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REVIEW ARTICLE

Contributions toward sustainable development: a bibliometric analysis of sustainability reporting research

Nana Adwoa Anokye Effah[1] · Qinggang Wang[1] · Godfred Matthew Yaw Owusu[2] · Octavia Ama Serwaa Otchere[2] · Bright Owusu[2]

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Abstract

The study determines the development of the sustainability reporting domain using a dataset of publications extracted from the Web of Science (WoS) core database and visualized with CiteSpace. This paper employs a bibliometric approach to review extant studies to present and describe the publication patterns from 2004 to 2021. The top 3 contributing journals are the Journal of Cleaner Production, Sustainability, and Accounting, Auditing, and Accountability Journal, whereas the author network depicts a low collaboration among authors. Many authors have autonomously conducted their research, and the regional contributions to the research domain have been uneven. The paper accentuates the need to bridge the uneven institutional and regional contributions toward the sustainability reporting domain, so more light is shed on environmental sustainability across regions through firm and institutional levels. The results will trigger the need for future studies and actions needed to improve reporting quality through extensive social, environmental, and governance disclosures.

Keywords Sustainability reporting · Sustainable development · Bibliometric analysis · SDGs · CSR · Citations

Introduction

The growing importance of a sustainable environment has attracted the accounting standard boards' attention to increase financial reporting quality. In a speech delivered by the chair of the International Accounting Standards Board (IASB), addressing delegates of the Chartered Institute of Management Accountants (CIMA) and the American Institute of Certified Public Accountants (AICPA) in December 2021, he reemphasised the crucial role of sustainability in their daily operations. As a matter of interest, he spoke about creating the International Sustainability Standards Board (ISSB), which was publicized and embraced by over 40 jurisdictions, including the USA, at the Conference of Parties (COP26) climate conference. Given emerging climate change issues, the ISSB would be responsible for establishing an all-inclusive global baseline of investor-based sustainability-related disclosure standards for markets. However, jurisdictions would be required to decide on how to incorporate those global standards into their requirements as there are no specifications for jurisdictions to use the International Financial Reporting Standards (IFRS).[1] With a global initiative of "Transforming our world: The 2030 agenda for sustainable development" to promote sustainable development to prevent compromising the needs of future generations, 193 United Nations member states adopted the Sustainable Development Goals (SDGs) in 2015 to protect the planet while ensuring prosperity for all. Accordingly, the goals "are integrated and indivisible and balance the three dimensions of Sustainable Development (SD): the economic, social and environmental" (UN 2015), that is, contributions toward economic growth while valuing the rights of people and protecting the environment via the implementation of risk-reducing strategies. Given that the agenda has heightened issues of ending all forms of inequalities and poverty and

Responsible Editor: Philippe Garrigues

✉ Nana Adwoa Anokye Effah
effahnanaadwoa@gmail.com

✉ Qinggang Wang
kjxywqg1125@126.com

[1] School of Accounting, Zhongnan University of Economics and Law, Wuhan, Hubei, China

[2] Department of Accounting, University of Ghana, Legon, Accra, Ghana

[1] https://www.ifrs.org/news-and-events/news/2021/12/connectivity-core-work-and-convergence/

tackling climate change threats, Sekarlangit & Wardhani (2021) aver that the SDGs would be realized if all societal entities join forces toward their attainment. They further highlight the pivotal role of private sectors and individual firms in attaining the SDG targets. Preferably, companies can contribute by implementing sustainable strategies, ensuring that their operations do not delay the agenda. Subsequently, strategy implementations are followed by periodic disclosures on the progress of the sustainable engagements in the company as they keenly contribute to the global movement. Because of this, the sustainability reporting domain has received much attention over the last decade (Burritt & Schaltegger, 2010; Mahmood et al. 2018; Pineda-Escobar 2019; Tiwari & Khan 2020) as reporting on sustainability issues has become a common company practice. Moreover, the sustainability reporting domain remains broad and varied due to stakeholders' pursuit for different economic, social, and environmental interests supported by the SDGs. As conventional accounting shifts organizational emphasis from the traditional profit-making viewpoint, the focus is currently on the overarching holistic triple bottom line (TBL) reporting on environmental, social, and economic issues or environmental, social, and governance (ESG) or isolated reporting on ecological issues (Hahn & Kühnen, 2013). At the same time, the voluntary nature of current sustainability practices has resulted in an influx of different terminologies signifying the various reporting practices of entities in previous literature. Many scholars have researched the trends and challenges of ESG reporting (Cucari et al. 2018; Husted & Sousa-Filho 2017; Muhmad et al. 2021; Weber 2013) the TBL (Gond et al. 2012; Hahn & Kühnen 2013; Hussain et al. 2018; Tiwari & Khan 2020) as well as other essential environmental and social issues among firms (Chung & Cho 2018; Mahmood et al. 2018; Reyes-Rodríguez et al. 2016). Sustainability reporting is a significant avenue for communicating management strategies to maintain a sustainable business environment and publishing reports to promote accounting and transparency. As a result, sustainability accounting has been linked to sustainability reporting. This is because it defines new accounting and information management methods that seek to provide high-quality information toward the global agenda, and reporting is needed to corroborate information concerning the progress of corporate sustainability (Schaltegger et al. 2006). However, irrespective of the various firm reports emanating from the several disclosure practices, they are geared toward harmonizing resources and adopting business practices that would contribute to a safe business environment. Additionally, regardless of the form of reporting companies take on, whether ESG, environmental, and social or sustainability reporting, these reports ought to offer relevant information on a firm's performance in relation to all corporate sustainability achievements and challenges in addition to future viewpoints (Schaltegger et al. 2006) that are valuable for the global move toward sustainable development. As the research advances, different findings have evolved, and it may be challenging to present an overview of the sustainability research domain. As such, a critical outlook of the sustainability research scope would be advantageous in unearthing the developments over time and the hotspots for future research. For the purpose of this research, TBL, ESG, and environmental reporting would all be referred to as sustainability reporting since they are all corporate reporting avenues toward sustainable development. Although a few reviews exist in the field (Ertz & Leblanc-Proulx 2018; Hahn & Kühnen 2013; Pasko et al. 2021), Hahn & Kühnen (2013) employed the systematic review process to review 178 articles to assess the determinants of sustainability reporting using a sample from 1999 to 2011. Ertz & Leblanc-Proulx (2018) also employed a bibliometric analysis to assess the collaborative research field of sustainability-related topics from 2010 to 2017, while Pasko et al. (2021) assessed articles from 1950 to 2019. While these reviews describe the state of the sustainability research domain, the unique choice of keywords, especially concerning the bibliometric analysis and the diverse findings of the studies, calls for broader and diversified reviews in this research area that would help create a concrete view of the domain. With the progressing outlook of the research domain, there may be substantial research papers and the origination of new branches in this diverse research area that might have been ignored in past reviews. Given the considerable advantages of bibliometric analysis that involves summarizing large volumes of data to report on the developments and emerging trends in a research field (Donthu et al. 2021), this study employs this method to review the extant literature on sustainability reporting. Since it is deemed an efficient methodology ideal for demonstrating the growing scope of a domain, this approach enables us to analyze previous literature qualitatively and quantitatively. Our review differs from the existing ones in several ways. To begin with, our review makes use of broader search criteria and covers a more recent period. Furthermore, we contribute to the dearth of bibliometric reviews in the sustainability domain through both performance and scientific mapping analysis. Thus, we comprehensively assess the intellectual, social, and conceptual structure of the sustainability reporting domain to provide scholars with an overview of the sustainability scope and examine the developmental stages over the last 18 years. Using data from the Web of Science (WoS) database and the CiteSpace software for visualization, our goals are to (i) assess the adequacy and excellence of the subject area through the identification of dominant authors, patterns, and performances of regions/countries or institutions; (ii) examine cooperations among institutions and countries that have massively been involved in sustainability reporting research

to uncover the research progress between countries/regions; and (iii) to determine current hotspots in the subject area based on keyword analysis and citation cluster analysis which may impact and shed more light on the avenues for future research in the field. Specifically, the following research questions are addressed: (1) What is the growing trend in this research area? (2) Which journals, subject categories, institutions, and regions involved in sustainability reporting are dominant? (3) Who are the most influential authors on sustainability reporting? (4) What is the current research's social (collaborative) and intellectual (citation and co-citation) structure? (5) What are the popular evolving themes in sustainability reporting research and areas that need further studies? The remaining sections of the paper are organized as follows: the "Overview of sustainability reporting research" section gives an overview of sustainability accounting and reporting research, while the "Methodology" section describes the methodology adopted for the study. The "Results" section outlines the results based on the subject areas, regional and authorship, and keyword analysis. The "Discussion and conclusion" section discusses the findings, the evolution of hot topics, and concludes with avenues for future research and the limitations.

Overview of sustainability reporting research

Climate change issues have heightened stakeholder interests in business operations as they demand transparency and accountability for firms' social and ecological impacts via policy espousal and production activities. As Schaltegger & Csutora (2012) aver, climate change's foremost causes and effects are linked directly to firms' economic and social activities. For sustainable development to be globally evident, companies must upgrade their product and service systems to reduce CO_2 emissions during business engagements. Similarly, Bose (2020) opines that due to growing investor interests in environmental and social disclosure, revising accounting and disclosure frameworks to trace non-financial performance measures while incorporating climate change-related issues is non-negotiable. Many scholars have ascertained firms' motives for reporting and their general contributions to sustainable development, voluntary, and mandatory reporting on ESG in some jurisdictions, as well as the challenges of reporting and the influence of management on reporting mechanisms (Braam et al. 2016; Dienes et al. 2016; Lavin & Montecinos-Pearce 2021; Mervelskemper & Streit 2016; Nicholls 2020; Rahman & Alsayegh 2021). Herzig & Schaltegger (2006) contend that many firms are motivated to engage in environmental and sustainability reporting because it increases corporate reputation and brand while maximizing accountability and transparency. Moreover, because comparing sustainability performance is usually difficult, sustainability reporting may signal stakeholders about the firm's performance and make them gain a competitive advantage over those who do not engage in it (Herzig & Schaltegger 2006). Essentially, it aids in legitimizing corporate activities and services and increases the supply of vital resources. However, the benefits that firms derive from engaging in sustainability reporting depend on characteristics unique to the firm, industry, and market, as well as stakeholder intentions and management proclivity. Herzig & Schaltegger (2006) aver that ideally, a highly developed strategy for sustainability reporting strongly connected to accounting, strategic and information management is necessary to realize the possible advantages (Herzig & Schaltegger 2006). In Lavin & Montecinos-Pearce's (2021) study on the effects of board heterogeneity on ESG disclosure, they report that ESG reporting is negatively affected amid interlocking directorates among controlling shareholders. Nicholls (2020) retorts that integrating environmental, financial, and social accounting would be undemanding if changes in public policies emerge through specific elucidations for investor motivations. In the Asian region, firms' profitability, leverage, and size increased the disclosure of ESG information, congruent with the legitimacy theory that firms engage in ESG reporting to signify their continuous existence (Rahman & Alsayegh 2021). In the same vein, in establishing the importance of environmental performance and assurance to corporate environmental reporting, Braam et al. (2016) report that the disparities in environmental reporting are attributable to the level of greenhouse gas emissions, external assurance, and water consumption of companies. They also highlight the importance of legitimacy in the firms' choice of environmental reporting strategies. Mervelskemper & Streit (2016) also assessed how capital market investors value ESG reporting and found that ESG reports are highly valued regardless of their integrative or stand-alone form. Dienes et al. (2016) evaluated the drivers of sustainability reporting and recorded firm size and media visibility as critical determinants of sustainability reporting. Additionally, they encouraged using more analytical, methodological approaches in the sustainability domain after observations that content analysis was among the prevailing methodological approaches aside from the few case studies and theoretical reviews.

Methodology

Data sources

The study employs bibliometric analyses as a review method for answering the study's research questions. As expounded by Afrane et al. (2021), the bibliometric analysis uses mathematical and statistical methods to discover and identify the characteristics and patterns of a document system based on articles in a research area. Similarly, Donthu et al. (2021) describe it as a review process that aims to summarize large data sets to report on the intellectual structure and emerging

trends in a research field. This study's data was collected from the Web of Science (WoS) database, amassed by Thompson Reuters and maintained by Clarivate Analytics. The WoS is a broad database that offers scientific citation indexing and permits interdisciplinary searches within the main and subspecialty of an academic discipline. It further provides statistics on different document types, journals, disciplines, funding agencies, authors, and countries or regions of research. In this study, academic publications on sustainability reporting and accounting from 2004 to 2021 were retrieved from the WoS core database using the Science Citation Index Expanded (SCI EXPANDED), Social Sciences Citation Index (SSCI), and the Arts and Humanities Citation Index (A&HCI) on February 4, 2022. By restricting the search to "topic," the search term used were "sustainability accounting" or "sustainable reporting" or "sustainab* reporting" or "environmental accounting" or "environmental, social and governance" AND "financial reporting" or "reporting." The search generated 1810, further refined to only articles written in English. This yielded a sample of 1624 articles analyzed with the CiteSpace software.

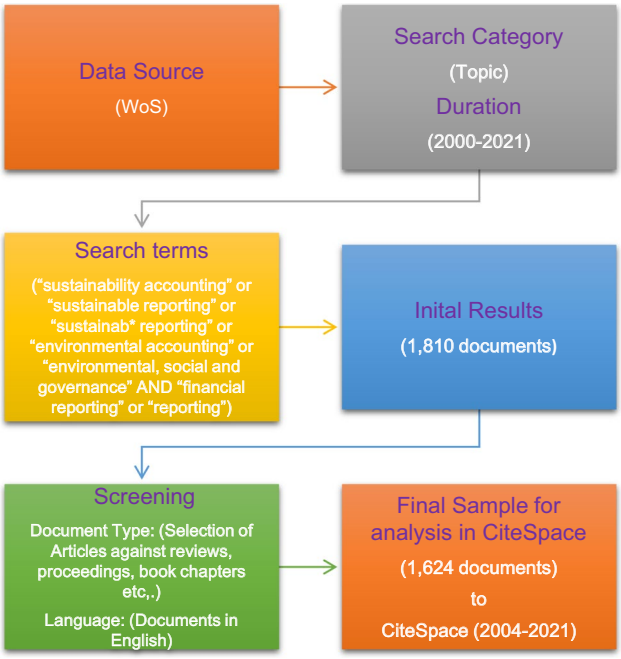


Fig. 1 Flow chart of data employed for bibliometric analysis

Bibliometric analysis using CiteSpace

Among the visualization software that can be employed to visualize research patterns in scientific research, such as Pajek, Bibexcel, VOSviewer, UCINET, and Biblioshiny, CiteSpace is one of the popular and widely used software for visualization in bibliometric analysis (Chen 2020; Guo et al. 2020; Ye et al. 2020). Developed by Chaomei Chen, CiteSpace is an open-source Java application that seeks to answer questions about the significant researched areas in a discipline, the most active areas, and the dominant papers and authors in a research field (Chen 2014). Visualizations in CiteSpace are made up of nodes and links/edges. The nodes represent references, journals, articles, keywords, institutions, countries/regions, categories/fields, and links and represent the co-citation links or the co-occurrence of items (Chen 2016). The nodes have characteristics worth acknowledging; node sizes may determine the frequency of citations, amount of papers from country analysis, and the centrality (degree or betweenness) based on the degree of connections between two or more groups (Chen 2016). In this study, the centrality of nodes is measured to identify those that connect at least two groups of nodes. As Chen (2014) indicates, nodes with higher centrality are identified by the thick purple rings around the nodes in the network map. We analyze the influence of authors, institutions, and countries in the network map based on their frequencies and centralities. This paper assesses the general characteristics of sustainability reporting from 2004 to 2021 since there were no available documents from 2000 to 2003, as illustrated in Fig. 1. This range was selected to specifically determine the growth of the domain in the last two decades, given the global agenda for a sustainable environment. Co-citation and collaboration analysis among authors, institutions, countries, or regions was then performed to determine the quantity and quality of research and identify the research advancement. CiteSpace was further employed by the mode of cluster analysis to detect the dominant research areas and timeline views of the sustainability and reporting research. The search strings employed in CiteSpace visualizations were time slicing (2004–2021), years per slice (1), linking retaining factor (3), look back years (8), node types (citation, keywords, institutions, cited journal, country), pruning (none/pathfinder and sliced network), link strength and scope (cosine & within slices), and selection criteria ($N = 50$).

The measure of influence (H-index and impact factor)

The h-index is a measure of the visibility of a group of publications and citations (Egghe & Rousseau, 2006). As underscored by Hirsch (2005), it measures the collective impact and significance of a researcher's scientific output in an impartial way. Since the h-index is obtained based on the number of publications with citations greater than h, authors, journals, and countries/regions can have h-indexes if h of their publications over a period have at least h citations each and the other publications below the h citations category have $<$ or $= h$ citations each (Hirsch, 2005). Guided by the importance of the h-index, this study employed it

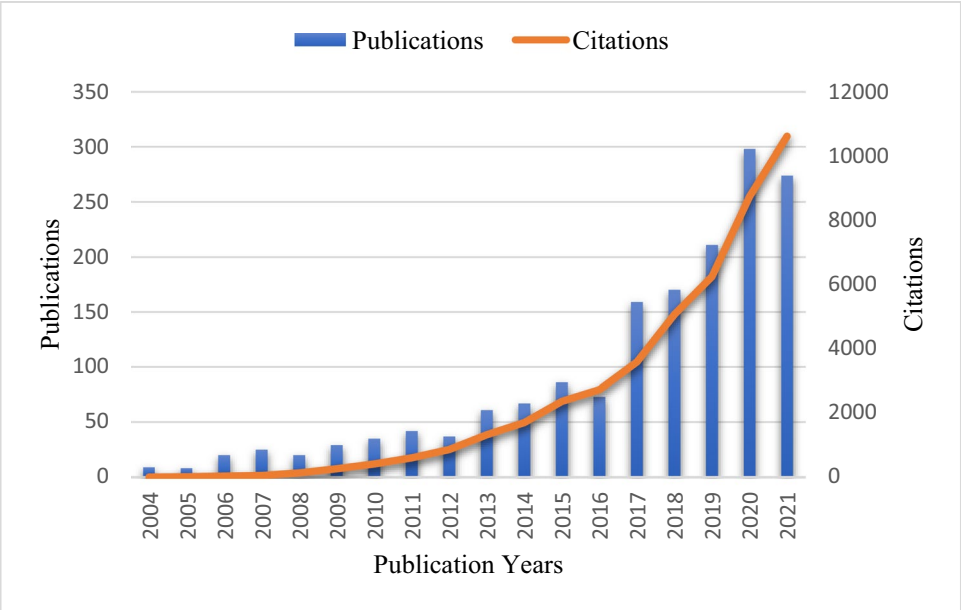


Fig. 2 Annual distribution of publications and citations

together with the total citations of authors, journals and countries. Furthermore, a standardized indicator for measuring the impact and the relative importance of journals in a chosen field (impact factor-IF) was also employed from the Journal Citation Reports (JCR) 2020 edition. As described by Sharma et al. (2014), the IF measures the frequency by which an average article receives citations in a journal in a specific period. As an indicator that applies to journals only, journals with the high IF are those that published extremely cited articles over a 2-year period.

Results

Growth in the research field over time

Figure 2 illustrates the growth of sustainability reporting research from 2004 since the keyword search yielded no publications from 2000 to 2003. Although 2005 recorded the least publications (8) within the sample period, 2020 recorded the most (298); after which, 2021 followed with 278 articles. Additionally, the first 9 years (2004–2012) contributed only 13.85% to the total sample of articles used in the review. This shows the growth of the sustainability research domain in the last few years (2013–2021) and the originality of the diverse research classifications under the scope. Though sustainability reporting research thrived before the COVID-19 pandemic, the era of the outbreak sparked more studies in 2020, some of which were driven by scholars' quest to determine whether a company's ESG performance shielded socially responsible firms from the devastating impact of the pandemic (Demers et al. 2020). On the one hand, after the publication increase in 2015, the increment was consistent (2017 to 2020), contributing to more than 50% (51.60%) of the paper coverage in the study. The graph also shows the citations recorded over the sample period. Unlike the number of publications, citations increased throughout the period. The least was recorded in 2004 (3) and the largest in 2021 (10,612), although fewer publications were in 2021 than in the preceding year. Overall, the 1624 documents have been cited 45,428 times, with an average citation per document estimated at 27.94.

The output of journals

The 1624 articles from our keyword search in the WoS database were published in 463 journals. In Table 1, while the top 5 journals contained more than 50 articles each, the top 10 productive journals constituted 41.93% of the total sample. Additionally, the "*Journal of Cleaner Production*" and "*Sustainability*" contributed more than 8% each to the total number of papers, making them highly productive journals in terms of the number of articles on the subject matter. However, based on the h-index, the *Journal of Cleaner Production* ranked first, followed by the *Journal of Business Ethics*, while "*Sustainability*" ranked 7th. Although the "*Journal of Business Ethics*" had fewer publications, their citations were more than "*Sustainability*," hence the reason for ranking 2nd based on the H-index. As anticipated, the h-index ranking of the journals and their citations were highly linked as "*Journal of Cleaner Production*" ranked 1st with the highest citations and "*Meditari Accountancy Research*" last with the least citations among the top 10. The journal IF differed as "*Business Strategy and the Environment*" preceded "*Journal of Cleaner Production*," and "*Corporate Social*

Table 1 Top 10 productive journals

Journal	No. of articles	Impact factor 2020	Total citations	H-index	%
Journal of Cleaner Production	145	9.297	7161	46	8.929
Sustainability	132	3.251	1519	20	8.128
Accounting Auditing & Accountability Journal	84	4.117	3393	28	5.172
Sustainability Accounting Management and policy Journal	61	3.354	648	14	3.756
Business Strategy and the Environment	55	10.302	2557	25	3.387
Corporate Social Responsibility and Environmental management	51	8.741	1765	21	3.140
Journal of Business Ethics	47	6.430	3081	30	2.894
Meditari Accountancy Research	45	-	465	11	2.771
Ecological Economics	33	5.389	2387	21	2.032
Ecological Modeling	28	2.974	908	16	1.724

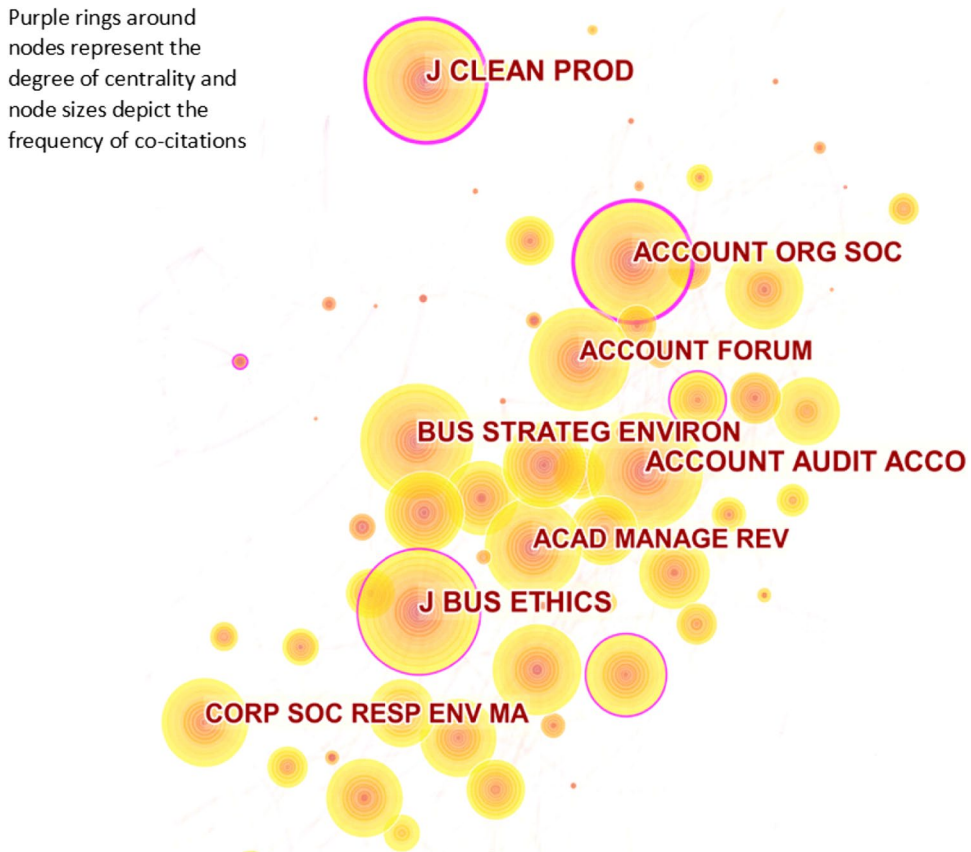


Fig. 3 Co-citation network of the most productive journals

Responsibility and Environmental management" had a higher IF than "*Sustainability*" and "*Accounting Auditing & Accountability Journal*" despite their article coverage. This is driven by the nature of articles published by the journals, the value scholars attach to them, and their citation frequencies.

Journal co-citation

Journal co-citation is crucial in ascertaining the intellectual structure and the relationship between two journals. This focuses on the co-citation relationship of two journals cited in a particular study, which in expanse determines the dominance and impact of the journal. It further aids in exploring the relationship among journals in a related field (Feng et al. 2017). Figure 3 illustrates the network of the most dominant and productive journals with node centrality represented by the purple rings around the nodes. The network consists of 260 nodes with 861 links with a density of 0.025, signifying a relatively robust network structure and linkage between journals. The threshold set resulted in the labeling of only journals that met it. As shown in the map, the top 3 journals

Table 2 Top 10 dominant subject areas

Subject categories	Number of articles	Percentage
Environmental sciences	455	28.01
Green sustainable science technology	436	26.85
Environmental studies	408	25.12
Business finance	399	24.57
Management	329	20.26
Business	275	16.93
Engineering environmental	184	11.33
Economics	127	7.82
Ecology	92	5.67
Ethics	53	3.26

with the highest co-citations were "The *Journal of Business Ethics*" (807), "*Journal of Cleaner Production*" (774), and "*Accounting Auditing Accounting journal*" (700). However, the "*Journal of Cleaner Production*" had the highest centrality (0.30), followed by the *Accounting Organisation and society* (0.26) before the "*Journal of Business Ethics*" (0.17). These centrality scores show the importance of these journals in connecting the other nodes in the network.

Ten most relevant subject areas

The coverage of the sustainability research domain has widened, and 101 subjects covered the research scope. Table 2 outlines ten dominant subject areas or categories, with the top 5 being *Environmental sciences* (28.01% of the sample), *Green Sustainable Science Technology* (26.85%), *Environmental Studies* (25.12%), *Business Finance* (24.57%), and *Management* (20.26%). Driven by the global contributions toward the fight for a sustainable environment (reducing the emission of harmful gasses, employing environmentally friendly business processes, and reporting on them), it is unsurprising that the top ten subject categories were classified under the *environmental sciences*, *green sustainable technology*, *business management*, and *finance*, considering the impact of businesses operations on society and the environment as a whole. It is, however, noteworthy that due to links between articles, most of them are classified under more than one category.

Institutional, regional contributions, and cooperation analysis

Table 3 shows the performance of the 10 top institutions based on authors' affiliations. The overall sample indicates that authors are affiliated with 1574 institutions, but the number of publications from each institution in Table 3 shows how dispersed the publications were. Each institution published more than 15 articles, constituting over 12% of the total sample. With a publication starting year later than the first five institutions, the *University of South Australia* still emerged first based on the number of published articles. Nonetheless, the *University of London* appeared first in terms of the number of citations received, followed by *the State University System of Florida*, deemed the second-largest university system in the USA, comprising 12 Universities (Florida Agricultural and Mechanical University, Florida Atlantic University, Florida International University, Florida Golf Coast University, etc.). As the university with the most-cited articles, the *University of London*'s h-index was higher than the *University of Australia* and *Parthenope University Naples*, based in Italy. Overall, sustainability reporting research has been dominant in Europe, with a density of European institutions (6 of the top ten).

The top fifteen countries/regions that have contributed to publications in the study area are listed in Table 4.

Table 3 Productive institutions

Institutions	Pub. start year	Geographical location	Total articles	Citations	H-index
University of South Australia	2010	Australia	33	1054	15
Parthenope University Naples	2008	Italy	28	742	15
University of London	2007	England	27	2354	16
Leuphana University Luneburg	2005	Germany	23	990	14
State University System of Florida (Composed of 12 Universities)	2006	USA	23	1733	13
University of Siena	2005	Italy	23	748	12
Monash University	2007	Australia	20	945	14
University of Zaragoza	2007	Spain	18	450	10
Royal Melbourne Inst. of Technology	2013	Australia	17	333	8
Bucharest University of Economics Studies	2009	Romania	16	89	6

Table 4 Fifteen most productive countries and regions

Countries	Year	No. of articles	Total citations
USA	2004	224	8983
Italy	2005	204	5418
England	2004	192	7987
Australia	2004	189	7165
Spain	2006	135	4297
Germany	2005	112	4125
Canada	2004	86	5472
China	2007	82	1234
Netherlands	2004	59	4640
New Zealand	2006	57	2274
France	2012	53	1521
South Africa	2006	48	1139
India	2011	47	299
Malaysia	2011	43	692
Romania	2009	43	293

Ninety-two regions were associated with the sample, but the top 15 comprised seven countries from Europe, two from the USA, two from Oceania, three from Asia, and one from Africa. Overall, Europe contributed the most to the sustainability reporting research (46.5%) with more citations. This reveals the position of academicians in Europe in discussing and researching sustainability issues to make recommendations for better reporting mechanisms that would increase firm accountability. Further observations show that most countries contributing to sustainability reporting research are economically developed, except those from Asia and Africa, deemed rapidly as developing countries.

In order to understand the collaborative patterns between the countries listed in Table 4, Fig. 4 shows the network and collaborations between the countries using CiteSpace. The network map consists of 78 nodes, 222 links, and a density of 0.07, signifying a close connection and a highly collaborative relationship among the countries. The centrality of England (0.35), China (0.18), the USA (0.15), Malaysia (0.13), Italy (0.11), and Germany (0.10) indicated their importance in connecting the other nodes.

Authors and authorship collaborations

Table 5 shows the top twenty dominant authors in the research domain based on the total publications, the publication start year recorded in the WoS database, and the number of citations received. Author Franzese PP emerged within 18 years with the highest publication, although his first publication listed in the database was in 2009. With a research area in environmental accounting, systems ecology, and others, his most cited article (86) among the seventeen papers was "Sustainable biomass production: A comparison between Gross Energy Requirement and Emergy Synthesis methods" in 2009. This article discussed two crucial

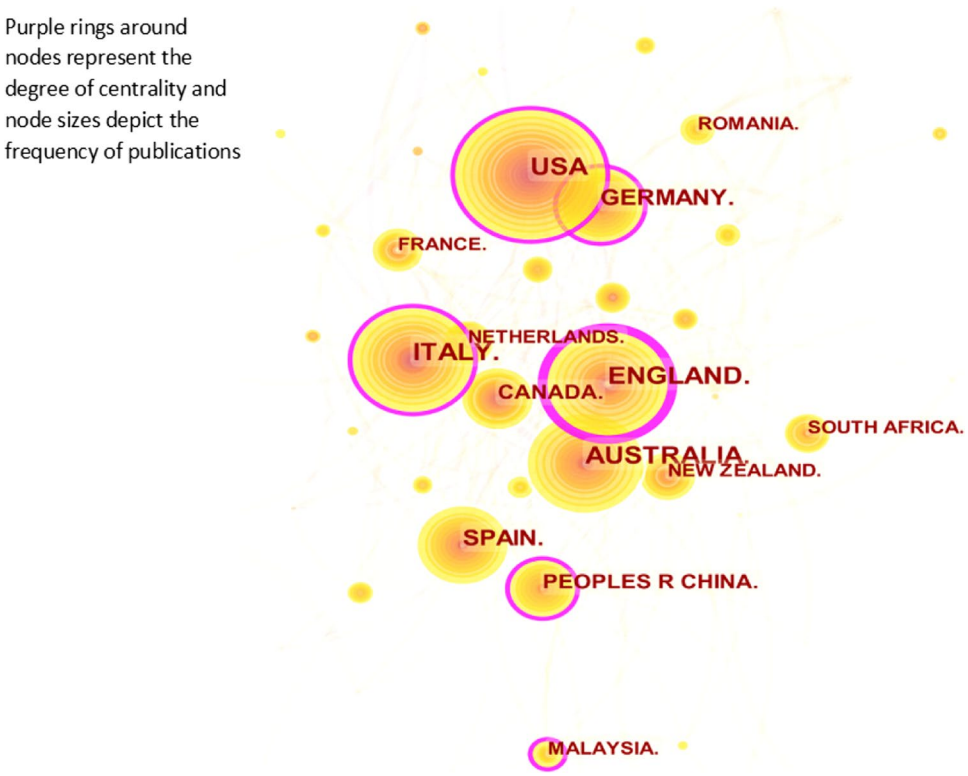


Fig. 4 Academic partnership among countries

Table 5 Top 20 performing authors

Author	No. of articles	Pub. year start	Total citations
Franzese PP	17	2009	412
Buonocore E	15	2014	289
Schalteggar S	14	2005	894
Giannetti BF	13	2006	417
Almeida CMVB	12	2006	413
Uyar A	12	2017	201
Buallay A	11	2019	154
Lozanao R	11	2006	1388
Lodhia S	11	2013	349
Boiral O	10	2013	514
Cho CH	10	2007	1407
Kilic M	10	2018	128
Larrinaga C	10	2008	286
Russo GF	10	2009	251
De Villiers C	9	2006	894
Manetti G	9	2009	512
Ulgiati S	9	2007	466
Bellucci M	8	2016	144
Higgins C	8	2013	464
Maroun W	8	2015	203

methods for environmental accounting and energy analysis as avenues for providing an inclusive and complete evaluation of the environmental sustainability of human-dominated production processes. Closely following was Buonocore E, with fifteen articles and citations lower than Franzese PP. His most cited article (48), co-authored with Franzese PP, was "Assessing the value of natural capital in marine protected areas: A biophysical and trophodynamic environmental accounting model" in 2017. This collaboration between the two authors may indicate the possibility of collaborations between author researching firms' sustainability reporting practices. Although Cho CH had ten articles, he had the highest citations over the period. His most cited article was "The role of environmental disclosures as tools of legitimacy: A research note." The study employed size-matched groups based on industry membership (environmentally sensitive versus non-environmentally sensitive) and environmental performance to examine the differences in the use of monetary and non-monetary non-litigation-related environmental disclosure. The study provided further support that firms use disclosure as a legitimizing tool. It can also be observed that with the most recent publication year in 2016, Bellucci M recorded the lowest citations and the least number of articles among the first 20 authors.

A collaborative network was run in CiteSpace, as illustrated in Fig. 5, to determine the collaborations among authors. The network comprised 184 nodes, 120 links, and a density of 0.0071, depicting a rather loose nature of collaborations among authors. This implies that most studies are conducted autonomously rather than among the authors listed in Table 5. Nonetheless, links between Franzese PP and Buonocore E show that they have co-authored some papers in the network, as discussed.

Citation analysis of the sustainability reporting domain

Most cited articles

Table 6 shows the ten most-cited articles within the study period. The least cited paper receiving a citation of 324 in less than 10 years of publication portrays the attention the sustainability domain has received over the years. *Accounting Organisations & Society* was the most represented journal among the top 10. This is not surprising since it had the second-highest centrality among the journal co-citation analysis in Fig. 3. The top three cited articles focused on environmental accounting practices and disclosures. Clarkson et al. (2008) examined the relationship between corporate environmental performance and environmental disclosure levels among US firms by developing an index for assessing the level of discretionary disclosures in sustainability reports. They reported that environmental performance positively influences discretionary disclosure levels among firms. Boyd & Banzhaf (2007) identified the inconsistently defined units of accounts in determining environmental contributions to human welfare and proposed a definition for such units that offers a structure for environmental performance measurements by markets and governments. Furthermore, they highlighted the importance of accounting for environmental services in public policymaking since it improves human welfare.

Co-citation of references

A co-citation relationship is formed when two studies get concurrently cited by a third. A co-citation analysis further depicts the frequency with which articles cite the pairs of articles together. The analysis of co-cited works aids in detecting the knowledge base of a research field through cluster evaluations in the citation network (Afrane et al. 2021). CiteSpace was employed to help transform the data into matrices so the patterns of earlier citations are clearly illustrated, as shown in Fig. 6. The network consisted of 486 nodes and 1324 links with a density of 0.0112, corresponding to the cooperative relationship between the cited references. Whereas the node sizes depict the frequency of co-citation, the red rings depict the burstness, and the purple rings represent the centrality of nodes. The burstness of co-cited references in Fig. 7 shows the trend of documents that have significantly surged in citations or gained massive

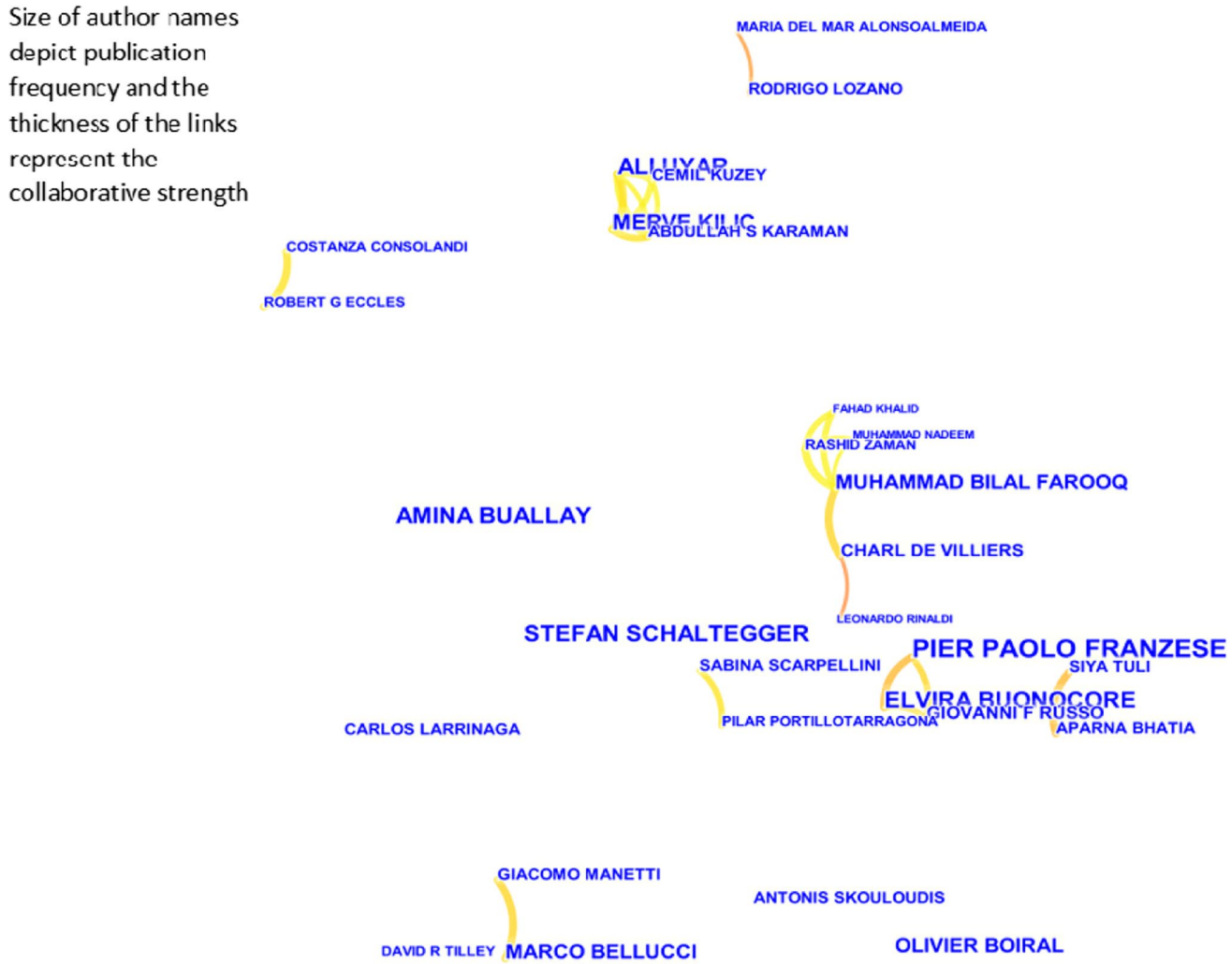


Fig. 5 Co-authorship network

attention within a period (Chen 2016). The references with the highest centrality in the map were Gray (2010), 0.25, Hahn & Kühnen (2013); Sìmnett et al. (2009), which were central nodes in the network, although the density of 0.011 shows a moderate link among the nodes. As indicated in Table 7, the most co-cited reference was "Determinants of sustainability reporting: a review of results, trends, theory, and opportunities in an expanding field of research (Hahn & Kühnen 2013)." By studying the adoption and extent of sustainability reporting quality, the authors unearthed the missing link to sustainability research theories, drawing future researchers' attention to the importance of establishing links to theories. Milne & Gray's (2013) paper subsequently discussed the current disassociation between sustainability reporting and the sustenance of life-supporting ecological systems upon which living organisms rely. They critiqued the stern focus of most businesses on the TBL amid the ignorance of ecological concerns. The third most cited document published in the *Critical Perspectives on Accounting* also assessed the broad category of CSR with emphasis on environmental goals, organizational approaches, ecological culture, etc., through stand-alone reports, assurance, and reporting guidance reporting practices. Michelon et al. (2015) reported that typically, firms using the three reporting practices tend to provide a lower quality of information than firms producing performance-related disclosures.

Citation bursts

Depicted by red rings around the nodes in Fig. 6, documents with citation bursts cannot be disregarded as burstness shows the attention a publication or node has received within a research period. The burstness of the top 25 cited references is exhibited in Fig. 7 based on the beginning of bursts using CiteSpace's burstness tool. The green timeline indicates the time intervals, whereas the red timeline depicts the strongest

Table 6 Top 10 most cited articles

Title	Journal	Times cited	Country/region	Reference
Revisiting the relation between environmental performance and environmental disclosure: An empirical analysis	Accounting Organisations & Society	1081	Canada	(Clarkson et al. 2008)
What are ecosystem services? The need for standardized environmental accounting units	Ecological Economics	1063	USA	(Boyd & Banzhaf 2007)
The role of environmental disclosures as tools of legitimacy: A research note	Accounting Organisations & Society	772	Canada	(Cho & Patten 2007)
Developing a framework for sustainable development indicators for the mining and minerals industry	Journal of cleaner production	511	England	(Azapagic 2004)
Is accounting for sustainability actually accounting for sustainability… and how would we know? An exploration of narratives of organisations and the planet	Accounting Organisations & Society	481	Scotland-E	(Gray 2010)
W(h)ither Ecology? The Triple Bottom Line, the Global Reporting Initiative, and Corporate Sustainability Reporting	Journal of business ethics	447	New Zealand	(Milne & Gray 2013)
A blueprint for mapping and modeling ecosystem services	Ecosystem services	393	Australia	(Crossman et al. 2013)
Measuring Organizational Performance: Beyond the Triple Bottom Line	Business Strategy and the environment	344	Australia	(Hubbard 2009)
Corporate Sustainability and Innovation in SMEs: Evidence of Themes and Activities in Practice	Business Strategy and the environment	331	Netherlands	(Bos-Brouwers 2010)
Integrated Reporting: Insights, gaps and an agenda for future research	Accounting Auditing & Accountability Journal	324	England	(de Villiers et al. 2014)

burstness period. Even though the earliest article among the top 25 was published in 2007, citation burstness began in 2010 with Cooper SM. Cooper & Owen (2007) assessed the missing link between corporate social reporting and stakeholder accountability. By extension, as CSR affects environmental, social, and sustainability reporting, they evaluated the intensity of institutional reforms designed to empower stakeholders and improve accountability from the voluntary initiatives and mandatory disclosure of an operating and financial review (OFR) by the UK quoted companies. Through analysis, they reported that the proposed mandatory reporting approaches through the OFR may not be adequate to facilitate actions among organizational stakeholders.

References with the most prolonged burst lasting 8 years were Gray (2010); Hopwood (2009) from 2011 to 2018. Though Gray (2010); Michelon et al. (2015) were among the top 5 co-cited references in Table 7, Michelon et al. (2015), Sìmnett et al. (2009), Gray (2010) were the top 3 with the highest citation burst strength of 14.69, 13.37, and 12.47. Sìmnett et al. (2009) examined the voluntary assurance market using a sample of companies from 31 countries that produced sustainability reports between 2002 and 2004. By hypothesizing that the credibility of reports is enhanced through assurance, they found that firms use assurance services to improve reporting credibility to build their corporate reputation regardless of the background of the assurance providers. Whereas the least burstness duration among the top 25 lasted for 2 years (O'Dwyer et al. 2011), the most recent burst episode that ended in 2021 but began in 2017 was by Bebbington & Larrinaga (2014). Bebbington & Larrinaga (2014) explored the emerging possibility that may arise for accounting in light of a sustainability science approach. Michelon et al. (2015), having attained the highest burstness strength, were also recorded among the recent citation bursts. This was followed by Boiral (2013), Cho et al. (2015), Diouf & Boiral (2017), Dienes et al. (2016), and Michelon & Parbonetti (2012) with burst strengths of 11.81, 10.48, 10.26, 8.86, and 8.81. These recent references with burstness in 2021 depict the direction of topics recently gaining interest in the domain. Given the growing attention to sustainable firm practices and development, Boiral (2013) studied the degree to which sustainability reporting can be regarded as a facsimile to conceal actual sustainable development issues and project a flawless view of entities' activities. They reported that firms did not report the majority (about 90%) of significant negative events in their sustainability reports, at odds with the principle of transparency, completeness, and balance in GRI reports. Similarly, Cho

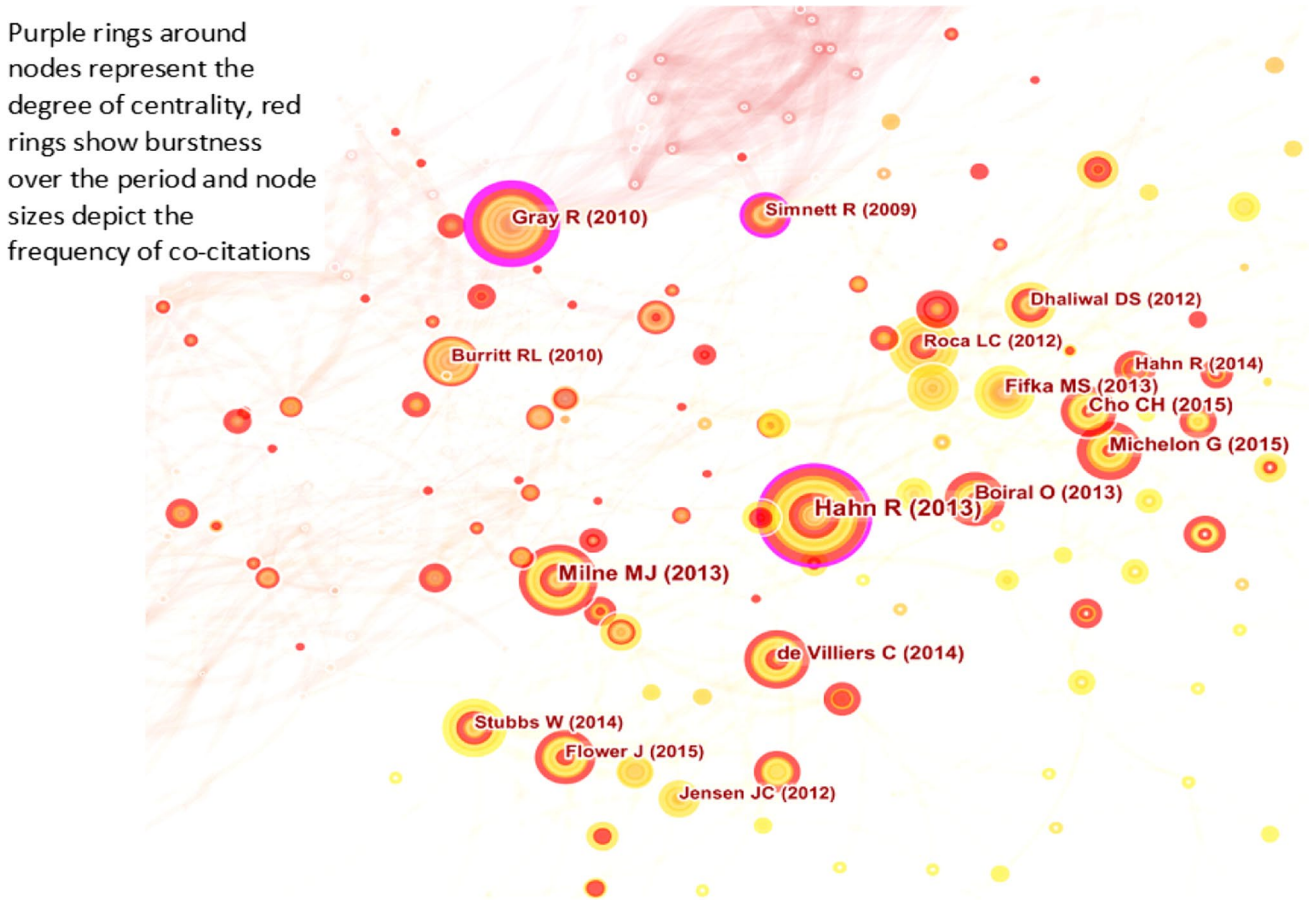


Fig. 6 Co-citation network of co-cited references

et al. (2015) argued that institutional and societal pressures necessitate organizations to engage in hypocrisy and develop facades that limit sustainability reports' substantive disclosures over the period. The reference with the least burstness strength (8.3) among those ending in 2021 by Kuzey & Uyar (2017) examined the determinants of sustainability reporting and its effects on firm value. Findings were that most firms seek external assurance for their reports, and sustainability reporting propels firm value.

Cluster analysis of co-cited references

After determining the most cited references and the burstness of the top 25 references, CiteSpace was further employed to group the knowledge-mapped network of references into clusters based on the closeness of connections between references. This clustering technique has been used by a few extant literatures tackling other aspects of the sustainability discourse (Pasko et al. 2021; Ye et al. 2020). Among the clusters generated, Fig. 8 shows the nine largest clusters of co-cited references represented by convex hulls and node colors based on the cluster membership. As Chen (2016) indicated, modularity and silhouette values are critical characteristics of cluster analysis that reveal the clear distinctions of a network and the closeness of nodes in a cluster. The closer the modularity value to 1, the clearer the overall structure of the network. In essence, a modularity value greater than 0.3 and close to 1 measure how a network can be disintegrated into multiple components. In our study, the estimated modularity value was 0.708, close to 1 and acceptable.

The log-likelihood ratio (LLR) labeling of clusters, which identifies clusters based on the main concepts of clusters, was employed to label the nine largest clusters based on keywords (K) in CiteSpace. However, attention was equally paid to the silhouette values of the clusters since it is a measure of cluster homogeneity, indicating the quality of the clustering configuration (Chen 2014). Like the modularity value, clusters with silhouette values closer to 1 are deemed consistent. Table 8 outlines the nine largest clusters with their mean cite year, the silhouette score, and the labeling based on LLR. The least silhouette score of 0.707 shows that the cluster nodes are consistent and highly similar. Cluster 0 is the largest cluster labeled as sustainability reporting with a

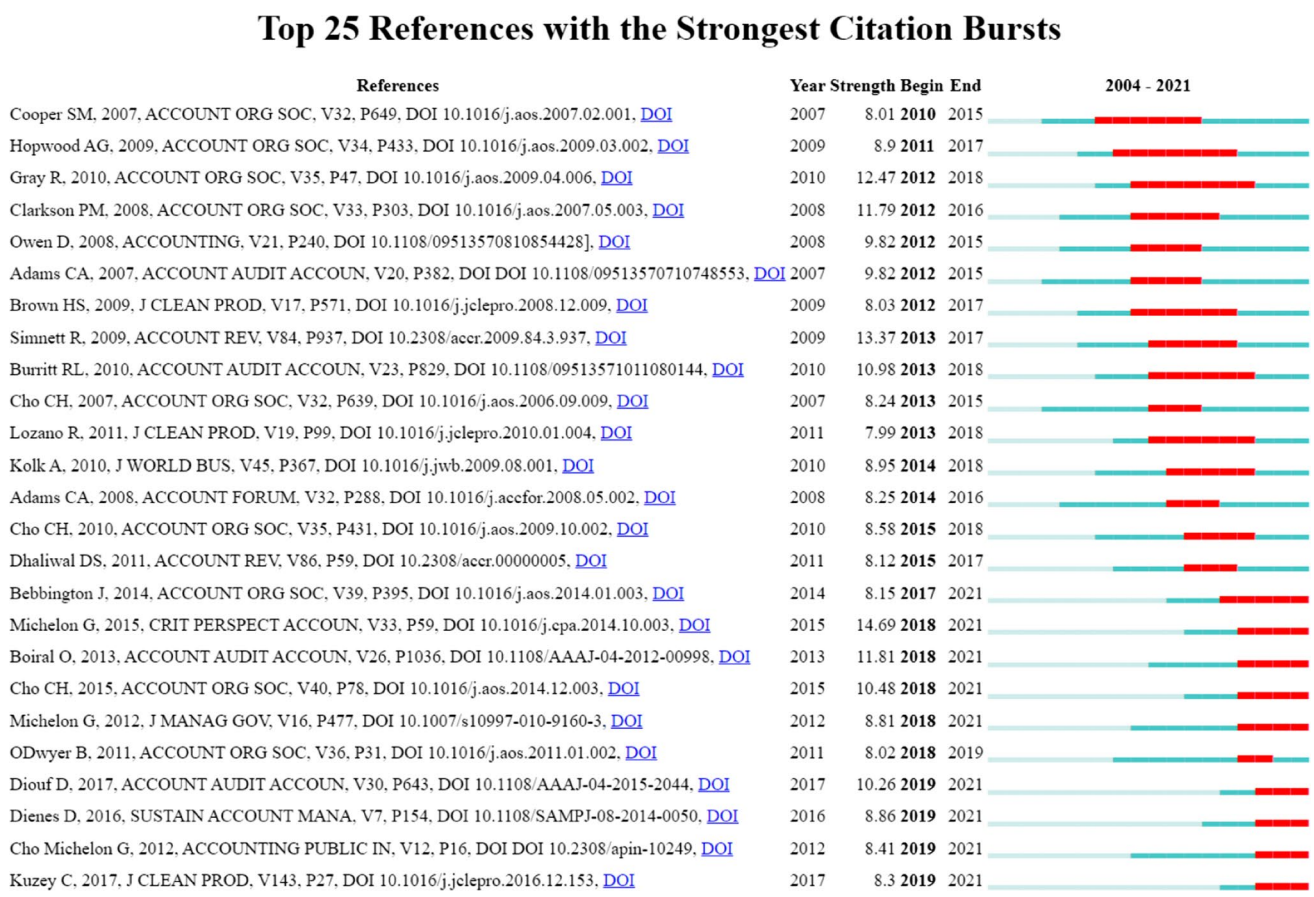


Fig. 7 Documents with citation burst

Table 7 Description of top 5 co-cited references

Title	Journal	Co-citations	Reference
Determinants of sustainability reporting: a review of results, trends, theory, and opportunities in an expanding field of research	Journal of Cleaner Production	158	(Hahn and Kühnen, 2013)
W (h) ither ecology? The triple bottom line, the global reporting initiative, and corporate sustainability reporting	Journal of Business Ethics	92	(Milne and Gray, 2013)
CSR reporting practices and the quality of disclosure: An empirical analysis	Critical Perspectives on Accounting	78	(Michelon et al., 2015)
Is accounting for sustainability actually accounting for sustainability…and how would we know? An exploration of narratives of organisations and the planet	Accounting, Organizations and Society	63	(Gray, 2010)
Sustainability reports as simulacra? A counter-account of A and A + GRI reports	Accounting, Auditing & Accountability Journal	63	(Boiral, 2013)

silhouette score of 0.731, 86 members of co-cited references, and a mean year of 2013, which shows that nodes in the cluster are pretty recent. The sustainability reporting (cluster 0) cited articles like those by Garcia-Sanchez (2021); Maas et al. (2016), who assessed corporate social reporting and assurance and the integration of corporate sustainability.

Cluster 1, the second-largest, labeled as social accounting, had 64 members with the mean year of 2007. As part of triple-bottom-line reporting, much attention has been shifted to including people and the planet in reporting. For instance, cluster 1 was composed of citing articles from Gray & Laughlin (2012); Michelon & Parbonetti (2012), who assessed TBL and changes

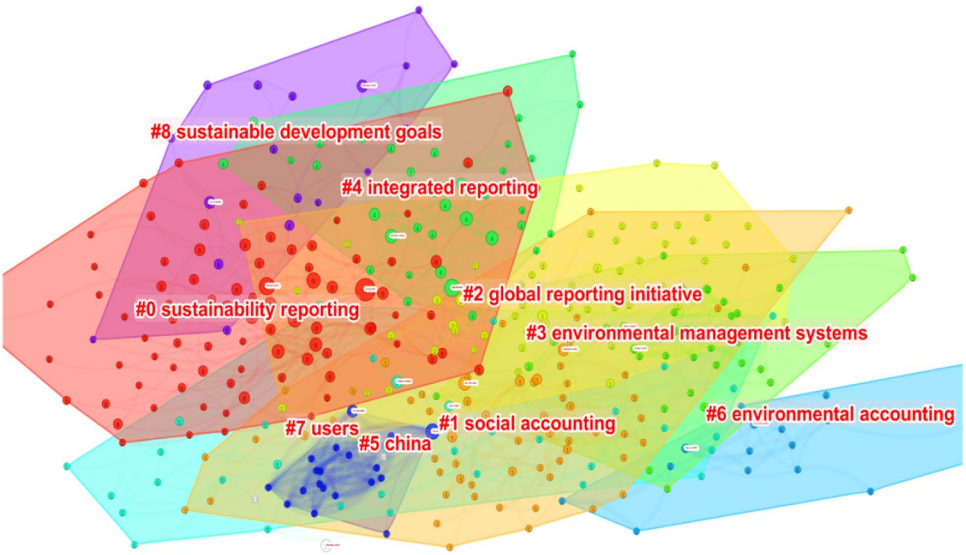


Fig. 8 Cluster analysis of co-cited references

Table 8 Summary of 10 largest clusters of co-cited references

Cluster ID	Size	Silhouette	Mean year	LLR
0	86	0.731	2013	Sustainability Reporting
1	64	0.732	2007	Social accounting
2	55	0.707	2008	Global reporting initiative
3	38	0.876	2005	Environmental management systems
4	36	0.924	2014	Integrated reporting
5	34	0.844	2006	China
6	24	0.94	2006	Environmental accounting
7	20	0.998	2007	Users
8	19	0.952	2015	Sustainable development goals

in reporting and evaluated a special issue to determine the take-home surrounding the social and environmental accounting and reporting literature. Cluster 2, the third, labeled as the Global Reporting Initiative (GRI), had members that were not as recent (2008) as cluster 0. Cluster 4, labeled integrated reporting, had a high silhouette value and the second most recent mean year. This indicates how the co-cited references have recently focused on integrated reporting, integrating firms' strategy, performance, and ESG into one report. Whereas cluster 7 had the highest silhouette score (0.998), signifying the homogenous nature of nodes in the cluster, cluster 8, labeled as Sustainable Development Goals (SDGs), had the most recent mean citing year (2015). This shows that most current citing documents focus intensely on the SDGs, discovering mechanisms to achieve them after it replaced the Millennium Development Goals (MDGs) in 2015 (Battaglia et al. 2020; García-Sánchez et al. 2020; Izzo et al. 2020).

Keywords co-occurrence analysis

Figure 9 shows the map of the widely used keywords and their co-occurrences as indicated by the links to recognize the research developments and hotspots. The network consists of 189 nodes and 1478 links with a density of 0.08, which portrays a close-fitting relationship. The node sizes represent the frequency of keywords, while the purple rings indicate their centrality. The frequently used keywords and their centralities have been presented in Table 9. The frequently used keywords were "*sustainability reporting*," "*corporate social responsibility*," and "*performance*," with 400, 359, and 289 occurrences, respectively. Unsurprisingly, corporate social responsibility emerged as the second most frequently used keyword, given the broad scope of CSR. As described by Ye et al. (2020), CSR has shifted from the philanthropic attribute to a broader spectrum, and the essence of CSR can be linked to the TBL as it encompasses environmental, social, and economic issues. Keywords with the highest centrality were "*environmental accounting*" (0.21), "*management* (0.14)," "*corporate social responsibility* (0.14)," and "*sustainability*" (0.13). As shown in Fig. 9, these nodes had a thicker purple ring and can be described as necessary in the network map since it indicates the relational ties of the keywords.

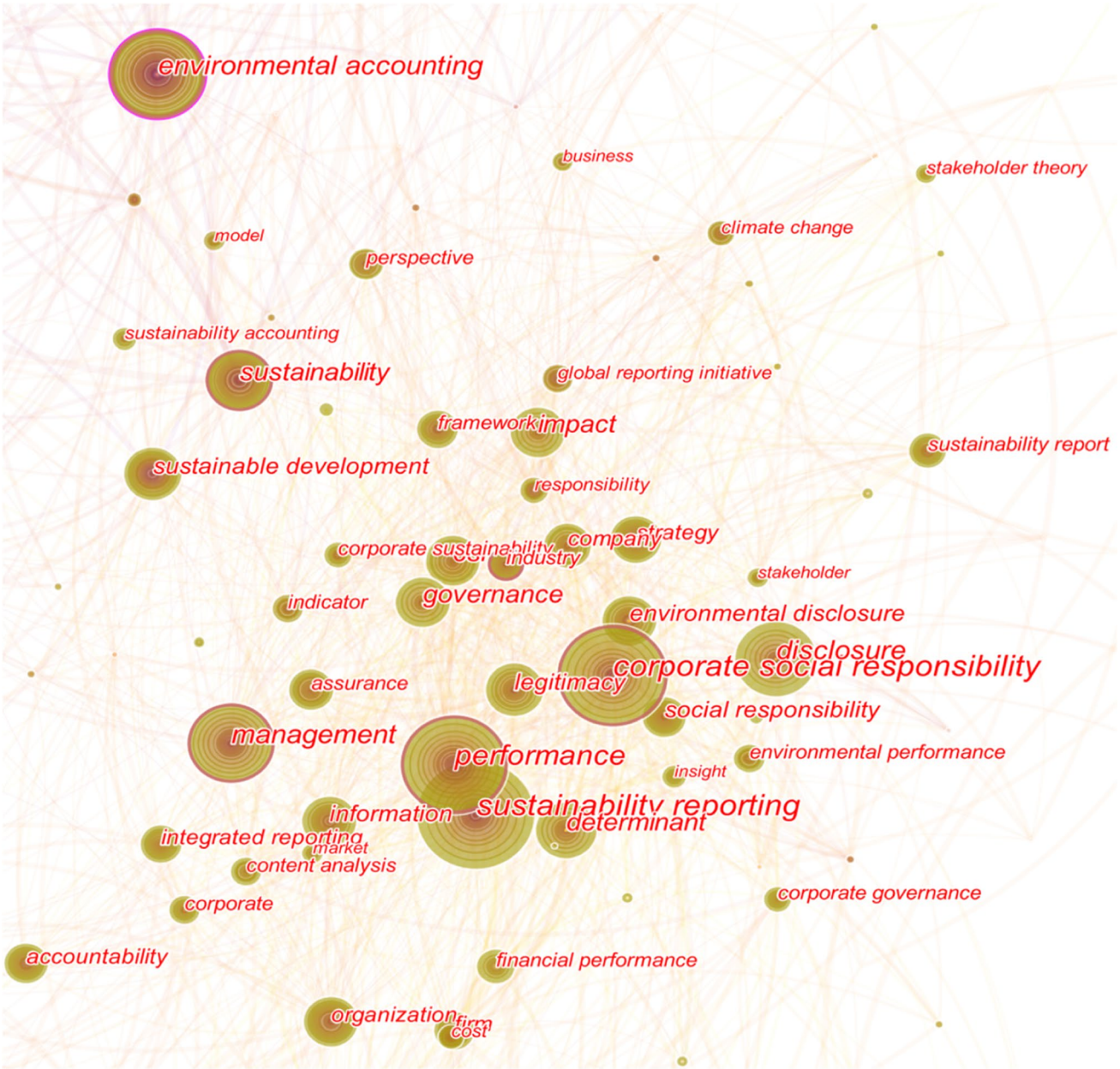


Fig. 9 Keyword co-occurrence map

Additionally, faced with the responsibility of preparing sustainability reports and disclosing the sustainable strategies of firms, management also had a centrality score of 0.14. Overall, the frequently used keywords portray the constituents of the sustainability domain; the importance of its determinants, the role of governance, legitimacy, and the global direction toward a sustainable environment.

To further interpret the keyword co-occurrence map, a cluster analysis was performed and labeled by the LLR. Figure 10 illustrates the ten largest keyword clusters, with the largest labeled #0 and the tenth cluster labeled #09. The silhouette scores of the clusters from the first (#0) to the tenth (#09) were 0.766, 0.931, 0.811, 0.817, 0.894, 0.909, 0.878, 0.939, 0.961, and 0.857, respectively. Cluster #0 focused on environmental accounting, sustainability reporting and accounting and the social accounting matrix. Cluster #1, focusing on business-society relations, was associated with link sustainability, reporting bridge, empirical findings, and studies in western Europe. Cluster #2 similarly related to environmental accounting, exhaustible resources (studies on resources that must be replenished after a few hundred years), strong sustainability, and the construction of a genuine savings indicator.

Table 9 Frequency of keyword co-occurrence

Keyword	Frequency	Occurrence
Sustainability reporting	400	0.03
Corporate social responsibiliy	359	0.14
Performance	289	0.10
Management	236	0.14
Disclosure	230	0.04
Environmental acounting	199	0.21
Determinant	161	0.06
Inpact	146	0.04
Sustainabiliy	136	0.13
Csr	130	0.04
Governance	130	0.03
Environmental disclosure	110	0.07
Legitimacy	110	0.05
Sustainable environment	106	0.08

As an essential sustainability indicator, genuine savings promote relevant policy questions that surpass traditional concerns with macroeconomic and microeconomic determinants of savings efforts (Hamilton 2000). Cluster #3 focused on emergy accounting, water management, specific emergy, and energy-based appraisal as part of environmental accounting and decision-making. As defined by Brown & Ulgiati (2004), "Emergy is the availability of energy (exergy) of one kind that is used up in transformations directly and indirectly to make a product or service." He further described emergy accounting as using a thermodynamic basis of energy forms, materials, and human services and converting them into a particular form of energy in producing goods and services. The last cluster, #9, was related to new assurance services, the complexity of reported information, zero emissions, and progressive social accounting.

Keywords with citation bursts

Burstness highlights the period when the occurrence or use of nodes is relatively much higher among other nodes (Chen & Wu 2017). Additionally, since burst keywords aid in unearthing the hotspot areas in the research domain or where researchers have focused over a period (Marrone et al. 2020), it contributes to understanding the developmental path of the sustainability reporting domain. Employed in previous studies (Aryadoust et al. 2019; Chen & Wu 2017; Ye et al. 2020), Marrone et al. (2020) aver that when there is a sudden spike in publications in a particular subject or area of interest, a keyword burst can reveal new developments linked to that field or area of interest. Furthermore, burstness shows nodes that have garnered significant attention in a brief period while displaying substantial changes in a frequency function over a short period (Chen 2016; Chen et al. 2010). With the red timelines in Fig. 11 depicting the duration of burstness, the study period is divided into three developmental phases: 2004–2009, 2010–2015, and 2016–2021 for more precise analysis. Given the duration of the study, the phases would help in understanding the hotspot areas better.

The 2004–2009 phase recorded the longest citation burst over the entire period. Although the burstness strength of

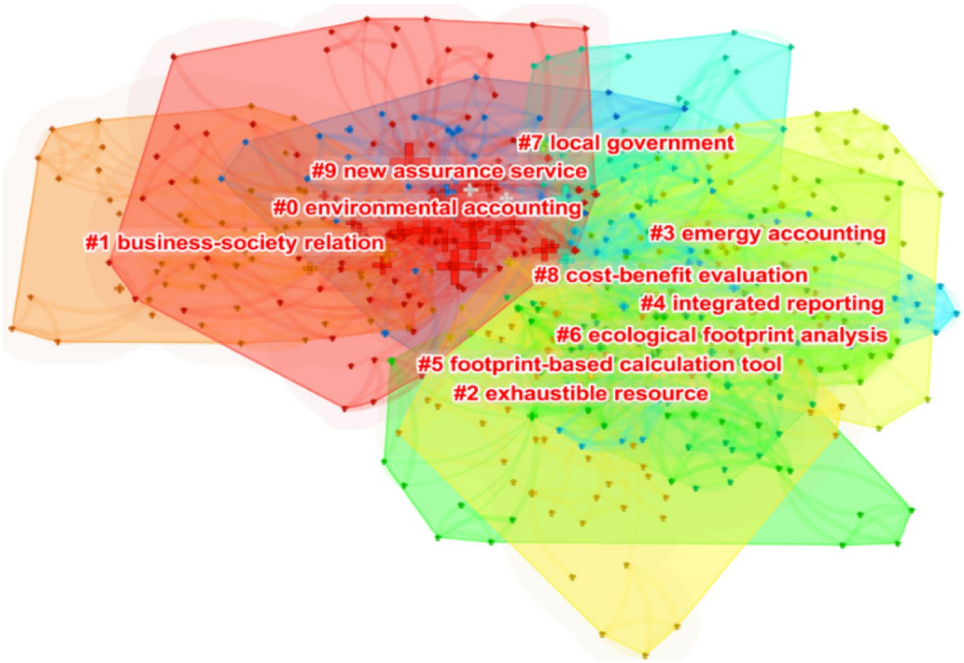
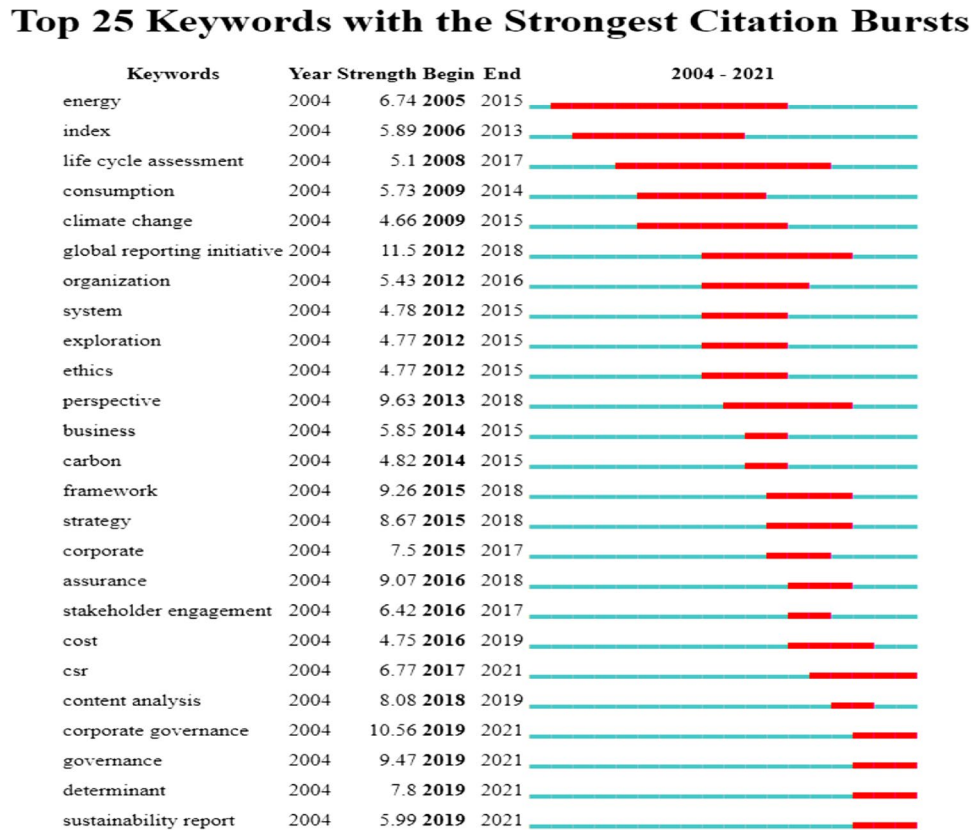


Fig. 10 Cluster analysis of keywords

Fig. 11 Burstness of keywords



the keyword "*energy*" was not the highest during the whole period, it was for the first phase, and the burst episode started in 2005 and ended in 2015. Many ESG, environmental, and sustainability reporting studies have been done in the energy sectors (Baran et al. 2022; Boiral 2013). Aside from that, others focused on carbon management studies and those determining how energy can be effectively organized (Azapagic 2004; Schaltegger & Csutora 2012). Chen (2014) indicates that keywords with a strong burstness point to potentially interesting studies that have attracted significant attention within a short period. "*Energy*" was followed by "*index*," "*life cycle assessment*," "*consumption*," and "*climate change*," with bursts lasting from 2006 to 2015. Studies developed indexes based on their research methodologies, which justifies why "*index*" was part of the top 25 keywords. Additionally, Azapagic (2004) retorts that methodologies like life cycle assessment are usually employed to assess the environmental impacts associated with all the life cycle stages. Phase 2 (2010–2015) recorded the keyword with the strongest citation burst (Global Reporting Initiative-11.50) during the entire period, with a burst episode from 2012 to 2018. Within the range, this was followed by "*perspective*" (9.63), with a burst episode from 2013 to 2018, "*framework*" (9.26), and *strategy* (8.67). Whereas the burst strengths of keywords in the range were relatively higher than in the first phase (2004–2009), the bursts were longer in the first period. Studies in this period largely focused on strategies, perspectives, exploration, systems, and corporate aspects of businesses. "*Global reporting initiative*" had the highest burstness score since it is a widely adopted framework for sustainability reporting (Bose 2020; Milne & Gray 2013; Tiwari & Khan 2020), although it was not listed as part of the top 15 frequently used keywords in Table 9. Founded in 1997 by the Coalition for Environmentally Responsible Economies, the UN environment program and the Tellus Institute, the GRI launches standards for corporate sustainability reporting (Bose 2020). The last phase (2016–2021) shows five keywords that have recently received significant attention in the sustainability domain. With the most extended burst episode from 2017 to 2021, "*CSR*" (6.77) remains an area still receiving much attention in the literature, considering its extensions to the overall sustainable development agenda. Other keywords still receiving much attention are "*sustainability report*," "*determinant*," "*governance*," "*corporate governance*," and "*determinant*." During this period, "*corporate governance*" instead attained the highest burst strength (10.56), followed by "*governance*" (9.47) and "*assurance*" (9.07). Its dominance is a result of how studies have ascertained the relationship between corporate governance and sustainability disclosure, identifying the impact of board characteristics and decisions on reporting (Fuente et al. 2017; Hussain et al. 2018; Liao

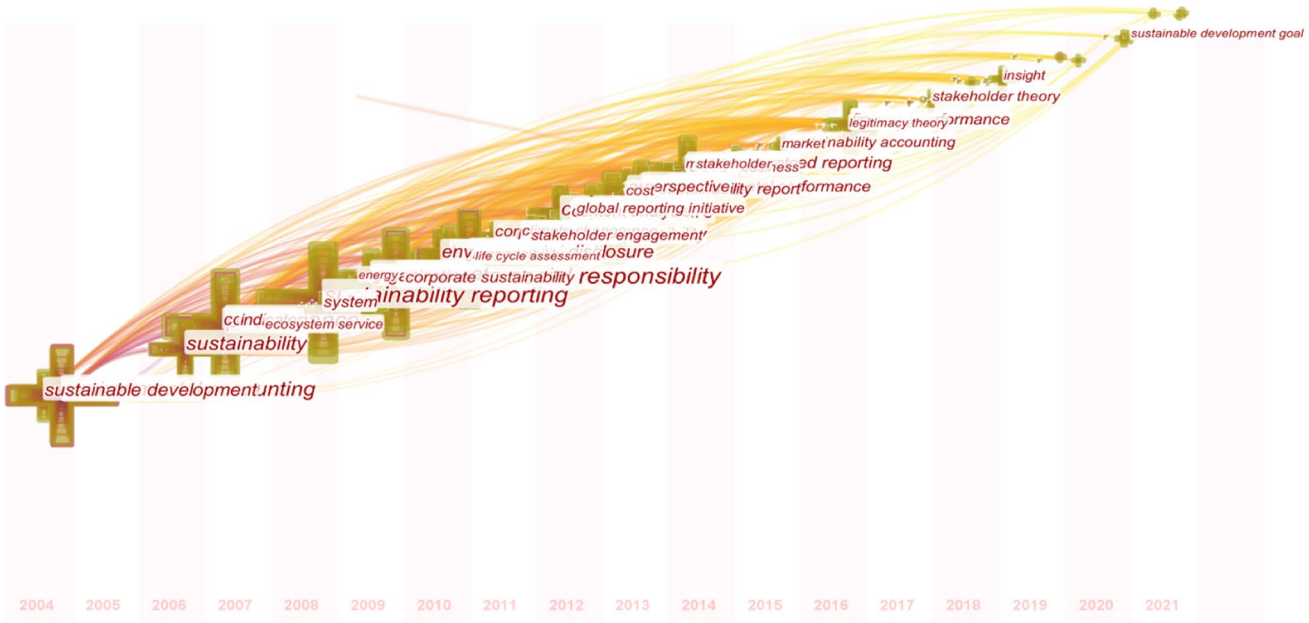


Fig. 12 Time zone analysis of keywords

et al. 2015). Potentially interesting studies emerged in the last phase as they recorded keyword bursts within a much shorter period than all phases.

Time zone and timeline analysis of keywords

Furthermore, CiteSpace was employed to illustrate keyword co-occurrence over the research period, as shown in Fig. 12. To identify the occurrence of keywords, keywords that appeared at least 15 times were included in the map, while the cross (node) size indicates the frequency of occurrence. Based on the transitional classification of burstness in Fig. 11, phase 1 (2004–2009) recorded a high frequency of keywords like "*sustainable development*," "*sustainability*," "*ecosystem service*," "*system*," and "*sustainability reporting*" while phase 2 (2010–2015) similarly recorded a high frequency of keywords like "*corporate sustainability*," "*stakeholder engagement*," "*global reporting initiative*," "*cost*," and "*perspective*." On the other hand, phase 3 (2016–2021) recorded few co-occurrences of keywords such as "*sustainability accounting*," "*stakeholder theory*," "*legitimacy theory*," "*performance*," "*insight*," and "*sustainable development goals*" at the latter part of 2020. These emerging keywords may suggest the focus on stakeholder and legitimacy theories in relating a firm's sustainability disclosures as a part of legitimation in firms' quest to be accountable to stakeholders. Many sustainability disclosures by companies have mainly referred to the SDGs to contribute to the global sustainable environment. In sum, this timezone analysis depicts that while the research scope seems to have widened because of the frequency of keyword co-occurrence in phases 1 and 2, the fewer keyword co-occurrence in the last phase portrays that aside from its link to previous studies in the initial phases, some major topics are still evolving. As such, there might only be a fair shift in focus as newer studies emerge.

Figure 13 illustrates a timeline analysis of keywords aligned with the clusters identified in Fig. 10. Keywords are presented in the columns based on a 3-year gap, with cluster IDs displayed by each row in the view. The top 3 keywords with the highest frequencies are also displayed under each cluster. As shown in Fig. 13, the dominance of keywords was within phases 1 and 2. With most of the keyword co-occurrence in cluster #0, the environmental accounting cluster, keywords such as "*GRI*," "*sustainability*," "*content analysis*," "*quality*," "*innovation*," "*behavior*," "*business*," and "*performance*" prevailed. Cluster #1 contained keywords on "occupational safety," "TBL," "corporate social responsibility," etc. Amid the dominance of keywords within the first two phases, clusters 1 to 4 and nine are still robust, reporting on hotspots such as "*SDG*," "*non-financial disclosure*," "*integrated reporting*," "*social and environmental reporting*," "*insight*," "*society*," and "*control system*."

Discussion and conclusion

Research development and contributions

With the objective to examine the sustainability reporting subject area through the identification of contributing

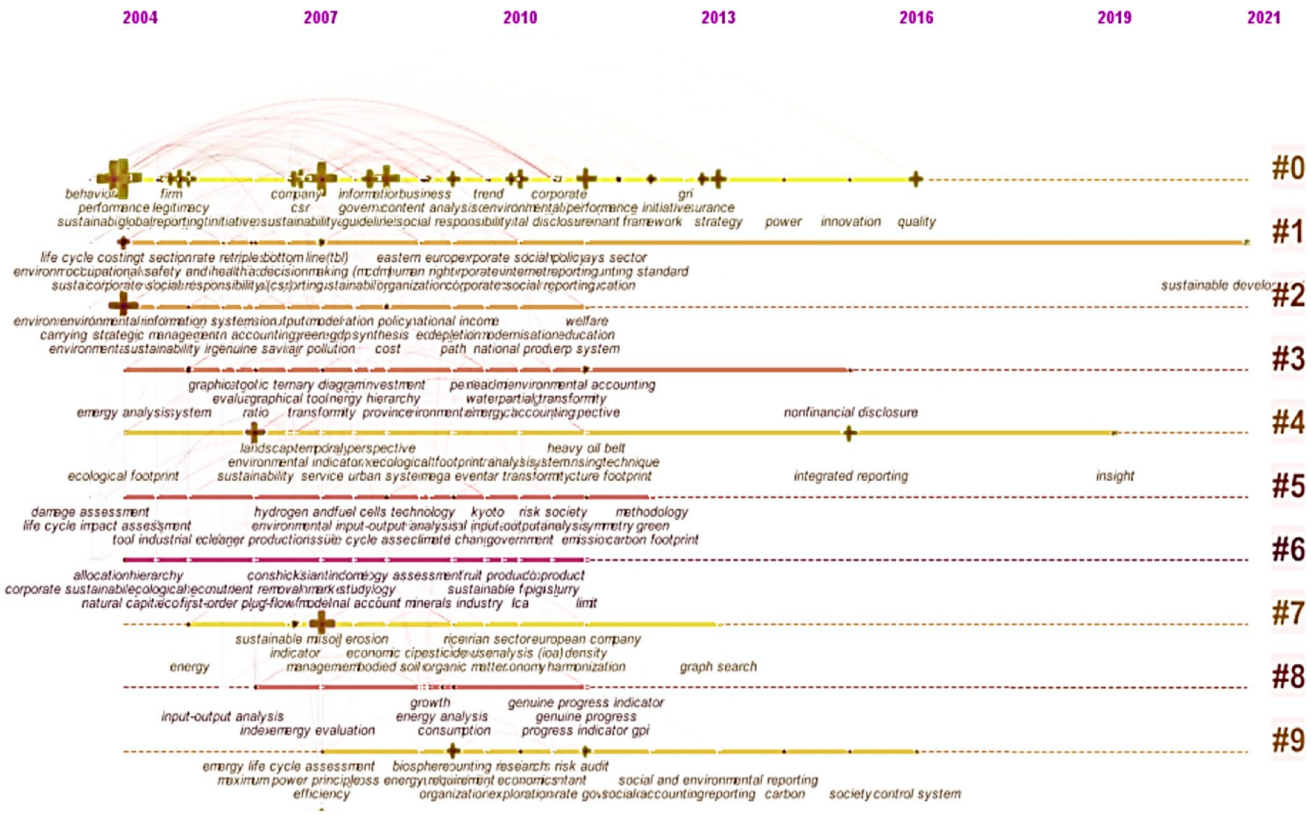


Fig. 13 Timeline analysis of keywords

authors, institutions, regions, and the current hotspots in the subject area based on keyword co-occurrence analysis, the research employed data from the WoS database from 2004 to 2021 and conducted visualizations in CiteSpace. Based on the keyword search in the WoS database, there was a gradual rise in the citations of articles. In contrast, the growth in publications took relatively unstable growth until 2017, when there were no fluctuations but a rapid rise till the 2021 year-end. Per the search date, the 1624 articles had been cited 45,428 times. This indicates a heightened interest in sustainability issues as researchers embark on projects to unearth the contributing factors to a global sustainable environment. *Journal of Cleaner Production, Sustainability* and *Accounting Auditing & Accountability Journal* were the top three research sources on sustainability reporting, contributing about 22% of the total sample of articles used in the analysis. Although not entirely the same, these results can resonate with similar extant studies (Pasko et al. 2021; Ye et al. 2020). Aside from the representation of institutions from Europe, the USA, and Oceania, Oceania was the highest contributing region as the *University of South Australia*, though with a publication start year from 2010, had 33 articles. In spite of the growth in publications, Africa and Asia were not represented among the top 10 institutions. The top three contributing regions, i.e., based on the addresses of corresponding authors, were the USA, Italy, and England. Although the USA, Oceania, Europe, Asia, and Africa were represented among the top 15 regions, Africa was less represented, with less than fifty articles from South Africa. There was also a close connection and an indication of regional collaboration among England, Australia, the USA, Germany, New Zealand, and Malaysia. Their high centrality scores indicate their importance in the collaborative network. Authorship analysis unearthed Franzese PP, Buonocore E, and Schalteggar S as the top three authors with at least 14 articles. Noteworthy among the top-performing authors is Cho Ch, who had the highest citation, although he had ten articles. However, authorship collaborations were not strong, as only a few had co-authored some papers. Based on the citations of these scholars, authorship collaborations may aid in developing innovative research ideas considering their dynamic institutional differences and academic experiences. The most cited articles also focused on the relevance of environmental and sustainability disclosures. The co-cited articles were published in the second phase (2010–2015) with at least 60 co-citations during the research period. Furthermore, Michelon et al.'s (2015) article on CSR reporting practices and disclosure quality had the highest burst strength and is still receiving maximum attention. The co-occurrence analysis of keywords revealing the research

hotspots showed "*sustainability reporting*, "*corporate social responsibility*," and "*environmental accounting*" based on their centralities as key hotspots in the research domain. This is worth acknowledging as they remain great avenues for future research. Keyword frequencies of over 250 portray the direction of most studies toward the varying aspects of sustainability. Currently, CSR expounds more on business responsibilities to society, contributing to a sustainable environment while improving performance. Overall, this study has contributed to the developments in sustainability reporting research by highlighting the leading authors and regions, examining the collaborations, citations and co-citations, and the current hotspots based on keyword analysis.

Future research direction and limitations

Through keyword occurrence and keyword clustering analysis, research hotspots and current research directions may be discovered (Chen 2016). Thus, the frequency of keyword co-occurrence and the burstness of keywords and the clusters obtained may aid in identifying the main research directions in the field. Although keywords like "*sustainability reporting*," "*CSR*," "*performance*," and "*management*" have received much attention because they are fundamental to the domain, other keywords such as "*governance*," "*legitimacy*," "*environmental disclosure*," and "*sustainable environment*" have equally received attention because they co-occur, and in most cases in accounting research, serves as key areas that would forever be influential in managing the affairs of organizations (for keywords like "*governance*" and "*legitimacy*"). The keyword clustering also illustrates most researchers' current focus. Such as environmental accounting disclosures, the role of management, the influence of boards, the business-society relationship that shifts the focus of entities solely from profit-making to the planet and people, and the need to engage in business operations that would preserve limited resources. There is also a focus on employing accounting methods or tools that aids in estimating resource consumption, waste assimilation requirements of a group of people against productive land use, and nature's ability to absorb waste and generate resources. The burstness of keywords further depicts what seems to be attention-grabbing in the domain. Corporate social responsibility at the firm level has contributed significantly to the global sustainability agenda and is expanding. Corporate governance has still not lost its grounds as research increases amid practical challenges in business. "*Governance*," "*determinant*," and "*sustainability report*" are similarly crucial as many organizations apply the GRI as a reporting framework for sustainability and are consistently finding the drivers or determinants of sustainability or environmental or social disclosures, although the burstness ended in 2015 in our study (García-Sánchez et al. 2020; Isukul & Chizea 2017; Kuzey & Uyar 2017). Results have indicated that sustainability reporting is vital. Regardless of the mechanisms corporations embrace, it would become an avenue for most firms to reap its associated benefits as they undertake their business activities. From the timeline and time zone analysis, it can be observed that although sustainable reporting had developed by the end of 2012 to 2013, the transition from the MDGs to the SDGs resulted in more research toward the global drive to a sustainable environment. The evolution of the identified keywords and concepts in the analysis have associations to a large extent with the emergence of an extensive agenda (SDGs) and strategy implementations by firms to still maximize shareholder wealth and produce positive effects through efficient resource utilization. Most importantly, businesses focus on how they can contribute their quotas to the SDG agenda by examining the impact of board activities and organizational factors (Rosati & Faria 2019; Sekarlangit & Wardhani 2021). Based on the review of the field, regional contributions were uneven. As such, there is a need for more sustainability reporting and accounting research, especially from the African region, seeing that South Africa was the only African country to have contributed to publications in the research domain. This symbolizes the need for more research by authors from the African region. Studies cutting across multiple contexts are more likely to enhance collaborations among regions and help reveal adopted sustainability reporting mechanisms. Additionally, future research may consider increasing studies of firms in diverse industries in specific countries to envisage the host countries' contributions to the SDGs. Regional and cross-author collaborations may also yield pioneering ideas that would enhance sustainability reporting research and gradually unearth findings that would inch us closer to attaining a sustainable society. This also comes from the disparity in institutional and regional contributions, with more concentration in developed contexts than in developing contexts or regions. Amid the contributions of the current study, the following limitations are worth acknowledging. To begin with, solely using data from the WoS database based on the study's keyword search and the research time may yield different results from other databases. Employing other databases like the Scopus database may produce diverse outcomes considering the databases' uniqueness aside from overlapping publication issues. Furthermore, although broader than some bibliometric study's keyword searches, the search may not have covered all the available publications related to our focus in the academic field since the investigation was restricted to only articles. Future studies may include other document types to increase the document base and discuss its impact on their analysis and findings. Nonetheless, our choice of only articles was to determine the

specific patterns in article publications toward the sustainability research domain.

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Declarations

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