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Navigating the knowledge landscape of Sustainable Development Goals: a scientometric analysis

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Abstract

Purpose – The purpose of this study is to analyze the research output in the field of Sustainable Development Goals (SDGs) and to examine various trends in the scientific literature on SDGs using bibliometric analysis.

Design/methodology/approach – The data was collected from the Web of Science database for the period 2020–2024 to assess the literature on the topic. A total of 6,340 retrieved documents/articles from 1,157 journals were analysed by using various modules of Biblioshiny and Excel.

Findings – The study highlights the rapid growth and global collaboration in research on SDGs, with China leading in scientific output, followed by the USA and the UK. *Sustainability* and the *Journal of Cleaner Production* are the most prolific and influential journals. Leading institutions include Beijing Normal University and the University of Chinese Academy of Sciences, with significant input from the University of Oxford. Keyword analysis emphasises “Impact”, “Management” and “Performance”. Annual scientific production peaked in 2023. The data reveal a dynamic research landscape with significant international collaboration, reflecting the global commitment to achieving sustainable development goals.

Practical implications – This study traces trends in the field of SDGs. It can guide researchers and institutions to focus on the impactful areas of SDG research and foster international collaboration to achieve global sustainability goals.

Originality/value – This study provides the most recent and temporally comprehensive assessment of the worldwide SDG research since it extends the analysis to mid-2024. It provides deeper insights into research structures and evolving thematic priorities in the research areas.

Keywords Sustainability, Research trends, Sustainable development goals, SDGs, Scientometric analysis, Scientific mapping

Paper type Research paper

Abbreviations

SDGs = Sustainable Development Goals;
WoS = Web of Science;
MDG = Millennium Development Goals;
USA = United States of America;
UK = United Kingdom;
UN = United Nations;

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TS = Topic Search;
TC = Total Citations;
PY = Publication Year; and
DT = Document Type.

Introduction

The United Nations (UN) Sustainable Development Goals (SDGs) are a universal political agenda that address collective action to achieve a better and more sustainable future for all, solving the social, economic and environmental issues that hinder global progress towards sustainability intended to be achieved by the year 2030 (Bennich *et al.*, 2020; Pradhan *et al.*, 2017; United Nations, 2015). The UN General Assembly approved Resolution A/RES/70/1 on "Transforming our world: the 2030 Agenda for Sustainable Development" (United Nations, 2017). The agenda outlines 17 SDGs and specific targets and indicators for each of the 17 SDGs, totalling 169 targets and 213 indicators that form a global action plan (Li *et al.*, 2023; Telleria and Garcia-Arias, 2021). The SDGs are a recognized blueprint essential for achieving shared and sustainable prosperity with global action among governmental and non-governmental organizations, businesses, industry, civil society organizations, research and technology development (Husainy *et al.*, 2024; Khaled *et al.*, 2021). As part of the 2030 Agenda for Sustainable Development, which outlined a 15-year strategy to attain these Goals, all the United Nations Member States adopted these 17 goals in 2015 (Donoghue and Higgins, 2023; Singh, 2024).

The United Nations General Assembly set these objectives in 2015 with the intention of addressing several global issues, such as poverty, inequality, environmental degradation, climate change, peace and justice (Bukhari *et al.*, 2023). The Millennium Development Goals (MDGs), which were implemented from 2000 to 2015, have yielded successes and lessons that the SDGs were built upon (Hickmann *et al.*, 2022; Knox and Orazgaliyev, 2024). As a worldwide challenge requiring cooperative action, sustainable development is recognized by the SDGs, which are universal and applicable to all countries, in contrast to the MDGs, which primarily focus on developing nations (Fukuda-Parr, 2023; Kushnir and Nunes, 2022). The objectives of SDGs are related to one another, with advancements in one field frequently influencing advancements in another (Henderson and Loreau, 2023; Leal Filho *et al.*, 2018; Salvia *et al.*, 2019).

An unprecedented amount of input and involvement from various stakeholders, including governments, academia, the commercial sector and civil society, has led to the creation of the SDGs (Donoghue and Higgins, 2023). These goals are relevant and sensitive to the various needs and interests of many nations and groups (Berrone *et al.*, 2023; Siegel and Bastos Lima, 2020). A strong set of indicators and targets that serve as a foundation for oversight and accountability support the SDGs. Tracking advancement, spotting gaps and directing resources and efforts where they are most needed depends on this framework (Arora-Jonsson, 2023).

Scientometric analysis offers a valuable approach for examining scientific literature on SDGs (Raman *et al.*, 2024; Sianes *et al.*, 2022; Yamaguchi *et al.*, 2023). By relying on scientometric techniques and data mining analyses, this study collected and analysed 6,340 papers published on the SDGs. The primary purpose of this paper is to develop a critical yet comprehensive scientometric analysis of global academic production on SDGs from 2020 to 2024, conducted using the Web of Science (WoS) database, which is a multidisciplinary citation indexing platform that provides access to high-quality scholarly literature for bibliometric and research analysis. Scientometrics (see Appendix) can provide insights into how research efforts align with SDGs, highlight key focus areas and identify emerging trends and other novel insights. This study will analyze publication trends, citation patterns, author collaborations, thematic focus of research, annual scientific production (see Appendix), core sources, most relevant affiliations, country production and social network analysis. By providing a detailed overview of the scientific contributions towards the SDGs, this research seeks to contribute to a deeper understanding of the role of research in advancing sustainable development.

Research significance

This study provides quantitative insights into the global research landscape on SDGs, offering valuable data for universities, libraries, funding agencies and policymakers to mobilize resources effectively. This study contributes as a comprehensive assessment of the impact of research, enabling stakeholders to identify prioritised research areas concerning publications and emerging trends. Knowing the scientometric trends in SDG research is essential for showcasing the focused scholarly efforts at the global level. Scientometric mapping not only concerns research productivity metrics but also plays a significant role in guiding education policies and pedagogical innovations to support effective SDG implementation at different levels. Such mapping ensures that scientific information aligns with policy requirements and societal challenges, which is crucial given the urgency of accomplishing Agenda 2030. Thus, the present study further adds value to the global discourse on sustainability and provides recommendations for enhancing the alignment of academic research with the SDG agenda.

Review of literature

Given the significance of SDGs, numerous bibliometric and scientometric mapping studies have been conducted worldwide on the body of literature. Several countries and institutions have actively contributed to SDG research (Bautista-Puig *et al.*, 2021). The USA, China and UK account for 31% of the contributions in the scientometric analysis of publications published between 2015 and 2022, which provides important insights into research output and trends in SDG literature (Mishra *et al.*, 2023). Alfirevic *et al.* (2023) reveal that the USA is the most productive country, and the results also show that scientific productivity is high in the UK, followed by India, Germany, Australia, China and Spain. The G20 countries have also actively contributed to SDGs, as their research publications account for approximately 57.75% of all research publications worldwide over the relevant period (Singh, 2024). Another study by Hsieh and Yeh (2024) also highlights that the countries with the most research in this field are China, India, the USA, the UK and Australia, with Environmental Sciences and Ecology being the most published domain.

Yamaguchi *et al.* (2023) present a thorough bibliometric analysis of literature reviews on the SDGs from 2015 to 2022 and found most documents within the general sustainability categories, such as Green Technology and Environmental Sciences. However, there were additional unidentified essential research fields, such as Economic Growth (SDG 8) and Technology (SDG 9). Hsieh and Yeh (2024) also identified 19 clusters intersecting climate change and SDGs, with the top five clusters in terms of proportion related to Agricultural and Food Systems, Water and Soil Resources, Energy, Economy, Ecosystem and Sustainable Management. The study by Raman *et al.* (2024) showcases that three main themes emerge: Poverty, Renewable Energy and Sustainable Development. The Global burden of diseases, Women's and Maternal health and Universal health coverage were also important themes (Sweileh, 2024). SDGs 11, 12, 13 and 15 were found to be among the most investigated SDGs. In contrast, SDGs 8 and 14 were among the least researched (Raman *et al.*, 2024). SDG research spans diverse subject areas, including health (SDG 3), Climate Action (SDG

13) and Gender Equality (SDG 5), and has received significant attention (Morales-Zapata *et al.*, 2021).

Despite the breadth of existing bibliometric and scientometric analyses on SDG-related research, certain gaps remain evident. As noted, most studies have concentrated on highly visible goals such as health (SDG 3), climate action (SDG 13) and gender equality (SDG 5), while comparatively less attention has been given to underexplored areas such as economic growth and decent work (SDG 8), industry, innovation and infrastructure (SDG 9) and life below water (SDG 14). This study directly addresses these gaps by systematically mapping the overlooked domains and identifying emerging interdisciplinary linkages that connect them with broader sustainability agendas. In doing so, this study not only expands the scope of SDG-related bibliometric research but also provides policymakers, researchers and institutions with a more balanced and comprehensive understanding of research trends. By highlighting these neglected areas and their intersections with dominant SDG themes, this work offers a significant contribution to guiding future.

Regarding journal contributions, *Sustainability* has produced the most SDG studies, with 2.7% of papers participating in WoS categories relevant to the environmental SDGs. The *Journal of Cleaner Production* is the second most prominent journal (Sianes *et al.*, 2022). Another study by Yumnam *et al.* (2024) aligns with the above study, as the results indicate that the *Journal of Cleaner Production* and *Sustainable Development* is not far behind. When citing publications, per publication were averaged, *Environmental Research Letters* was undoubtedly at the top. In terms of the h-index (see appendix), the most notable sources are *Sustainability* and *Journal of Cleaner Production*. The *Lancet j*ournal has been recognized for publishing significant and high-calibre research pieces (Hossain *et al.*, 2022).

The top 10 most referenced research papers on SDGs published between 2015 and 2021 were thoroughly analysed by Yamaguchi *et al.* (2023), providing a valuable opportunity to understand the current level of knowledge on the particular topic. "Global, regional, and national causes of under-5 mortality in 2000–15: an updated systematic analysis with implications for the Sustainable Development Goals," written by Liu *et al.*, has the greatest overall citation count. Researchers visualize the possibility for clusters in each keyword from the reviewed papers using VOSviewer software (Sood *et al.*, 2021). The studies by Sianes *et al.* (2022), Singh *et al.* (2023) and Yamaguchi *et al.* (2023), highlight the importance of understanding citation patterns to identify influential papers and authors related to SDGs.

The USA and the UK were the top two nations in terms of publications, working with 11 and 9 countries, respectively, which means these two countries actively participate in international partnerships for SDG research publications. Yumnam *et al.* (2024) support this claim through the findings that researchers from the USA and the UK collaborated the most, with an astounding frequency of 103 publications. India is ranked eighth with 38,261 citations, 99.12 citations per paper and an h-index of 152.

Conceptual structure analysis, which reveals clusters of keywords related to the SDGs, Sustainable Development, Poverty and Renewable Energy, have emerged as the central themes (Bellantuono *et al.*, 2022; Gunnarsdottir *et al.*, 2021). Three-field plotting visualizes trends across disciplines, linking environmental science, economics and social sciences (Singh, 2024; Wani *et al.*, 2023). Co-citation coupling and bibliographic coupling provide insights into intellectual networks (Bernatović *et al.*, 2022). The study by Kleminski *et al.* (2020) also explored co-citation patterns among influential authors.

This study holds significant relevance, as it provides a comprehensive scientometric mapping of global research on the SDGs, thereby generating valuable evidence for universities, libraries, funding agencies and policymakers to effectively mobilize and redirect resources. By quantitatively assessing research impact, high-impact publications and emerging thematic areas, the study enables stakeholders to identify priority domains and optimize strategies for advancing sustainability. Beyond traditional productivity metrics, this analysis underscores the broader role of scientometric mapping in shaping educational policies and informing pedagogical innovations that directly support SDG implementation at multiple levels. Importantly, it ensures that scholarly output remains aligned with pressing policy needs and societal challenges, an essential consideration given the urgency of achieving the targets of Agenda 2030. Thus, the present research contributes not only to strengthening the evidence base for sustainable development but also to advancing the global discourse on aligning academic research with the SDG agenda.

Research objectives

(1) To analyze annual scientific output, country-wise contributions.

RQ1. What are the trends and patterns in annual scientific publication output across countries, and how do these contributions vary over time?

(2) To analyze and assess authorship productivity, including patterns, prolific authors and citation impact.

RQ2. What are the patterns of authorship productivity, which authors are most prolific, and how does citation impact vary among contributors?

(3) To identify leading Sources, top institutions and key keywords that highlight emerging thematic trends.

RQ3. Which sources, institutions and keywords dominate the literature, and what emerging thematic trends can be identified?

(4) To analyze collaboration networks, document coupling, research clusters and thematic connections within the literature.

RQ4. How are collaboration networks, document coupling and research clusters structured, and what key thematic connections exist within the research landscape?

Methodology

The methodology adopted for the study consists of the following four main stages, including database selection, data acquisition and refinement, software tools and analytical procedures.

Step I. Selection of database

The Web of Science (WoS) Core Collection was selected as the primary database because of its rigorous indexing standards, multidisciplinary coverage and suitability for bibliometric and scientometric studies. It provides structured citation metadata and comprehensive coverage in environmental sciences, sustainability and policy-related research, which ensures reliability and comparability.

Step II. Data acquisition and refinement

Data was retrieved in July 2024, using the following search query: TS = (“SUSTAINABLE DEVELOPMENT GOALS” OR “SDGs”) AND PY = (2024 OR 2023 OR 2022 OR 2021 OR 2020) AND DT = (“Articles”). This search yielded 6362 records. To enhance validity and replicability, the data cleaning process was undertaken. Duplicate entries, mainly caused by indexing overlaps across WoS sub-collections, were removed. After thorough verification, the final data set comprised 6340 unique peer-reviewed journal articles published across 1,157 Sources. The other formats, like editorials, meeting abstracts, reviews and letters, were excluded to ensure analytical comparability and scientific rigour.

Step III. Software and tools

The analysis was conducted using a combination of tools.

Biblioshiny (see appendix) (R-based) web-based application for the analysis of extracted data using its distinct modules to draw bibliometric inferences like productivity patterns, collaboration mapping and thematic evolution. MS Excel was used for the refinement and building of summary tables.

Step IV. Data analysis and interpretation

The analysis combined both traditional indicators and advanced techniques to provide a richer picture of the research landscape. These indicators include descriptive indicators for revealing annual growth rates, country contributions, prolific authors, leading journals and citation impact. Performance indicators to highlight top institutions, sources and influential keywords. This step is further enriched by incorporating more advanced techniques for analysing, such as coupling network of documents, cluster mapping, keyword clouds and tree maps, etc. (Figure 1).

Results

Main information about data

Table 1 represents the primary information regarding the data set. The data spans from 2020 to 2024, encompassing 6,340 documents from 1,157 journals. This represents a substantial body of literature with an annual growth rate of 10.44%, indicating a continuously expanding field. The analysis reveals an average of 12.68 citations per document, indicating a moderate level of scholarly exchange within the field. Furthermore, 320,487 references are identified, highlighting the extensive body of knowledge that informs current research. An examination of document content reveals a diverse range of keywords. A higher number of author-assigned keywords (16,853) suggests a focus on emerging or domain-specific terminology. Authorship patterns (see Appendix) indicate a prevalence of collaborative research, with an average of 5.11 co-authors per document. While a small number of single authors exist (538), the data suggest a trend towards collaborative research efforts. Interestingly, 44.09% of documents include international co-authorship, highlighting an increasing level of global collaboration within the field.

Annual scientific production

Table 2 depicts Annual Scientific Production, highlighting a steady increase from 783 in 2020 to a peak of 1,659 in 2023, with an average annual growth rate over the years of 10.44%. These results align with those of Yamaguchi *et al.* (2023), revealing an increase in the yearly scientific production of documents in the field. However, a slight decline is projected for 2024, with only 1,165 articles. The drop is attributed to mid-year data

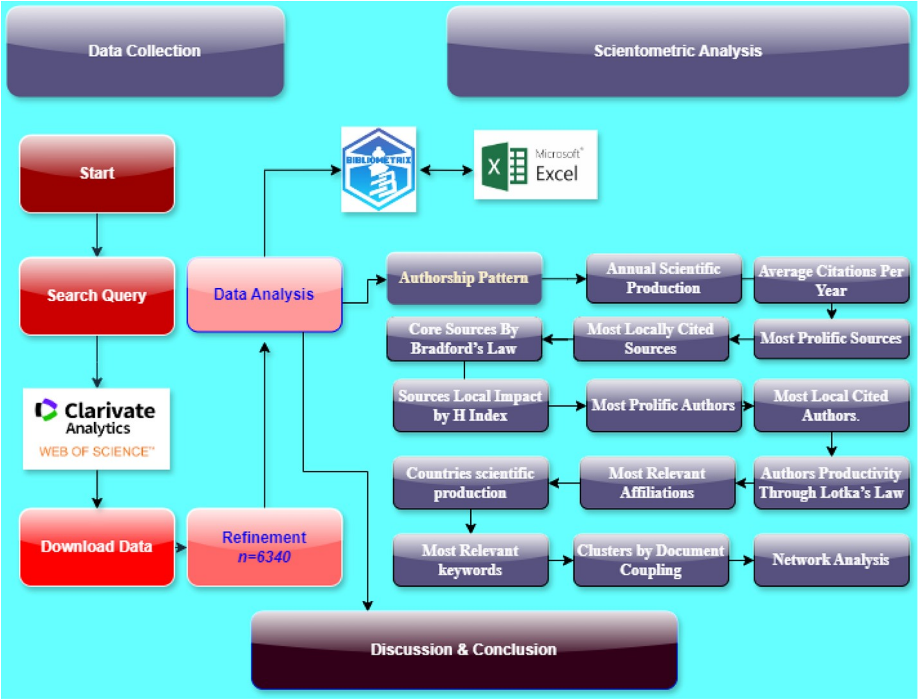

Figure 1. Brief illustration of steps involved in methodology
Source: Self Illustration

extraction but could also reflect indexing delays, global policy or research shifts, affecting citation count as well.

This trend indicates a strong upward trajectory in SDG-related research, reflecting growing global interest and investment in sustainability studies.

Countries scientific production

Table 3 shows countries' scientific production by examining the total research output produced by each country in the data set. China leads significantly with a frequency of 5255, followed by the USA (2,027) and the UK (1,992). India (1,694) and Spain (1,597) also contributed substantially. Mid-range contributors include Australia (1,217), Italy (1,143) and Germany (963). Japan (741) and Brazil (687) occupy the lower end of this data set. The results highlight China's dominance in scientific output, producing more than double the publications of the USA, with the UK closely trailing. Raman *et al.* (2024) also came up with similar results, where China topped the list regarding the most publications. These figures indicate significant regional disparities in research output, with a concentration of productivity in a few leading nations. This underscores global differences in research capacity and investment.

Authors' productivity through Lotka's law

Table 4 presents the findings from the present corpus of literature through Lotka's law (see Appendix), which is one of the principles in bibliometrics (see Appendix) that helps to understand

Table 1. Description about data

Main information about data	
Description	Results
Timespan	2020–2024
Sources (journals, books, etc)	1,157
Documents(Articles)	6,340
Annual growth rate	10.44%
Article average age	1.81
Average citations per article	12.68
References	320,487
Document contents	
Keywords plus (ID)	7,424
Author keywords (DE)	16,853
Authors	
Authors	23,518
Authors of single-authored docs	487
Author collaboration	
Single-authored Documents	538
Co-authors per document	5.11
International co-authorships %	44.09

Source(s): Primary Data

Table 2. Annual scientific production

Year	No. of articles
2020	783
2021	1,190
2022	1,535
2023	1,659
2024	1,165

Source(s): Primary Data

Table 3. Countries scientific production

Region	Frequency
China	5,255
USA	2,027
UK	1,992
India	1,694
Spain	1,597
Australia	1,217
Italy	1,143
Germany	963
Japan	741
Brazil	687

Source(s): Primary Data

Table 4. Authors' productivity through Lotka's law

No. of articles	No. of authors	Frequency
1	19,503	0.82
2	2,488	0.10
3	719	0.03
4	321	0.01
5	145	0.006
6	75	0.0031
7	61	0.0025
8	41	0.0017
9	34	0.0014
10	22	0.0009

Source(s): Primary Data

scientific productivity and the relationship between authors and the number of papers they contribute to (Kawamura *et al.*, 2000). The study found that among 23,409 authors, the majority (19,503) authored one article, (2,488) authored two articles and (22) contributed ten articles. The frequency of authors declines exponentially with increasing output, demonstrating Lotka's principle: a few authors dominate output, while most contribute minimally. For instance, 75 authors produced six articles. The results demonstrated a high degree of author dispersion in SDG research. This pattern suggests a broad and diverse research community that contributes to this field.

Most prolific authors

Fractionalized articles, which measure an author's share of contribution in multi-authored papers, are used to analyze collaboration patterns and impact distribution (Goh and See, 2021; Scheinerman and Ullman, 2011). Table 5 depicts the most prolific authors, with Liu Y leading as the most prolific author, having a Total Article Count of 54 and Fractionalized Articles of 10.29, indicating both a high research output and a substantial independent contribution. Further, Wang Y and Li Y follow with 48 and 46 articles, respectively, along with notable fractionalized scores of 8.07 and 8.33. Several authors, such as Zhang Y, Liu J and Wang J, exhibit high fractionalized scores relative to their total article counts, suggesting active collaboration in multi-author publications. This ranking highlights the influential

Table 5. Most prolific authors

Authors	Total no. articles	Articles fractionalised
Liu Y.	54	10.29
Wang Y.	48	8.066
Li Y.	46	8.32
Liu J.	42	7.27
Wang J.	39	6.58
Zhang J.	39	6.15
Zhang Y.	39	7.39
Wang X.	38	6.14
Zhang X.	37	6.97
Li X.	35	6.46

Source(s): Primary Data

researchers driving academic discourse on sustainability, with authors such as Liu Y not only producing the highest volume of work but also maintaining substantial independent contributions, making them key figures in the field.

Authorship pattern

Table 6 lists authorship trends in the field of SDG. A total of 5,801 authors were found in varying collaboration patterns, ranging from 2 to 255, revealing that three-authored

Table 6. Authorship pattern

	Publication year					
Authorship pattern	2020	2021	2022	2023	2024	Grand total
1	98	107	136	123	75	539
2	140	225	243	290	197	1,095
3	167	256	285	315	255	1,278
4	125	207	292	326	232	1,182
5	87	129	177	207	157	757
6	48	89	128	145	76	486
7	34	46	78	78	52	288
8	17	30	59	49	34	189
9	20	25	37	38	23	143
10	12	23	27	22	21	105
11	7	9	18	16	14	64
12	4	8	13	19	9	53
13	3	11	4	3	4	25
14	4	6	2	8	3	23
15	2	4	5	4	3	18
16	2	2	10	3	2	19
17	5	1	3	2	2	13
18	2		3	5	1	11
19		1	2	1		4
20		1	3	1		5
21		2	1	2	2	7
22	1	1				2
23	1		2		1	4
24		1	1	1		3
25	1	1	1			3
26			1			1
27	2	1	1			4
28		2				2
31			1			1
32	1					1
33		1				1
37		1	1			2
46		1		1		2
75				1		1
153				1		1
168		1				1
186			1			1
250	1					1
255	1	1	2	1		5
Grand total	*785*	*1,193*	*1,537*	*1,662*	*1,163*	*6,340*

Source(s): Primary Data

works are predominant, with 1,278 (20.15%), followed by 1,182 (18.64%) four-authored works, 1,095 (17.27%) as two-authored documents and 2,246 (35.42%) documents ranging from 5 to 255 authored documents. The maximum number of multi-authored works was 1,662, published in 2023, followed by 1,537 and 1,193 in 2022 and 2021, respectively. Similarly, a total of 539 (8.50%) single-authored publications were retrieved during the study period, with 136 publications in 2022, followed by 123 works in 2023. Moreover, this study highlights the research papers with authorship patterns of 26, 31, 32, 75, 153, 168, 186 and 250 have a frequency of 1.

Most local cited authors

Table 7 identifies the most locally cited authors, providing insight into those most frequently referenced within the data set (Appio *et al.*, 2014). *Pradhan P* leads with 156 local citations, signifying a strong influence and substantial recognition within the research community. S*inha A* (114) and *Warchold A* (100) also rank highly, cementing their roles as pivotal figures in shaping the discourse. *Adebayo TS* and *Kim RE* each have 95 citations, reflecting similar levels of impact and relevance in local academic discussions. Authors such as *Pradhan P* and *Sinha A* are critical intellectuals for subsequent studies. Simultaneously, the presence of several other high-impact contributors demonstrates the field's collaborative and multifaceted nature.

Authors' local impact by h-index

Table 8 demonstrates the authors based on key bibliometric metrics. Adebayo TS has the highest h-index (17) and m-index (see appendix) (4.25), indicating its recent and impactful productivity since 2021. Zhang J leads in the g-index (33), reflecting the influence of highly cited work, while Sinha A has the highest total citations (1,819), showcasing cumulative scholarly impact. Liu Y emerged as the most prolific with 54 publications. These metrics highlight diverse strengths and underscore varied contributions to the field.

Top 10 most cited countries

Table 9 ranks countries by total citations (TC) and average citations per article. *China* leads with 14,556 citations but averages 12.9 citations per article, indicating high output but relatively moderate impact per paper. *The Netherlands* has the highest average citations (16.8) despite a lower total number of citations (2,094), signalling high-impact research. The

Table 7. Most local cited authors

Author	Local citations
Pradhan P.	156
Sinha A.	114
Warchold A.	100
Adebayo T.S.	95
Kim R.E.	95
Thijssens T.	93
Van Der Waal J.W.H.	93
Rosati F.	86
Pizzi S.	80
Venturelli A.	80

Source(s): Primary Data

Table 8. Authors local impact by h-index

Author	h-index	g-index	m-index	TC	NP	PY
Adebayo T.S.	17	32	4.25	1,412	32	2021
Bekun F.V.	14	24	2.8	613	27	2020
Sinha A.	14	18	2.8	1,819	18	2020
Wang X.	14	23	2.8	566	38	2020
Leal Filho W.	13	24	2.6	680	24	2020
Liu Y.	13	22	2.6	574	54	2020
Zhang J	13	33	2.6	1,125	39	2020
Alola A.A.	12	18	2.4	760	18	2020
Liu J.	12	28	2.4	844	42	2020
Wang J.	12	29	2.4	864	39	2020

Note(s): TC=Total Citations (Total Citations is the measure of cumulative amount of citations that a source/journal has received within the given period of time) NP=Number of Papers/Articles(Total number of papers/articles published within the given period of time PY=Publication Year (Publication Year refers to the year in which a document was published, with the first year of the selected time period taken as the starting point for analysis)
Source(s): Primary Data

Table 9. Top 10 most cited countries

Country	Total citations	Average article citations
China	14,556	12.9
United Kingdom	5,512	13.8
USA	5,158	16.2
Spain	4,673	11.3
Italy	4,407	14.7
India	3,896	11.4
Germany	3,443	16.4
Australia	3,256	14.6
The Netherlands	2,094	16.8
Japan	1,960	12.8

Source(s): Primary Data

USA and *Germany* also exhibit high averages (16.2 and 16.4, respectively), reflecting impactful research outputs. Other notable contributors include the *UK* (5,512 citations, 13.8 average) and *Italy* (4,407 citations, 14.7 average). While Yamaguchi *et al.* (2023) highlighted the UK as the most prolific region. This data highlights China's volume-driven prominence in global research, while Western nations and The Netherlands, in particular, lead in citation efficiency and impact.

Average citations per year

Table 10 illustrates the average number of citations per document per year, trending downwards over the selected period. It reached a high of 5.85 in 2020 and then decreased to 1.19 in 2024. Such a decline may be due to an increased publication volume, a decrease in citation counts, or a change in the subject matter of studies over a given period. Here again, the exponential decline in mean citations in 2024 is because data was collected in mid-2024. Even though there has been a decrease in the index over the period, the figures for 2020 and

Table 10. Average citations per year

Year	Mean TC per article	No. of articles	Mean TC per year	Citable years
2020	29.24	783	5.85	5
2021	20.93	1,190	5.23	4
2022	13.95	1,535	4.65	3
2023	5.85	1,659	2.92	2
2024	1.19	1,165	1.19	1

Note(s): TC = Total Citations (Total Citations is the measure of cumulative amount of citations that a source/journal has received within the given period of time)
Source(s): Primary Data

2021 clearly show a significant number of citations that depict the relevance and standard of such publications.

Most prolific sources

From Table 11, which depicts the journals with the number of articles, it is evident that the journal *Sustainability* tops the list with 1,131 articles, followed by the *Journal of Cleaner Production* with 256 articles and *Sustainable Development* with 174 articles. The journals containing the least number of articles included *Science of the Total Environment* (86 articles), *Journal of Environmental Management* (77 articles) and *Sustainability Science*, which contains the fewest articles (68). This study aligns with Raman *et al.* (2024) and Meschede (2020). These journals are leading platforms for disseminating SDG research, highlighting their central role in advancing knowledge in this field.

Most locally cited sources

Table 12 emphasizes Most Locally Cited Sources, where the *Journal of Cleaner Production* is the most locally cited source with 12,508 articles, followed by *Sustainability* with 10,984 articles and *Environmental Science and Pollution Research* with 4,997 articles. In contrast, *Nature* is the least cited source, with only 2,389 articles. This study aligns with Pizzi *et al.* (2020), where the *Journal of Cleaner Production* is the most *Cited Journal*. This suggests significant research interest and output in these areas, reflecting their critical importance in addressing global environmental challenges.

Table 11. Most prolific sources

Sources	No. of articles
Sustainability	1,131
Journal of Cleaner Production	256
Sustainable Development	174
Environmental Science and Pollution Research	134
Environment Development and Sustainability	101
International Journal of Sustainability in Higher Education	96
Science of the Total Environment	86
Journal of Environmental Management	77
Sustainability Science	68

Source(s): Primary Data

Table 12. Most locally cited sources

Sources	No. of articles
Journal of Cleaner Production	12,508
Sustainability	10,984
Environmental Science and Pollution Research	4,997
Science of the Total Environment	4,589
Renewable and Sustainable Energy Reviews	3,310
Energy Policy	2,917
Sustainable Development	2,779
Journal of Environmental Management	2,573
Nature	2,389

Source(s): Primary Data

Core sources identified using Bradford's law

By using Bradford's law (see Appendix) to identify the core sources in the given field of research, the journals have been categorized into three zones: a core zone, i.e. Zone 1, containing highly relevant sources. Zone 2 has a large number of moderately relevant sources, and Zone 3 has fewer relevant sources. From Table 13, *Sustainability* ranks 1st among Zone 1 sources with both Frequency and Cumulative Frequency of 1,131, followed by the *Journal of Cleaner Production*, indexed to WoS categories related to Environmental SDGs, with a Frequency of 256. These results are in tune with the study conducted by Sianes *et al.* (2022). This reflects Bradford's Law of Scattering, where a small core of journals captures the bulk of research influence, whereas journals in Zone 2, having less frequency, such as *Energies* (66), *LAND* (63) and *PLOS ONE* (62) represent less central but relevant contributions. Zone 1 journals are pivotal in advancing the sustainability discourse, making them a primary literature review and publication resource. These sources have been identified as key repositories of SDG research and play a key role in disseminating high-impact studies.

Sources local impact by h-index

Sources Local Impact by h-index, a method of analysing the influence of specific sources within a particular research area by examining their h-index. Table 14 presents a bibliometric analysis of the top 10 journals based on several indices. These metrics offer insights into the journal's impact, productivity and relevance. The h-index indicates the number of articles with a significant number of citations. The *Journal of Cleaner Production* (47) and *Sustainability* (38) ranked highest, indicating their strong academic influence. The g-index (see Appendix), which emphasizes highly cited papers, is also the highest for *Journal of Cleaner Production* (71), reinforcing its impactful contributions.

Regarding productivity, *Sustainability* leads to NP (1131) and TC (9800), showcasing its prolific publication volume and significant community engagement. The m-index, reflecting the citation impact adjusted for time, is the highest for the *Journal of Cleaner Production* (9.4), indicating its rapid influence since 2020. This study is in line with Raman *et al.* (2024), which provides insights into the leading sources of scientometric research on SDGs, suggesting that *Sustainability* accounts for the highest number of publications related to SDG research, while the *Journal of Cleaner Production* leads with the most citations and average citations.

Table 13. Core sources by Bradford's law

Sources	Rank	Frequency	Cumulative frequency	Zone
Sustainability	1	1,131	1,131	Zone 1
Journal of Cleaner Production	2	256	1,387	Zone 1
Sustainable Development	3	174	1,561	Zone 1
Environmental Science and Pollution Research	4	134	1,695	Zone 1
Environment Development and Sustainability	5	101	1,796	Zone 1
International Journal of Sustainability in Higher Education	6	96	1,892	Zone 1
Science of the Total Environment	7	86	1,978	Zone 1
Journal of Environmental Management	8	77	2,055	Zone 1
Sustainability Science	9	68	2,123	Zone 1
Energies	10	66	2,189	Zone 2
Land	11	63	2,252	Zone 2
Plos One	12	62	2,314	Zone 2
Heliyon	13	57	2,371	Zone 2
Remote Sensing	14	56	2,427	Zone 2
International Journal of Environmental Research and Public Health	15	55	2,482	Zone 2
Resources Policy	16	50	2,532	Zone 2
International Journal of Sustainable Development and World Ecology	17	45	2,577	Zone 2
Water	18	43	2,620	Zone 2
Business Strategy and the Environment	19	42	2,662	Zone 2

Source(s): Primary Data

Table 14. Sources local impact by h-index

Source	h-index	g-index	m-index	TC	NP	PY
Journal of Cleaner Production	47	71	9.4	6,623	256	2020
Sustainability	38	54	7.6	9,800	1,131	2020
Science of the Total Environment	32	54	6.4	3,173	86	2020
Environmental Science and Pollution Research	29	43	5.8	2,235	134	2020
Journal of Environmental Management	22	37	4.4	1,590	77	2020
Sustainable Development	22	35	4.4	1,693	174	2020
Sustainability Science	19	35	3.8	1,383	68	2020
Renewable & Sustainable Energy Reviews	18	31	3.6	1,014	31	2020
Technological Forecasting and Social Change	18	30	3.6	943	34	2020
World Development	18	35	3.6	1,251	35	2020

Note(s): TC = Total Citations (Total Citations is the measure of cumulative amount of citations that a source/journal has received within the given period of time) NP = Number of Papers/Articles(Total number of papers/articles published within the given period of time PY = Publication Year (Publication Year refers to the year in which a document was published, with the first year of the selected time period taken as the starting point for analysis) h-index = A researcher has an *h-index* of h if h of their publications have each received at least h citations, indicating balanced productivity and impact g-index = A researcher has a *g-index* of g if their top g most-cited publications together received at least g^2 citations, giving more weight to highly cited works m-index = The *m-index* is calculated as the h-index divided by the number of years since the first publication, reflecting consistent scholarly impact over time
Source(s): Primary Data

Top 10 most prolific affiliations

Table 15 depicts the most relevant affiliations contributing to the present research, with Beijing Normal University and the University of the Chinese Academy of Sciences leading with 177 articles each. The Institute of Geographic Sciences and Natural Resources Research follows with 125 articles, while the University of Oxford has 111, reflecting significant global participation. Other notable contributors include the Tehran University of Medical Sciences (104 articles), Wuhan University (97) and Istanbul Gelisim University (91), showing regional diversity with strong representation from Asia, Europe and the Middle East.

Table 15. Top 10 most prolific affiliations

Affiliation	Articles
Beijing Normal University	177
University of Chinese Academy of Sciences	177
Institute of Geographic Sciences and Natural Resources	125
University of Oxford	111
Chinese Academy of Sciences	109
Tehran University of Medical Sciences	104
Wuhan University	97
Zhejiang University	92
Istanbul Gelisim University	91
Lebanese Amer University	88
Tsinghua University	87

Source(s): Primary Data

Most prolific keywords
The most prolific keywords were analysed using Word Cloud (Figure 2) and TreeMap (Figure 3). By clustering at the 50-word level, this method captures the most significant and recurring keywords in the data set. The keywords represent prominent themes or topics within the study, emphasizing their significance in understanding the broader research area.

According to a keyword analysis (see Figure 2, Table 16), the most common terms are "Impact" (488 instances), "Management" (468) and "Performance" (346). This indicates that the SDG scholarship has a strong focus on measurement and real-world results. Significant increases since 2021 have been seen in "Economic Growth" (268), "Governance" (267) and "Energy" (247), indicating similar trends with heightened global policy advocacy on green growth and sustainable governance frameworks. Temporal keyword analysis, visualized in Figure 3, shows emerging attention to themes such as "Trade-off" and "Interdisciplinary Collaboration," while previously strong tags like "Inequality" and "No Poverty" have plateaued or modestly declined. This evolution aligns with periodic shifts in SDG funding and the increasing complexity of research connecting multiple SDGs. Themes that are missing or declining, such as "Partnerships" (SDG 17) and "Infrastructure" (SDG 9), could be signs of research saturation, a lack of new measuring frameworks, or a reduction in financing, all of which should be taken into consideration by funding agencies in the future.

Clusters by document coupling
Document coupling clusters can reveal information about collections of documents that are connected by common references. Information regarding groups of documents linked by

Figure 2. Keyword Cloud
Source: Primary Data

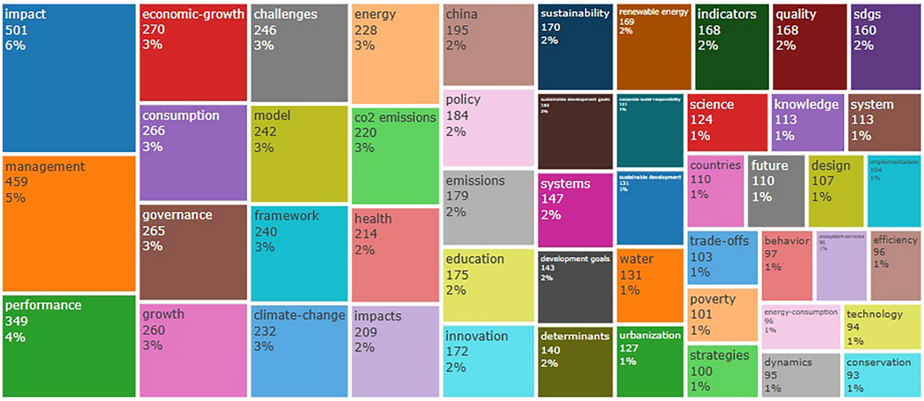

Figure 3. Tree Map
Source: Primary Data

Table 16. Cluster by document coupling

Label	Group	Frequency	Centrality	Impact
SDGs – conf 36.6% governance – conf 56.5% development goals - conf 47.8%	1	67	0.331	5.37
Trade-offs – conf 83.3% SDGs – conf 63.4% energy – conf 92%	2	158	0.445	6.538

Source(s): Primary Data

shared references can be uncovered using document-coupling clusters (García-Lillo *et al.*, 2023) . Moving to clusters, research publications on *governance* confidence make up the majority of Cluster 1, with 56.5% of the total, followed by *development goals* at number two (47.8%) and SDGs (36.6%).In cluster 2, the second most common theme was *energy*, which had a 92% confidence rate, followed by *trade-offs* and SDGs, which had 83.3% and 63.4% confidence rates, respectively. Cluster 2 had more than twice as many documents as Cluster I, which had 64 documents. This suggests that debates and conversations regarding the role of governance in sustainable energy use and SDG trade-offs are more common in the data set. In terms of cited references, Cluster 2 has a higher centrality score of 0.445 as compared to 0.331 of Cluster 1, suggesting that documents in Cluster 2 are more central or influential regarding cited references (Table 16 and Figure 4).

Coupling network of documents

Figure 5 represents the visualization of a coupling network of documents based on Citation Relationship (CR), showcasing how academic papers are interconnected through shared references. Each node is a research paper, and the lines connecting them indicate how frequently they cite the same sources. The different colours represent different research themes, in which blue, red and green clusters represent closely related individual studies. The most prominent and central document is (Eisenmenger *et al.*, 2020, Sustainability Science) as a keystone reference in

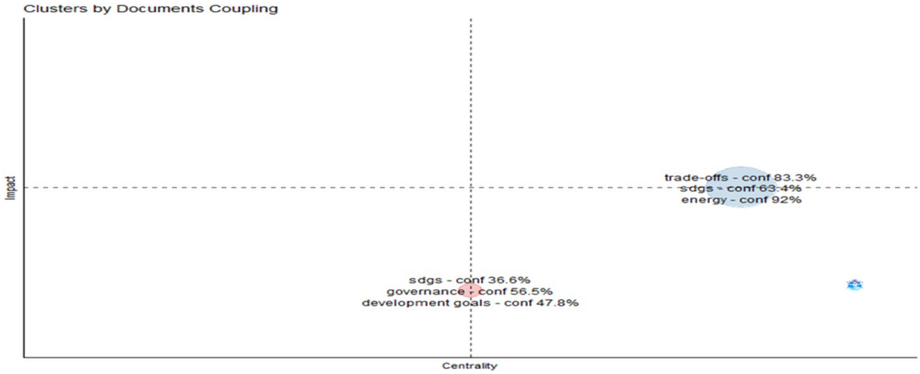

Figure 4. Clusters by document coupling in Sustainable development research
Source: Primary Data

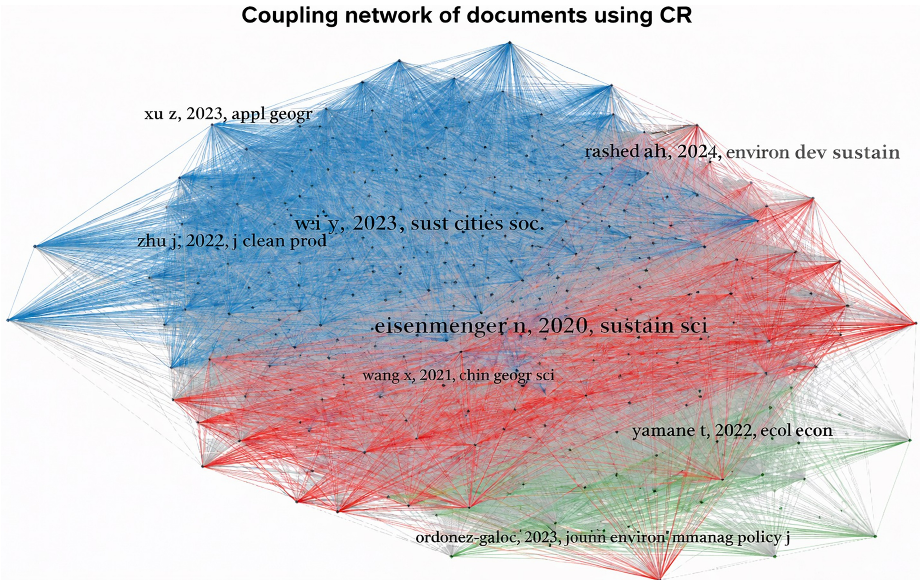

Figure 5. Figure coupling network of documents in sustainable development research using cited reference
Source: Primary Data

connecting clusters, i.e. the reference is cited by various clusters. Other influential papers, including Wei *et al.* (2023, Sustainable Cities and Society), Rashid et al. (2024, Environment, Development and Sustainability), also exhibit strong citation linkages, reflecting their influence on a specific academic.

Network collaboration

Figure 6 represents the collaboration network among authors, where nodes represent collaborative relationships. A threshold of 10 nodes was applied, ensuring the only significant collaborations are highlighted, allowing for a clearer visualization of key research connections and influential partnerships within the study. "Liu y" emerges as the most central figure with the largest node size and numerous strong connections, whereas "Wang y" also plays a significant role, while individuals like "li y" and "liu j" form secondary connections.

Figure 7 illustrates a global collaboration network between countries, where "China" is the central hub with the most extensive connections, followed by "USA" and "UK." Both networks are densely interconnected, indicating a collaborative environment. These

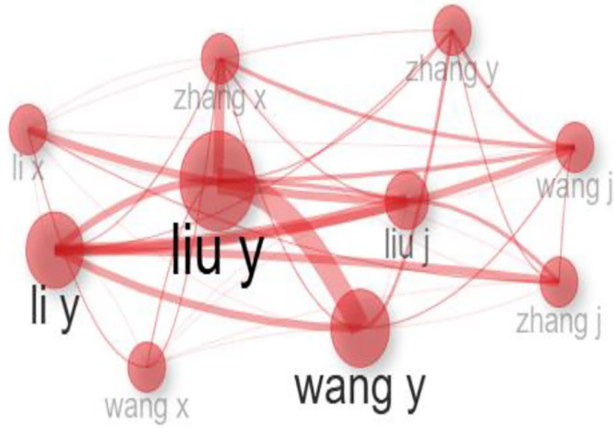

Figure 6. Author network
Source: Primary Data

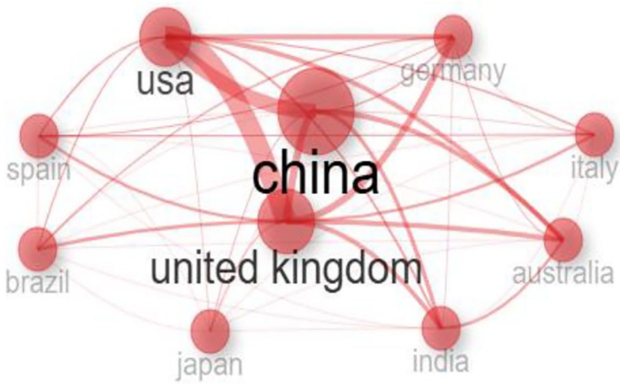

Figure 7. Countries network
Source: Primary Data

visualizations are valuable for identifying influential stakeholders and optimizing collaboration strategies.

Discussion and conclusion

SDGs have been a serious concern of the stakeholders at different levels, including funding agencies, policy-making and governing bodies, research institutions and agencies, focus groups, etc. This is quite evident through the depth of the available research in this area. The current study's results generally concur with the corpus of literature already available on scientometric assessments of SDG-related research. According to our findings (Table 2), research production increased steadily between 2020 and 2023, with a minor decline in 2024 as a result of mid-year data extraction. This is consistent with Yamaguchi *et al.* (2023), who also reported an increasing trend in yearly scientific production of SDG-related documents. The domination of China, followed by the USA and the UK (Table 3), is consistent with the findings of Mishra *et al.* (2023), Raman *et al.* (2024) and Hsieh and Yeh (2024), who found that the most productive contributors were China, the USA, the UK, India and Australia. The application of Lotka's Law (Table 4) revealed that a majority of authors contributed only one article, reflecting a dispersed authorship pattern. This observation resonates with global bibliometric principles (Kawamura *et al.*, 2000) and further validates the broad and diverse participation in SDG research, also emphasized by Raman *et al.* (2024). Prior research (Yamaguchi *et al.*, 2023) found similar tendencies in important author contributions, which is consistent with the dominance of Liu Y, Wang Y and Li Y as prolific authors (Table 5).

The predominance of multi-authored works (Table 6) reflects increasing collaboration, which aligns with Yumnam *et al.* (2024), who reported high co-authorship and cross-country collaboration, especially between the USA and the UK. Our results (Tables 7–8) support previous research (Sianes *et al.*, 2022; Hossain *et al.*, 2022) that identified prominent individual researchers as intellectual leaders by confirming that authors such as Pradhan P and Adebayo TS have great citation impact and h-/m-indices. China leads in total citations, while Western nations such as The Netherlands and Germany exhibit higher citation averages per article (Table 9). This supports Yamaguchi *et al.* (2023) who emphasized the UK's strong performance and citation efficiency, underscoring regional disparities in research quality versus quantity. Similar to patterns observed in Sweileh (2024), where citation impact varied over time, the downward trend in average citations per year after 2020 (Table 10) is a result of growing publication output diluting citations.

In terms of publication volume, citations and h-/g-/m-indices, Sustainability and the *Journal of Cleaner Production* are prominent (Tables 11–14). These findings are consistent with those of Sianes *et al.* (2022), Yumnam *et al.* (2024) and Raman *et al.* (2024), who found that these journals are essential to the conversation around the SDGs. The strong representation of Chinese universities (Table 15) corresponds with China's overall publication dominance as noted by Mishra *et al.* (2023) and Hsieh and Yeh (2024).

The importance of themes such as "Impact," "Management," and "Performance," as well as growing interest in "Economic Growth," "Governance," and "Energy," is confirmed by our keyword mapping (Figure 2–3). This mirrors the thematic clustering of Poverty, Renewable Energy and Climate Action highlighted by Raman *et al.* (2024), Hsieh and Yeh (2024) and Morales-Zapata *et al.* (2021). The findings of Yumnam *et al.* (2024) and García-Lillo *et al.* (2023) are supported by document coupling (Tables 16, Figures 4–5) and collaboration networks (Figures 6–7), which show how SDG research is interconnected through thematic clusters and international collaboration, with China, the USA and the UK serving as important hubs. Overall, our findings support worldwide growth, nation dominance, journal prominence and thematic concentration in SDG research, and they are generally consistent with other bibliometric evaluations (e.g. Yamaguchi *et al.*, 2023; Sianes *et al.*, 2022; Mishra *et al.*, 2023). However, our research also identifies new tendencies that were not as prominent in previous studies, such as changing keywords (e.g. "Trade-offs," "Interdisciplinary Collaboration"), uneven regional influence and a fall in citations around the middle of 2024. This draws attention to both new and ongoing developments in bibliometric research on the SDGs.

Limitations

The study relied entirely on WoS. As such, pertinent publications indexed in other databases, such as PubMed or Scopus, might have gone unnoticed. The language was selected as English, which limits the inclusion of multilingual documents in the analysis. By emphasizing only Research Articles and quantitative metrics, bibliometric approaches limit our understanding of the qualitative aspects of SDG-related research.

Future directions

Building on these results, Future scientometric studies on SDGs should go beyond descriptive metrics and integrate longitudinal thematic evolution, policy linkages and socio-economic impacts of scientific collaboration. This includes:

- mapping research gaps in underexplored SDGs (such as SDG 8 "Decent Work" and SDG 14 "Life Below Water");
- expanding coverage to non-English and Global South outputs often excluded from WoS;
- conducting comparative analyses across databases (WoS, Scopus, PubMed) to minimize index bias; and
- incorporating qualitative and mixed-method approaches alongside citation-based metrics to capture societal and policy relevance.

Continuous analysis will frequently update new trends and changes in research patterns. Opportunities for more inclusive research initiatives can be found by examining how low-income and developing nations participate in SDG research collaboration. Future research might also analyze how academic efforts are translating into real-world policy adoption, technology transfer and progress towards SDG targets.

Implications

The insights from this study can guide researchers and institutions to focus their efforts on the most impactful areas of SDG research and foster international collaboration to achieve global sustainability goals. By identifying key trends and influential contributors, this study provides a roadmap for strategic research planning to ensure that research efforts are aligned with global sustainability priorities. Governments and UN agencies can use these insights to prioritize neglected SDGs (e.g. 8 and 14) by channelling targeted funding. Themes such as "Impact," "Management" and "Performance" highlight priority areas for targeted research and suggest that SDG research is shifting toward implementation and outcome evaluation, providing opportunities for organizations to link academic outputs to on-the-ground SDG monitoring and reporting directly. Institutions can use these insights to benchmark their efforts, while researchers can focus on influential journals such as *Sustainability* and the *Journal of Cleaner Production* for maximum impact and to enhance global visibility. Institutions can use these findings to compare their efforts.

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Appendix. Key concepts

- *Annual Scientific Production:* Annual scientific production refers to the total number of research publications produced by an author, institution, or country in a given year (Aria and Cuccurullo, 2017).
- *Lotka's Law*: Lotka's Law explains the frequency distribution of scientific productivity, showing that few authors publish many papers while most publish only a few (Lotka, 1926).
- *Bradford's Law:* This law states that if journals are arranged in order of decreasing productivity on a subject, they can be divided into a core zone and several zones containing the same number of articles (Bradford, 1934).
- *Authorship Pattern:* Authorship pattern refers to the distribution of publications by single and multiple authors, indicating collaboration trends in research (Subramanyam, 1983).
- *h-index:* The h-index measures both productivity and citation impact, where a scholar has an h if h papers are cited at least h times each (Hirsch, 2005).
- *m-index:* The m-index is calculated by dividing the h-index by the number of years since the first publication, normalizing productivity by career length (Hirsch, 2005).

- *g-index*: The g-index defines the highest number g such that the top g papers have at least g^2 citations in total, giving more weight to highly cited works compared to the h-index (Egghe, 2006).
- *Bibliometrics/Scientometrics:* Bibliometrics and scientometrics are quantitative methods for analyzing academic publications and citations, assessing research productivity, impact, collaboration and knowledge growth patterns (Pritchard, 1969; Hood and Wilson, 2001).
- *Biblioshiny:* Biblioshiny is a Web interface for the R-package *bibliometrix*, designed for easy bibliometric and scientometric analysis, providing interactive tools for data visualization, performance analysis and science mapping (Thangavel and Chandra, 2023).

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