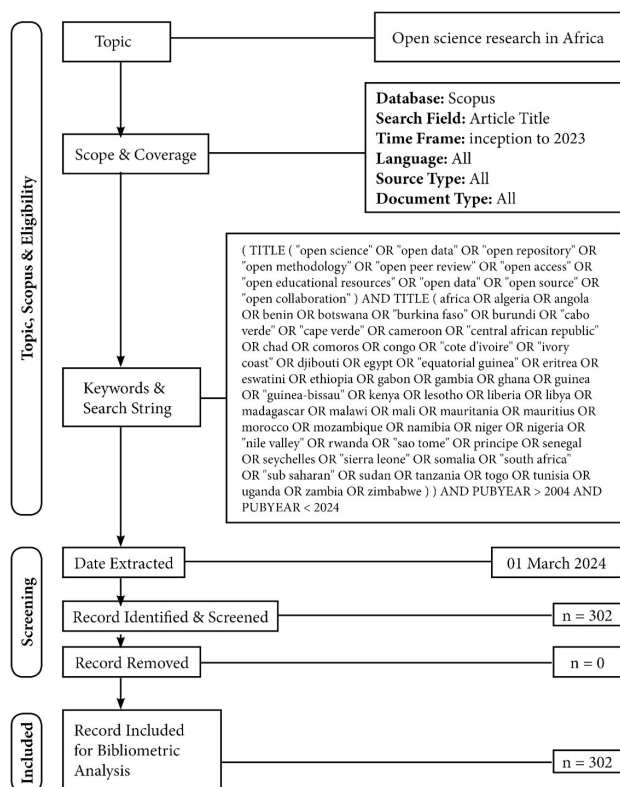


Figure 1. Flow diagram of the search strategy

4. Results

This section presents the results of the bibliometric analysis, structured under the following categories: document and source types, year of publication, languages of documents, subject areas, most active source titles, keyword analysis, geographical distribution of publications, authorship patterns, text analysis, most influential institutions, and citation analysis.

4.1. Document and Source Types

Table 1 shows the distribution of different types of documents in the dataset. The results show that

most of the publications were Articles, accounting for 194 (64.24%) of the total 302 documents, followed by Conference Papers 45 (14.90%), and Book Chapter 40 (13.25). The review recorded 12 (3.97) of the total publications. Other document types that recorded less than 1% of the total publication were Editorial 3 (0.99%), Note 3 (0.99%), Data Paper 2 (0.66%) and Erratum 2 (0.66%). The document type with the least publication was letter 1 (0.33%). Overall, the document distribution underscores the active engagement of African researchers in various scholarly activities, with a strong emphasis on articles and conference presentations. This pattern is indicative of a robust research culture that values both the dissemination of new findings and participation in scholarly dialogues.

Table 1: Document Type

Document Type	Total Publications (TP)	Percentage (%)
Article	194	64.24%
Conference Paper	45	14.90%
Book Chapter	40	13.25%
Review	12	3.97%
Editorial	3	0.99%
Note	3	0.99%
Data Paper	2	0.66%
Erratum	2	0.66%
Letter	1	0.33%
Total	302	100.00%

Table 2 presents the types of sources of the publications. From the table, most of the publications were found in Journals, constituting 211(69.87%) publications, followed by Conference Proceedings 36(11.92%) and Book 34(11.26%). Only few publications were found in Book Series 16(5.30 %) and Trade Journal 5(1.66%). Overall, the distribution of publication sources highlights a strong emphasis on journals and conferences, reflecting a robust research culture that values both peer-reviewed dissemination and academic dialogue. The presence of books and book series further enriches the scholarly landscape, offering detailed and authoritative resources for researchers.

Table 2: Source Type

Source Type	Total Publications (TP)	Percentage (%)
Journal	211	69.87%
Conference Proceeding	36	11.92%
Book	34	11.26%
Book Series	16	5.30%
Trade Journal	5	1.66%
Total	302	100.00%

4.2. Year of Publications/Evolution of Published Studies

Table 3 presents the distribution of publications over the years from 2005 to 2025. The table and the graph show an increasing trend in publications over time, with the most recent years having a higher number of publications. The table and graph depict a significant growth in the past six years (2017-2023), with the most significant growth occurring in 2020 (14%), 2023 (12%), and 2021(10%). The year 2005 to 2009 marks the evolution stage of research in the field of open science in Africa, showing low publications. Indeed only 3 (1%) of publications were recorded in 2007 as well as in 2008. In all, the distribution of publications over the years reflects a positive and accelerating trend in Open Science research in Africa. This growth not only signifies increased academic output but also underscores a commitment to the principles of openness, transparency, and collaboration in the scientific community.

Table 3: Year of Publications

Year	Total Publications	Percentage (%)	Cumulative Percent
2023	35	11.59%	11.59%
2022	24	7.95%	19.54%
2021	29	9.60%	29.14%
2020	41	13.58%	42.72%
2019	25	8.28%	50.99%
2018	23	7.62%	58.61%
2017	24	7.95%	66.56%
2016	14	4.64%	71.19%
2015	12	3.97%	75.17%

2014	13	4.30%	79.47%
2013	13	4.30%	83.77%
2012	8	2.65%	86.42%
2011	9	2.98%	89.40%
2010	10	3.31%	92.72%
2009	7	2.32%	95.03%
2008	3	0.99%	96.03%
2007	3	0.99%	97.02%
2006	4	1.32%	98.34%
2005	5	1.66%	100.00%
Total	302	100.00	

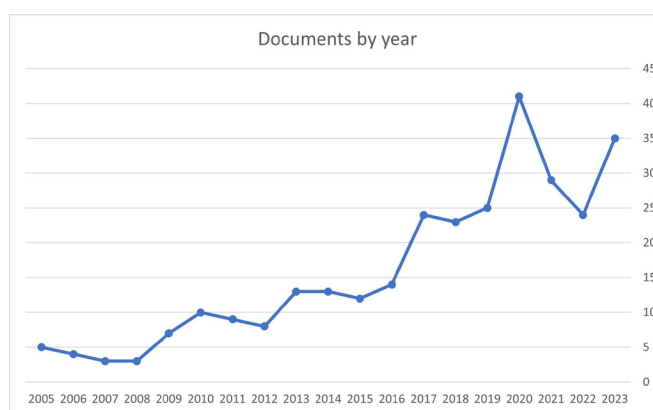


Fig. 2: Document by Year

4.3. Languages of Documents

Table 4 shows languages used for the publication of open science in Africa. As depicted in the Table, the most predominant language used in the publication was English, recording 299 (99.01%) publications over the period. Only 1 (0.33%) and 2 (0.66%) were published in Spanish and French respectively. The language distribution underscores the hegemony of English in the scholarly landscape of Open Science research in Africa. While this trend aligns with global scientific practices, efforts to promote linguistic diversity could enhance inclusivity and accessibility, ensuring that research benefits a wider range of communities across the continent.

Table 4: Languages Used for Publications

Language	Total Publications	Percentage (%)
English	299	99.01%
French	2	0.66%
Spanish	1	0.33%
Total	302	100.00%

4.4. Subject Area

Table 5 displays the distribution of open science research across various subject areas. The table depicts that open science publication in Africa is interdisciplinary. Social Sciences recorded the highest number of publications distribution of 175 (32.53%), followed by Computer Sciences 86 (16.54%). Other prominent areas included Medicine 32 (5.95%); Arts and Humanities 31(5.76); Earth and Planetary Sciences 29(5.39); Business, Management and Accounting 26(4.83%); Engineering 25(4.65%); and Environmental Science 25(4.65%). Areas of less prominent recording less than 1% publications included Chemistry 1(0.19%); Chemical Engineering 1(0.19%); Pharmacology, Toxicology and Pharmaceutics 2(0.37%); Physics and Astronomy 3(0.56%); and Immunology and Microbiology 3(0.56%). The interdisciplinary nature of Open Science publications in Africa suggests a collaborative and holistic approach to addressing societal challenges and advancing knowledge. It encourages cross-disciplinary collaborations, fosters innovation, and promotes the ethical and transparent dissemination of research findings. Moving forward, fostering awareness, building capacity, and enhancing infrastructure for Open Science across all disciplines can further strengthen research impact and contribute to sustainable development goals in Africa.

Table 5: Subject Area

Subject Area	Total Publications (n= 538)	Case Percentage (%)
Social Sciences	175	32.53%
Computer Science	89	16.54%
Medicine	32	5.95%
Arts and Humanities	31	5.76%
Earth and Planetary Sciences	29	5.39%
Business, Management and Accounting	26	4.83%
Engineering	25	4.65%
Environmental Science	25	4.65%
Agricultural and Biological Sciences	21	3.90%

Economics, Econometrics and Finance	17	3.16%
Decision Sciences	16	2.97%
Biochemistry, Genetics and Molecular Biology	13	2.42%
Energy	10	1.86%
Mathematics	9	1.67%
Multidisciplinary	5	0.93%
Immunology and Microbiology	3	0.56%
Physics and Astronomy	3	0.56%
Pharmacology, Toxicology and Pharmaceutics	2	0.37%
Chemical Engineering	1	0.19%
Chemistry	1	0.19%
Health Professions	1	0.19%
Materials Science	1	0.19%
Neuroscience	1	0.19%
Nursing	1	0.19%
Psychology	1	0.19%

4.5 Most Active Source Titles

Table 6 lists journals with their publication on open science in Africa. Library and information science journals published the most articles on open science in Africa, recording 17(6.8%). Other journals with relatively significant publications on open science in Africa included Open Access Implications for Sustainable Social Political and Economic Development 8(3.20%); African Journal of Library Archives and Information Science 7(2.80%); Frontiers in Research Metrics and Analytics 7(2.80%). Applied Geography and African Journal of Science Technology Innovation and Development Journals recorded the least publications on open science, with 2(0.80%) publications each. The distribution of publications across diverse journals reflects a multidimensional approach to Open Science in Africa, integrating disciplinary insights and regional contexts. It emphasises the need for continued collaboration, capacity-building, and policy support to advance

Open Science practices across different sectors and disciplines within the continent. Strengthening partnerships between researchers, institutions, and journals can further enhance the visibility, impact, and sustainability of Open Science initiatives in Africa.

Table 6: Most Active Source Title

Source Title	Total Publications (n=250)	Case Percentage (%)
Library Philosophy and Practice	17	6.80%
Open Access Implications for Sustainable Social Political and Economic Development	8	3.20%
African Journal of Library Archives and Information Science	7	2.80%
Frontiers In Research Metrics and Analytics	7	2.80%
International Archives of The Photogrammetry Remote Sensing and Spatial Information Sciences ISPRS Archives	5	2.00%
International Review of Research in Open and Distance Learning	5	2.00%
2013 1st Africa Conference and Exhibition 1st Africa 2013	4	1.60%
Journal Of Academic Librarianship	4	1.60%
ACM International Conference Proceeding Series	3	1.20%
BMC Research Notes	3	1.20%

Data Science Journal	3	1.20%
Electronic Library	3	1.20%
IFIP Advances in Information and Communication Technology	3	1.20%
Lecture Notes in Educational Technology	3	1.20%
Library Hi Tech	3	1.20%
Library Management	3	1.20%
Open Data in Developing Economies Toward Building Evidence Base on What Works and How	3	1.20%
South African Journal of Science	3	1.20%
African Journal of Science Technology Innovation and Development	2	0.80%
Applied Geography	2	0.80%

4.6 Keywords Analysis

The keyword analysis of Open Science research in Africa reveals several key themes. “Open Access” is prominent, emphasising accessibility and transparency in 4.71% (n=49) of publications. Regional focus is evident with “Africa” 35(3.36%) and specific country mentions like “South Africa” 24(2.31%) and “Kenya” 22(2.11%). Technological integration includes “Open-Source Software” 29(2.79%) and “GIS” 16(1.54%). Human-centered keywords 49(4.71%) and “Developing Countries” 23(2.21%) highlight societal impact. Institutional support via “Institutional Repositories” 18(1.73%) is crucial. This analysis underscores diverse research interests and regional leadership in advancing Open Science principles across Africa.

Table 7: Top Keywords

Author Keywords	Total Publications (n=1041)	Case Percentage (%)
Open Access	49	4.71%
Africa	35	3.36%
Open Data	34	3.27%
Open-Source Software	29	2.79%
Open Systems	29	2.79%
Human	28	2.69%
South Africa	24	2.31%
Developing Countries	23	2.21%
Kenya	22	2.11%
Humans	21	2.02%
Institutional Repositories	18	1.73%
Nigeria	18	1.73%
Computer Software	16	1.54%
GIS	16	1.54%
Open Science	16	1.54%
Article	15	1.44%
Remote Sensing	15	1.44%
Tanzania	15	1.44%
Ghana	12	1.15%
Software	12	1.15%

4.7 Geographical Distribution of Publications - Most Influential Countries

Table 8 presents the contribution of the top countries to open science research in Africa. South Africa, Nigeria and the United States were the leading contributors with 59(12.45%), 56(11.81%) and 55(11.60%) respectively. Other countries with significant contribution to open science publication were Kenya 37(7.81%) and the United Kingdom 34(7.17%). Among the top 20 countries, China, Switzerland, and Ethiopia contributed the least with 5(1.05%), 6(1.27%), and 6(1.27%) publications respectively. The distribution of Open Science publications among these top 20 countries highlights the collaborative and multidimensional nature of research in Africa.

It emphasises the importance of fostering global partnerships, enhancing research capacities, and promoting inclusive participation to strengthen Open Science practices across the continent. Continued support from diverse stakeholders, including governments, institutions, and international organisations, is essential for sustaining momentum and achieving impactful research outcomes in Africa's Open Science landscape.

Table 8: Most Influential Countries

Country	Total Publications (n= 474)	Case Percentage (%)
South Africa	59	12.45%
Nigeria	56	11.81%
United States	55	11.60%
Kenya	37	7.81%
United Kingdom	34	7.17%
Ghana	14	2.95%
Tanzania	14	2.95%
Botswana	13	2.74%
Zimbabwe	10	2.11%
Canada	9	1.90%
France	8	1.69%
Italy	8	1.69%
Netherlands	8	1.69%
Uganda	8	1.69%
Germany	7	1.48%
Malaysia	7	1.48%
Sweden	7	1.48%
Ethiopia	6	1.27%
Switzerland	6	1.27%
China	5	1.05%

4.8 Authorship

Table 9 lists the number of authors per document. The findings indicate most publications have fewer authors. Two-author articles had the most publication 84(27.81%), followed by sole-author articles 71(23.51%). Three and four-author articles recorded 57(18.87%) and 28(9.27%) publications, respectively. Generally, articles with more than 10 authors recorded just 1(0.33%) publication. The results indicate a

vibrant and active research community engaged in Open Science in Africa, with opportunities to expand collaborative efforts further and enhance research impact through strategic support and infrastructure development.

Table 9: Number of Author(s) per Document

Author Count	Total Publications	Percentage (%)
1	71	23.51%
2	84	27.81%
3	57	18.87%
4	28	9.27%
5	11	3.64%
6	16	5.30%
7	9	2.98%
8	6	1.99%
9	7	2.32%
10	4	1.32%
11	1	0.33%
12	1	0.33%
13	2	0.66%
15	1	0.33%
18	1	0.33%
23	1	0.33%
29	1	0.33%
0*	1	0.33%
Total	302	100.00%

*No author is listed.

Table 10 showcases the authors' productivity based on the number of documents on open science in Africa produced. Most of the authors have made 2-3 papers. Only two authors, Ezema, I.J. and Nwagwu, W.E., produced 4 (1.50%) documents each. The productivity analysis highlights a dedicated group of researchers contributing to Open Science in Africa, with opportunities to enhance and expand their impact through strategic support and community-building efforts.

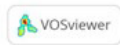
Table 10: Most Productive Authors

Author's Name	Total Publications (n=266)	Case Percentage (%)
Ezema, I.J.	4	1.50%
Nwagwu, W.E.	4	1.50%
Arderne, C.	3	1.13%
Bakar, A.D.	3	1.13%
Din, J.	3	1.13%
Howells, M.	3	1.13%
Kibet, C.K.	3	1.13%
Kodua-Ntim, K.	3	1.13%
Korkovelos, A.	3	1.13%
Onyancha, O.B.	3	1.13%
Verhulst, S.	3	1.13%
Young, A.	3	1.13%
Zulzalil, H.	3	1.13%
Akakandelwa, A.	2	0.75%
Atiso, K.	2	0.75%
Bangani, S.	2	0.75%
Baro, E.E.	2	0.75%
Bashorun, M.T.	2	0.75%
Bawa, A.C.	2	0.75%
Bezuidenhout, L.	2	0.75%

4.9 Text Analysis

Figure 6 shows the network visualization map which provides a comprehensive analysis of the relationships between texts in open science research in Africa. This map aids in understanding the prevailing research trends by illustrating how frequently various texts co-occur in literature.

The map encompasses a total of 62 texts, grouped into four (4) distinct clusters represented by different colours. These texts are interconnected by 657 links, reflecting a total link strength of 1353 thematically organised around open access, human, Africa, and open-source software. This dense network indicates a robust interrelationship among the research topics in the field.



4.10 Most Influential Institutions

Table 11: Most influential institutions

Institution	Total Publications (n= 352)	Case Percentage (%)
University of South Africa	17	4.83%
University of Nigeria	13	3.69%

University of Botswana	10	2.84%
University of Nairobi	10	2.84%
University of Cape Town	8	2.27%
University of KwaZulu-Natal	8	2.27%
University of Oxford	8	2.27%
University of Ibadan	7	1.99%
University of Pretoria	5	1.42%
International Centre of Insect Physiology and Ecology Nairobi	5	1.42%
University of Dar es Salaam	5	1.42%
Federal University of Technology, Owerri	4	1.14%
The Royal Institute of Technology KTH	4	1.14%
Nuffield Department of Medicine	4	1.14%
University of the Witwatersrand, Johannesburg	4	1.14%
Kenyatta University	4	1.14%
Wellcome Trust Research Laboratories Nairobi	4	1.14%
Sokoine University of Agriculture	4	1.14%

4.11 Citation Analysis

Table 12 shows the analysis of open science research in Africa from 2005 to 2023 revealing insightful citation metrics, reflecting the impact and dissemination of research outputs within this

period. The data encompasses 302 papers, receiving a total of 2,538 citations over 19 years (2005-2024). On average, this equates to 133.58 citations per year, with each paper receiving an average of 8.40 citations. Furthermore, the analysis shows a total of 934 citations per author and an average of 147.88 papers per author, indicating the collaborative nature of research in this domain with an average of 3.20 authors per paper. The h-index and g-index values are 26 and 40, respectively, underscoring the significant impact of the most influential papers within the dataset.

Table 12: Citations Metrics

Metrics	Data
Publication years	2005-2023
Citation years	19 (2005-2024)
Papers	302
Citations	2538
Citations/year	133.58
Citations/paper	8.40
Citations/author	934.00
Papers/author	147.88
Authors/paper	3.20
h-index	26
g-index	40

Highly Cited Articles

The most influential articles in open science research in Africa demonstrate the significant impact of various studies on the field. Leading the list is the work by Mentis et al. (2017) titled “Lighting the World: The First Application of an Open Source Spatial Electrification Tool (OnSSET) on Sub-Saharan Africa” which has garnered 140 citations, followed by Duan et al. (2019), which received 100 citations. Moreover, Asiimwe et al. (2011) made a notable contribution with 82 citations. Mtebe and Raisamo (2014) have two influential articles investigating the barriers and challenges to using open educational resources in Tanzanian higher education with 82 and 80 citations, respectively. Moritz et al. (2013) received 79 citations for their research on the pastoral management of common-pool resources in the Chad Basin and, Tom-Aba et al. (2015) is notable with 71 citations. These highly cited articles reflect the broad impact and interdisciplinary nature of open science research in Africa, illustrating how open access and collaborative tools can address diverse and pressing challenges across the continent.

Table 13: Highly cited articles

Authors	Title	Year	Cites	Cites Per Year
D. Mentis, M. Howells, H. Rogner, A. Korkovelos, C. Arderne, E. Zepeda, S. Siyal, C. Taliotis, M. Bazilian, A. De Roo, Y. Tanvez, A. Oudalov, E. Scholtz	Lighting the World: the first application of an open source, spatial electrification tool (OnSSET) on Sub-Saharan Africa	2017	140	20
Z. Duan, Y. Tuo, J. Liu, H. Gao, X. Song, Z. Zhang, L. Yang, D.F. Mekonnen	Hydrological evaluation of open-access precipitation and air temperature datasets using SWAT in a poorly gauged basin in Ethiopia	2019	100	20
C. Asiimwe, D. Gelvin, E. Lee, Y. Ben Amor, E. Quinto, C. Katureebe, L. Sundaram, D. Bell, M. Berg	Use of an innovative, affordable, and open-source short message service-based tool to monitor malaria in remote areas of Uganda	2011	82	6.31
J.S. Mtebe, R. Raisamo	Investigating perceived barriers to the use of open educational resources in higher education in Tanzania	2014	82	8.2
J.S. Mtebe, R. Raisamo	Challenges and Instructors' intention to Adopt and use open educational resources in higher education in Tanzania	2014	80	8
M. Moritz, P. Scholte, I.M. Hamilton, S. Kari	Open Access, Open Systems: Pastoral Management of Common-Pool Resources in the Chad Basin	2013	79	7.18

Authors	Title	Year	Cites	Cites Per Year
D. Tom-Aba, A. Olaleye, A.T. Olayinka, P. Nguku, N. Waziri, P. Adewuyi, O. Adeoye, S. Oladele, A. Adeseye, O. Oguntimehin, F. Shuaib	Innovative technological approach to Ebola virus disease outbreak response in Nigeria using the open data kit and form hub technology	2015	71	7.89
S.P. Upashe, T. Tekelab, J. Mekonnen	Open Access Assessment of knowledge and practice of menstrual hygiene among high school girls in Western Ethiopia	2015	55	6.11
A. Korkovelos, B. Khavari, A. Sahlberg, M. Howells, C. Arderne	The role of open access data in geospatial electrification planning and the achievement of SDG7. An onset-based case study for Malawi	2019	54	10.8
F.L.K. Ohemeng, K. Ofosu-Adarkwa	One way traffic: The open data initiative project and the need for an effective demand side initiative in Ghana	2015	53	5.89
T. Tuti, M. Bitok, C. Paton, B. Makone, L. Malla, N. Muinga, D. Gathara, M. English	Innovating to enhance clinical data management using non-commercial and open source solutions across a multi-center network supporting inpatient pediatric care and research in Kenya	2016	52	6.5
D.M. Matheka, J. Nderitu, D. Mutonga, M.I. Otiti, K. Siegel, A.R. Demaio	Open access: Academic publishing and its implications for knowledge equity in Kenya	2014	47	4.7
R. Lasaponara, B. Murgante, A. Elfadaly, M.M. Qelichi, S.Z. Shahraki, O. Wafa, W. Attia	Spatial open data for monitoring risks and preserving archaeological areas and landscape: Case studies at Kom el Shoqafa, Egypt and Shush, Iran	2017	40	5.71
J. Thakrar, D. Zinn, F. Wolfenden	Harnessing open educational resources to the challenges of teacher education in sub-Saharan Africa	2009	38	2.53
W.E. Nwagwu	Open Access Initiatives in Africa - Structure, Incentives and Disincentives	2013	37	3.36
P. Murphy, F. Wolfenden	Developing a pedagogy of mutuality in a capability approach: Teachers' experiences of using the Open Educational Resources (OER) of the Teacher Education in sub-Saharan Africa (TESSA) programme	2013	36	3.27
D.G. Dillon, F. Pirie, S. Rice, C. Pomilla, M.S. Sandhu, A.A. Motala, E.H. Young	Open-source electronic data capture system offered increased accuracy and cost-effectiveness compared with paper methods in Africa	2014	36	3.6
L. Rayne, M.C. Gatto, L. Abdulaati, M. Al-Haddad, M. Sterry, N. Sheldrick, D. Mattingly	Detecting change at archaeological sites in North Africa using open-source satellite imagery	2020	34	8.5
C. May	Escaping the TRIPs' trap: The political economy of free and open source software in Africa	2006	34	1.89
N. Khalaf, T. Insoll	Monitoring Islamic Archaeological Landscapes in Ethiopia Using Open Source Satellite Imagery	2019	31	6.2

5. Discussion of results

The results from this study provide a comprehensive overview of the landscape of open science research in Africa, highlighting key trends, influential contributors, and areas of focus. These insights are critical for understanding the current state and potential future directions of open science on the continent.

Most of the publications on open science in Africa were articles, constituting 64.24% of the total documents.

This predominance of articles aligns with the global general trend, where articles are the primary mode of disseminating scientific knowledge (Atieno et al., 2022; Burrell et al., 2024). Conference papers and book chapters also contributed significantly, accounting for 14.90% and 13.25% of the documents, respectively. Furthermore, the types of sources for these publications were predominantly journals (69.87%), followed by conference proceedings (11.92%) and books (11.26%). These results are consistent with the literature, which indicates a high concentration of open science research in multidisciplinary and specialised journals (Lee et al., 2022).

The distribution of publications over the years reveals a significant growth in open science research in Africa, particularly in the past six years (2017-2023). The most notable increases occurred in 2020, 2023, and 2021, reflecting a growing interest and investment in open science. This trend mirrors global patterns where the open science movement has gained momentum due to technological advancements and increased advocacy for open access (Ezema & Onyancha, 2017; Okafor et al., 2022). Despite this progress, the initial adoption of open science practices in Africa was slow, indicating persistent challenges such as limited digital infrastructure and economic constraints (Bezuidenhout et al., 2017; Mwelwa et al., 2020).

In terms of subject areas, social sciences recorded the highest number of publications (32.53%), followed by computer sciences (16.54%). This distribution highlights the interdisciplinary nature of open science, encompassing both the humanities and STEM fields. The prominence of social sciences in open science research may be attributed to the field's focus on societal issues and the potential for open access to enhance public engagement and policy impact. Similarly, computer science's significant contribution aligns with the field's central role in developing and implementing open science tools and platforms (Ahmed et al., 2024; Lee et al., 2022).

Moreover, South Africa, Nigeria, and the United States emerged as the leading contributors to open science research in Africa. South Africa contributed 12.45% of the publications, Nigeria 11.81%, and the United States 11.60%. This result underscores the pivotal role of South Africa and Nigeria in driving open science initiatives on the continent. It also highlights the importance of international collaboration, as evidenced by the significant contributions from the United States (Onyancha, 2020; Waleed & Elbadawy, 2021).

Furthermore, the citation analysis identified Mentis et al. (2017) and Duan et al. (2019) as the most cited articles, with 140 and 100 citations, respectively. This indicates that these works have had a substantial impact on the field of open science in Africa. The high citation count reflects the recognition and influence of these studies within the academic community, contributing to the broader discourse on open science practices and their implications (Duzyol et al., 2011).

Finally, the results reveal that open science research in Africa is growing steadily, and that certain key works have significantly influenced the field, thereby validating the use of the conceptual framework in understanding research growth and impact.

In summary, this study provides valuable insights into the types, sources, and trends of open science publications in Africa. While there has been notable progress in recent years, significant barriers remain that need to be addressed to fully realize the potential of open science on the continent. By understanding these patterns and leveraging the contributions of key countries and influential research, stakeholders can better promote and support the adoption of open science practices in Africa, ultimately enhancing research visibility, fostering collaboration, and addressing complex societal issues.

6. Conclusion

This study provides a comprehensive bibliometric analysis of open science research in Africa, systematically capturing and analysing relevant bibliographic data to map trends, contributors, and thematic focus areas. The analysis revealed an increasing trend in open science publications, with South Africa and Nigeria being the most influential countries. Key contributors and institutions were identified, and keyword analysis highlighted prominent themes such as open access, Africa, and open data. The visualisations offered insights into the collaborative networks and thematic clusters within the research landscape.

The study contributes significantly to the understanding of open science practices in Africa. By identifying key trends, influential authors, institutions, and thematic focus areas, this research provides a valuable resource for researchers, policymakers, and educators. The findings support the advancement of open science by highlighting areas of strength and potential growth, thereby promoting greater transparency, innovation, and collaboration in African scientific research. Additionally, this study aligns with

the United Nations Sustainable Development Goals (SDGs) by promoting inclusive and equitable access to knowledge, fostering innovation, and enhancing global partnerships.

While this study offers valuable insights, it is not without limitations. The reliance on Scopus (Elsevier) as the sole database may have excluded relevant publications indexed in other databases, potentially leading to a partial representation of the open science landscape in Africa. Furthermore, the analysis was limited to documents explicitly focusing on open science within the African context, which may have overlooked interdisciplinary research that indirectly contributes to open science practices. Additionally, language barriers and the availability of full-text access might have impacted the comprehensiveness of the data collected.

Future research should aim to address the limitations of this study by incorporating data from multiple databases and exploring interdisciplinary research contributions to open science. Expanding the analysis to include more recent publications and assessing the impact of open science policies and initiatives across different African countries will provide a more nuanced understanding of the evolving landscape. Additionally, qualitative studies exploring the experiences and challenges faced by African researchers in adopting open science practices could complement the bibliometric analysis, offering deeper insights into the barriers and facilitators of open science in Africa. Further research should also investigate the role of language and regional collaborations in shaping open science practices on the continent.

In conclusion, this study lays the groundwork for a deeper understanding of open science research in Africa, providing a foundation for future efforts to promote open science and support the achievement of the SDGs through enhanced scientific transparency, innovation, and global collaboration.

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