A Bibliometric Analysis of Biodiversity Reporting in Accounting

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Article Info:	Abstract:
	Purpose: Over the years, biodiversity reporting has received increasing interest due to its importance in understanding our impact on the environment and biodiversity loss. The purpose of this study is to present a bibliometric analysis of emerging and relevant publications on biodiversity reporting in accounting.
	Methodology: This study synthesizes previous works of literature on biodiversity reporting in accounting using the bibliometric analysis approach. The data covering the period of 1996 - 2021 was collected using the Scopus database to ascertain the publications, countries, authors, keywords, and journals that have contributed to the body of knowledge. VOSviewer software was used as a visual output for the relevant data points and interpretation.
Corresponding Author: Drae Bent **Email:** drae.bent@ua.pt	**Findings:** The findings showed that biodiversity reporting in accounting is still an emerging topic, and there are continued maturing interests.
Paper Type: Research Paper	**Implication:** This paper concludes by highlighting the main trends in research on biodiversity reporting and offers potential opportunities for future research in this field.

INTRODUCTION

The term "biodiversity" and its origins date back to the 1980s and were propagated by the American botanist Walter G. Rosen in 1986 at a forum on biodiversity (Sarkar, 2001). The phenomenon of biodiversity has since found meaning and relevance in all aspects of life. DeLong (1996) highlighted that a fundamental definition of biodiversity is one that "is an attribute of an area and specifically refers to the variety within and among living organisms, assemblages of living organisms, biotic communities, and biotic processes, whether naturally occurring or modified by humans" (p.175). In a more general concept, biodiversity is the variety of life (Adler et al., 2017). It is commonly called the total number and abundance of species in any area (Pielou, 1977).

Recently, many reports and studies have supported the need for biodiversity loss reporting. A profusion of studies has investigated corporate responsibilities for biodiversity loss (Atkins & Maroun, 2018; Jones & Solomon, 2013; Samkin et al., 2014), while others examined the application of the accounting framework in biodiversity accounting (Freeman, 2013; Siddiqui, 2013). Moreover, due to the recent pandemic, some studies have identified biodiversity loss as a direct cause of COVID-19 (Hassan et al., 2020 UN, 2020; World Health Organisation, 2020).It poses another area of research within biodiversity related to business. Given the critical role of biodiversity on the planet, understanding its accounting and reporting aspects will better equip the earth's inhabitants and prepare them to enrich the earth's supply and prevent biodiversity loss continuously. According to Jones and Solomon (2013), the accounting community has yet to attend to biodiversity accounting as a critical global issue, and more contribution to research is needed. With this understanding, the indisputable value of biodiversity and the neglect by many accounting researchers have driven the desire to carry out more studies on this topic.

Therefore, considering the importance of biodiversity loss and the role that accounting plays in the environment, the present study seeks to examine the body of knowledge through bibliometric analysis.

Bibliometric analysis is an established quantitative method that allows the researcher to investigate publishing patterns of scholarly work (Tijjani et al., 2021). This quantitative technique is advantageous in identifying the leading trends in terms of publications, journals, citations, authors, and keywords (Martinez-Lopez et al., 2018). Furthermore, the bibliometric technique allows researchers to establish the intellectual structure of a particular field without bias (Xue et al., 2018). Over the years, bibliometric analysis has received increased attention. It has become a fundamental methodology for analyzing a topic, and many publications have used it (Merigó & Yang, 2017). This paper seeks to methodically capture trends and patterns of publications on biodiversity reporting in accounting.

Biodiversity has been widely studied in many disciplines, such as agriculture, biology, environmental science, ecology, and medicine, to name a few. This paper will present biodiversity from the financial and management accounting angles. It will raise awareness and promote positive changes through research to prevent further biodiversity loss. The authors seek to discover these findings by examining the trends and patterns in leading publications, countries, researchers, and journals. The study aims to examine and review research publications that have contributed to biodiversity reporting in accounting thus far by using bibliometric analysis. More concretely, the paper will address the following questions: What is the contribution over the years based on trends in publications by journals, authors, and countries pioneering research on biodiversity reporting in accounting? What topics have yet to be covered and should be included in the future research agenda?

The paper is structured as follows. Section 2 presents the literature review of biodiversity reporting in accounting. Section 3 follows the data collection and methodological approach. Section 4 reports the results and findings of the bibliometric analysis. The discussion is presented in section 5, while section 6 discusses the limitations of the paper. Section 7 provides concluding remarks.

Literature Review of Biodiversity Reporting in Accounting. In recent years, environmental accounting and reporting have found importance in accounting research compared to its neglect in earlier years (Haque & Jones, 2020; Jones, 2003; Jones & Solomon, 2013). Accountants have long glazed over issues about wildlife, and their contributions can increase awareness of corporate accountability by disseminating and communicating biodiversity conservation at various organizational levels (Jones, 2003; Hassan et al., 2021). Policymakers must provide sufficient guidance on biodiversity reporting (Hassan et al.,2021) to improve understanding of environmental impacts and hold businesses accountable to those standards. In earlier literature, Jones (2003) provokes organizations to be conscious of their environmental assets and act as stewards in exemplifying organizational responsibility to the environment. During the COVID-19 pandemic, several multidisciplinary studies confirmed that nature pandemics result from biodiversity loss and a consequence of negative human contributions to the environment (UN, 2020; World Health Organisation, 2020). Therefore, organizations should report on biodiversity and its non-financial activities to mitigate future biodiversity loss (Hassan et al., 2021).

Promoting biodiversity in businesses is essential to both parties (Adler et al., 2018). The connection between biodiversity loss and company activities is two-way (Adler et al., 2018; Hassan, 2020). As highlighted by the International Finance Corporation (IFC) (2006), "Biodiversity is a fundamental component of long-term business survival" (p. 1). Hence, the crucial need for better reporting from companies on biodiversity loss has grown rapidly and significantly. In a survey report by KPMG (2020), the findings suggest that it is a critical time for companies to focus on disclosing the risks of biodiversity loss, and there is a long road ahead in producing a complete picture of risks in their reporting. Public disclosures on biodiversity serve as a window that transparently informs stakeholders about the business practices and their actions regarding biodiversity-related activities (Jones et al., 2013). Therefore, businesses are responsible for accurately disclosing and providing transparency in their sustainability practices (Talbot & Boiral, 2018; Talbot & Boiral, 2020).

METHODS

This study utilizes bibliometric methods to analyze the existing literature on biodiversity reporting in accounting. Our bibliometric analysis is similar to that followed by Shareefa and Moosa (2020), who applied a similar approach to examine the characteristics of existing literature, research trends, and future research directions on differentiated instruction using Scopus and VOSviewer. This study used Scopus and Web of Science (WoS) to source the data for analysis on December 17, 2021. Scopus and Web of Science (WoS) databases are considered the most reliable sources for research evaluations (Pranckutė, 2021). However, after data synthesis, Scopus was mainly used as the data pool produced more articles, and this decision did not result in any loss of data points. After collecting the data from both databases, the data were synthesized using a PRISMA flow diagram, analyzed, and presented using Scopus, Microsoft Excel, and VOSviewer. VOSviewer is available at www.vosviewer.com and is a free computer program for constructing, viewing, and interpreting extensive data bibliometric maps (Van Eck & Waltman, 2010). VOSviewer was selected as the preferred software because of the visualization of data and its ability to handle sources from multidisciplinary fields (Börner et al., 2003).

This section outlines all the steps in this bibliometric analysis, which consists of collecting, synthesizing, and analyzing the data. Subsequently, the interpretation of the analyzed data is presented and discussed in the results section.

Data Collection. Google (google.com) was utilized as the leading search engine for collecting the data for this research. The keywords relevant to this research were extracted directly from the main topic and combined in different ways to maximize output in data both across Scopus and Web of Science (WoS). The choice of keywords was restricted to "accounting for biodiversity," "biodiversity accounting," "biodiversity reporting," "biodiversity disclosure," "biodiversity reporting in accounting," "extinction accounting," "extinction reporting," "extinction disclosure," and "accounting for biodiversity extinction" to capture publications contributing to biodiversity reporting as it related to the field of accounting. The publications were assimilated and extracted from both Scopus and Web of Science (WoS) databases on December 17, 2021. In a preliminary search for keywords, Scopus and Web of Science (WoS) search repositories produced 129 and 94 records, respectively.

While analyzing the data collected across both databases, the population included publications from various disciplines. Therefore, the authors applied an inclusion and exclusion criterion to capture articles reflective of the present study's theme, subject to the accounting field. As such, only publications categorized as 'articles' and 'review articles' were selected from the subject areas of business, business finance, management, accounting, economics, econometrics, and finance. Furthermore, only articles published in English were included for screening. There was no restriction on the year of publication; as such, articles published at any time were considered.

Data Synthesis and Analysis. The final population output after refining the data was 57 documents in Scopus and 45 in Web of Science. 102 records retrieved from both databases were exported to Microsoft Excel and subjected to further screening. The synthesis of this data was first subjected to a conditional formatting function in Excel to check for duplicates. According to this check, only 57 articles remained after identifying and removing duplicates. Of this total, 12 articles were excluded from Scopus and Web of Science (WoS). These 12 articles were unique to Scopus and not included in the Web of Science (WoS) database.

For this reason, Scopus was the default database used to substantiate the research's conclusions. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) outlines a flow chart for these steps. The PRISMA statement consists of a checklist covering all critical issues that should be reported and a flow diagram that presents the research procedure (Altman et al., 2009). The stages of PRISMA are depicted in Figure 1 below.
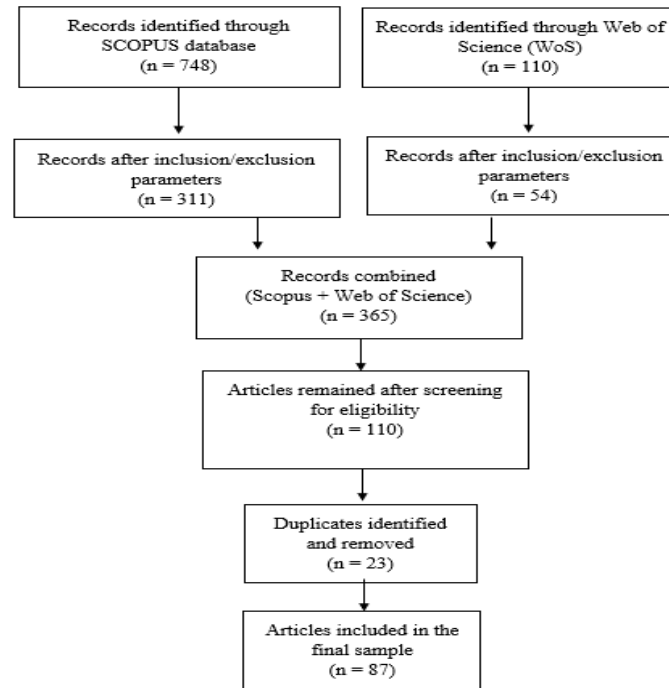
Figure 1. PRISMA Flow Diagram of the Selection and the Analysis Process for the Bibliometric Analysis.

The following data analysis stage involved downloading the data from Scopus and exporting this data as a comma-separated value (CSV) file into VOSviewer software for further analysis. VOSviewer, a free computer program, is utilized for its data visualization capabilities and for investigating the relationships between the authors, countries, institutions, keywords, bibliometric coupling, and citation analysis (Hoppen & de Souza Vanz, 2016). Furthermore, VOSviewer is a user-friendly computer program and is an ideal option for analyzing and mapping co-citations, keywords, and co-author networks (Varma et al., 2021). In addition to VOSviewer, we used Microsoft Excel to help with the analysis process and produce visuals and graphs from output data in VOSviewer. The outcomes of these analyses are compiled into various representations detailed in figures and tables within this paper's findings and results section.

RESULTS AND DISCUSSION

In this section of the paper, the results have been presented and discussed in the following subsections: publications and citations trend, publications trend by country, leading journals, most cited articles, keywords occurrence, most cited authors and bibliometric coupling network. Furthermore, the presentation of the bibliometric results includes various graphs, tables, and visualizations.

Publications and Citations Trend Year Over Year. Figure 2 shows the annual distribution of articles by year. This graph clearly shows that the first contribution to biodiversity reporting in accounting was published in 1996. This article was published in the British Accounting Review journal, which paved the way for continued research in the coming years. There was a brief hiatus with very few studies between 1996 and 2012.

Contrary to this period, increased activities and fluctuations occurred from 2013 to 2021. The period of 2019 through 2021 experienced a continuous increase in the trend line. Notably, 2021 had the most publications volume, with 13 articles published on biodiversity reporting in accounting. This increasing trend line signifies

emerging interests among researchers and scholars. A plausible possible reason could be attributed to the collective endeavors of many countries and their current focus on improving sustainability efforts. This upward trajectory of the graph also tells us that biodiversity reporting in accounting is an increasing topic emerging among scholars and researchers.
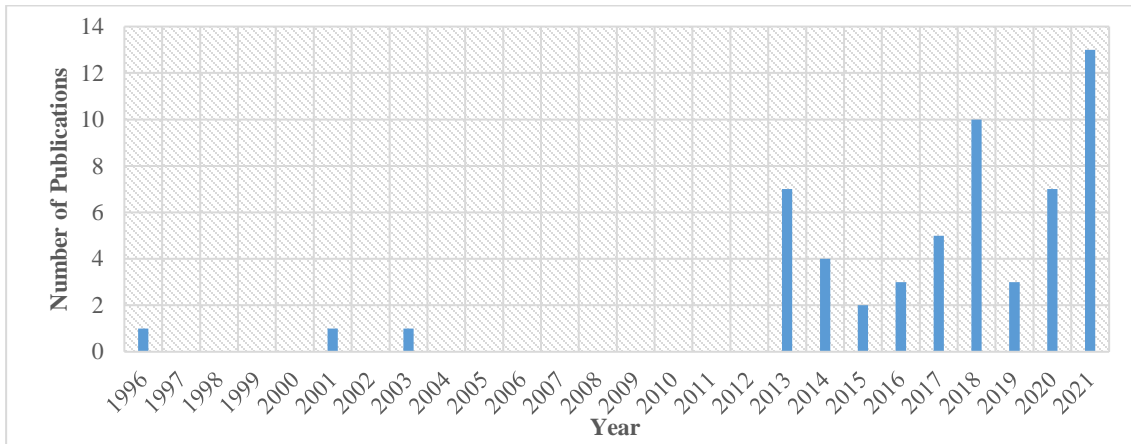
Figure 2. Annual Distribution of Papers (Per Year) on Biodiversity Reporting in Accounting.
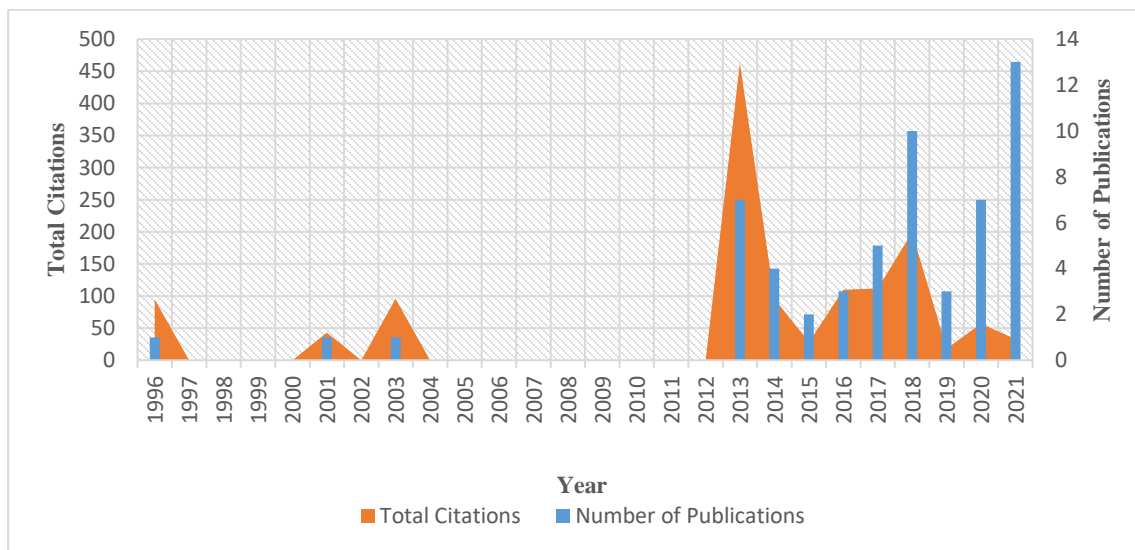
Figure 3. The Number of Publications Versus the Total Citations (Per Year) on Biodiversity Reporting in Accounting.

Figure 3 depicts the total number of articles published over the years and the most cited papers on biodiversity reporting in accounting. As seen from this figure, there has been a fluctuation in volume from the first publication year 1996 until most recently (2013-2021), which accounted for the most activity in publications. It

can be seen that the total citation was the highest, as reported in the year 2013 when the first set of publications emerged after an absence of publications. The total citations fluctuated after that, with 2018 reporting the highest peak since 2013. Though the most recent years, 2020 through 2021, had the most activity in publications, the total citations were lower than in previous years. The smaller slopes directly relate to the time needed to accumulate citations for the most recent publications in 2020 and beyond. With this in mind, we expect a steady increase in the citation count and trend as more scholars and researchers produce papers on the topic.

Publication and Collaboration Trends by Country. Figure 4 depicts the countries and their contributions to all the publications between 1996 and 2021 on biodiversity reporting in accounting. This graphical depiction included countries contributing to at least one published paper among the 14 countries represented. The United Kingdom takes the lead as the clear dominant contributor in the research field, with a volume of 30 articles and the most citations, 769, as reported in Table 1. As indicated in the graph of Figure 4, the United Kingdom is followed by South Africa, New Zealand, and Australia, with a total volume in articles' contributions of 11, 8, and 6, respectively.

The United Kingdom contributed significantly more than all the countries, holding 43% of the total publications. Furthermore, the top four countries contributed 80% of the publications together. It is a fascinating observation, suggesting that the East and Europe are leading and expanding within the research topic.

The remaining countries, accounting for 20% of the total, reveal that the topic is making strides but show the need for more studies on biodiversity reporting in accounting. Alternatively, developed countries and emerging economies in the West, such as the United States, Canada, and Brazil, contribute minimally to only. This shows a gap and a need for more studies in the Western region and Europe.
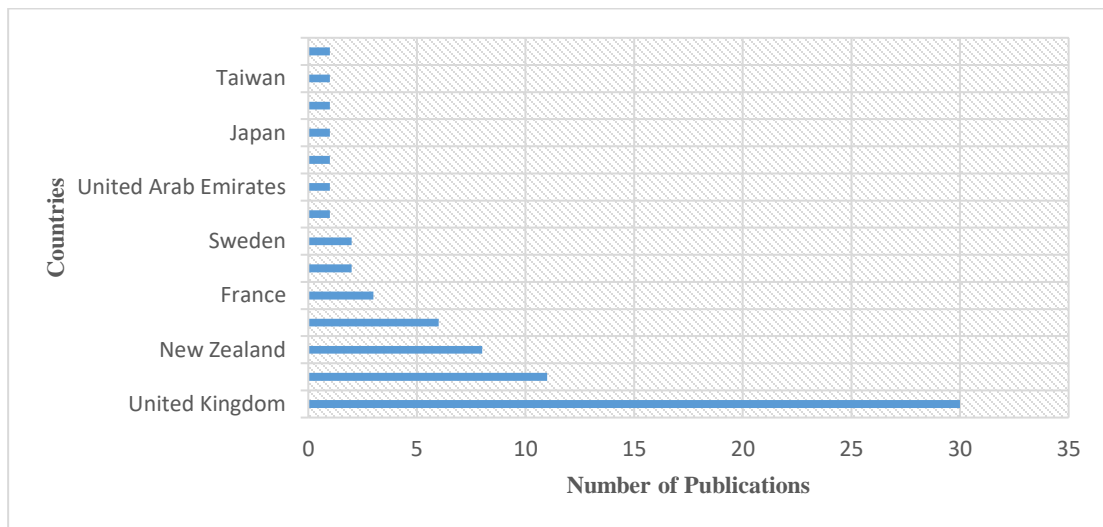
Source: VOSviewer www.vosviewer.com

Figure 4. The Total Number of Publications and Contributions by Country (1996 - 2021) on Biodiversity Reporting in Accounting.

**Table 1.** List of Countries Ranked Based on Citations.

Country	Documents	Citations	Total Link Strength	Average Citation
United Kingdom	30	769	291	25.63

New Zealand	8	202	127	25.25
South Africa	11	121	150	11.00
Canada	2	88	42	44.00
Sweden	2	80	59	40.00
Denmark	1	71	42	71.00
France	3	51	2	17.00
Australia	6	44	62	7.33
United Arab Emirates	1	17	13	17.00
Indonesia	1	3	7	3.00
Japan	1	3	21	3.00
Malaysia	1	1	5	1.00
Taiwan	1	1	5	1.00
Italy	1	0	10	0.00

Source: VOSviewer www.vosviewer.com

Turning our attention to Table 1, it is evident that the studies from the United Kingdom, New Zealand, South Africa, and Canada are extensively cited in the literature and have the highest citation counts. An interesting observation is that although countries like Canada, Sweden, and Denmark contributed less to articles than Australia, these countries' literature is more heavily cited. It indicates the influence of the studies conducted in these countries. Alternatively, all the other countries had fewer hits in the citation count. It could have been attributed to the year that the studies were published. These countries' publications were distributed in the early 2020s, requiring more time to garner attraction and citations among researchers.

We utilized VOSviewer to generate insightful collaboration networks to investigate the collaboration among countries further. Of the countries in this network, only 14 reported authentic connections contributing to at least one article or more, as demonstrated in Figure 5 and Table 1. The results revealed five clusters of connections, indicated by the colors in Figure 5. Compared to the other countries, Canada, the United Kingdom, and Sweden led the highest in the number of linkages, 12, 11, and 11. However, these countries have weaker link strengths than the United Kingdom (link strength = 291) and South Africa (link strength = 150), with the top positions based on link strength and citations. These two countries lead in the strength of collaboration and have collaborated with most other countries in each cluster. It is not surprising that the top citation countries, the United Kingdom, South Africa, and New Zealand, all reported the most vital total link strengths of collaboration in clusters of gold, red, and blue. On the other side of the spectrum, France has the weakest link and collaboration with other countries. In the future, countries with lower citations should aspire to collaborate with those top citation countries to produce more impactful future studies within the research field. By forming these collaborative efforts, the resources in knowledge would help the weaker linkage countries, especially in the Asian territories, and could strengthen the collaboration within Europe and the West.
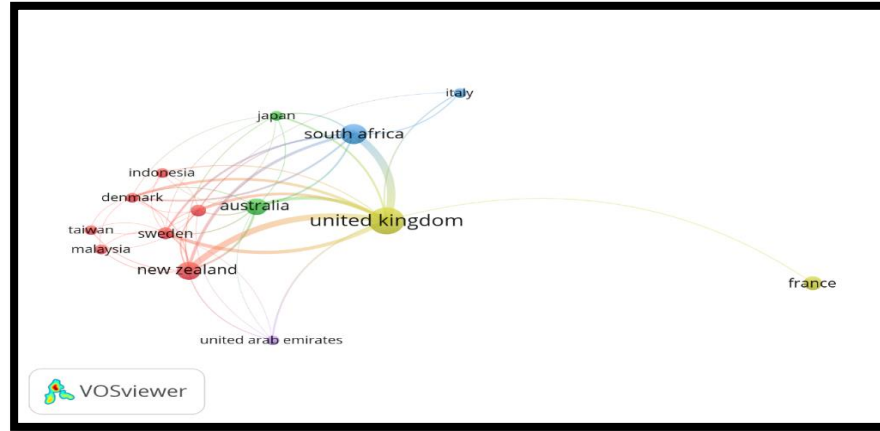
Notes: Visual output is based on the number of publications by country and citations. A minimum of 1 was applied to the number of documents per country. Of the 17 countries that met the threshold, only 14 revealed connections.

Source: VOSviewer www.vosviewer.com

Figure 5. Visual Depiction of Countries' Collaboration Network (1996 - 2021) on Biodiversity Reporting in Accounting.

Leading Journals. Over the years, biodiversity reporting in accounting has emerged at the forefront of well-known journals. Articles on biodiversity reporting in accounting are widely distributed across many fields and studied by many different scholars. To investigate its presence in highly reputable journals in Business and Economics, we constructed a similar table based on Shareefa and Moosa's (2020) study. We ranked it by total citations (TC).

As shown in Table 2, the publications are distributed in a wide assortment of journals. A keen observation from the table is the order of most productive journals. It can be seen that the Accounting, Auditing, and Accountability Journal reported the highest number of citations (TC = 916) and total publications (TP = 24). This journal is followed by the British Accounting Review, Journal of Business Ethics, and Ecological Economics, which all produced 2, 1, and 3 articles, respectively. Journal of Business Ethics only produced one publication. However, it is the third most cited (TC = 87) compared to all the other journals with at least one or more publications, except for the top-ranking journal, Accounting, Auditing, and Accountability Journal. The article produced by this journal was written by Olivier Boiral and published in 2016 on the topic of Accounting for the Unaccountable: Biodiversity Reporting and Impression Management. The impact of the citations was very prolific and influential for this article. This journal also reported the second-highest metrics in CiteScore for the annual year 2020, a CiteScore 9.

Table 2. Ranking of Journals.

Journal name	TP	TC	AAC	CiteScore [2020]	SJR [2020]
Accounting, Auditing and Accountability Journal	24	916	38.17	6.0	1.741, Q1
British Accounting Review	2	112	56.00	7.0	1.223, Q1
Journal of Business Ethics	1	87	87.00	9.0	2.209, Q1

Journal	TP	TC	AAC	CiteScore	SJR
Ecological Economics	3	61	20.33	9.1	1.917, Q1
Social and Environmental Accountability Journal	5	31	6.20	2.0	0.361, Q3
Business Strategy and the Environment	6	30	5.00	10.3	2.123, Q1
Accounting Forum	2	26	13.00	4.6	0.942, Q1
Sustainability Accounting, Management and Policy Journal	2	20	10.00	3.6	0.619, Q1
South African Journal of Economic and Management Sciences	2	18	9.00	1.7	0.277, Q2
Managerial Auditing Journal	1	10	10.00	3.1	0.422, Q1
Environment, Development and Sustainability	1	10	10.00	3.8	0.597, Q1
European Review of Agricultural Economics	1	10	10.00	4.3	1.400, Q1
Corporate Social Responsibility and Environmental Management	1	7	7.00	8.0	1.519, Q1
Qualitative Research in Accounting and Management	1	7	7.00	2.0	0.462, Q1
Social Responsibility Journal	4	5	1.25	3.5	0.528, Q1
Corporate Ownership and Control	1	0	0.00	N/A	N/A

Notes: Data based on articles in this bibliometric analysis: TP = Total publications; TC = Total citations; AAC = Average article citation (TC/TP). Data based on all publications by the journal CiteScore is based on 2020 and extracted from Scopus. Data based on all publications by the journal: SJR is based on the year 2020 by ScimagoJR.
Source: Scopus www.scopus.com

Based on the results of Table 2, the lower-ranking journals based on total citations and average citations were Corporate Social Responsibility and Environmental Management, Qualitative Research in Accounting and Management, Social Responsibility Journal, and Corporate Ownership and Control, which all ranked below a total of 10 and less influential base on the metrics presented. Regarding the average article citation, the Journal of Business Ethics is the most relevant and influential, with an average article citation (ACC) of 87, followed by the Accounting, Auditing and Accountability Journal, with an average (ACC) of 38. The journal with the lowest average article citation (ACC) = 0 was Corporate Ownership and Control, which produced only one article. It is essential to draw attention to the SJR rankings here. Most of the journals in the results ranked in the upper quartile of Q1, indicating that the articles on biodiversity reporting in accounting are from the top-ranking journals.

Most Cited Articles. In this bibliometric analysis, it was crucial to investigate the most cited articles to reveal the body of work that is considered more influential on biodiversity reporting in accounting. Citations assess the influence and contribution to shaping conversations in an area and measure the impact on the topic (Culnan, 1987; Varma et al., 2021). To conduct this investigation, we selected the top 10 cited articles based on total citations and presented them in Table 3. The relevant title, author(s), year, journal, and total citations of the top 10 most cited articles were provided.

As shown in Table 3, the highest cited paper was published by the authors Michael Jones and Jill Solomon. This article has been in circulation since 2013 and was published by Accounting, Auditing & Accountability Journal with 100 citations at the time of this bibliometric analysis. Jones and Solomon (2013) addressed the role accounting

plays in biodiversity loss and extinction while urging corporations to take accountability for biodiversity loss. This paper was one of the first articles ever published on biodiversity in accounting and has garnered much influence in the research field. 60% of the articles from the top 10 most cited list were published in 2013. These were published by the following author(s): Jones and Solomon M. (citations = 100), Rimmel G. and Jonäll K. (citations = 79), Van Liempd D. and Busch J. (citations = 71), Tregidga H. (citations = 70), Cuckston T. (citations = 57), and Siddiqui J. (citations = 52). These articles have paved the way for breaking ground for biodiversity reporting in accounting and continue to stand as influential studies. The second most influential paper was written by Jones, M. and published by Accounting, Auditing & Accountability Journal in 2003. Unsurprisingly, this journal was top-cited, as discussed earlier in previous sections. Rounding off the top 10 are articles published in 1996, 2016, and 2014, as indicated in Table 3 rankings. Of these top 10, one author, Jones, M., is considered among the most productive and contributed to three publications, with one of the very first articles published on accounting for biodiversity in 1996. Another important observation from the table of results is that 8 out of the 10 articles were published in the Accounting, Auditing & Accountability Journal. As previously seen and discussed, this journal is the most productive and influential per Table 3 and Table 2.

Table 3. Ranking of Most Cited Articles on Biodiversity Reporting in Accounting.

Author (s)	Title	Year	Journal	Citation
Jones M., Solomon J.	Problematizing accounting for biodiversity	2013	Accounting, Auditing & Accountability Journal	100
Jones M.	Accounting for biodiversity: Operationalising environmental accounting	2003	Accounting, Auditing & Accountability Journal	96
Jones M.	Accounting for biodiversity: A pilot study	1996	British Accounting Review	95
Boiral O.	Accounting for the Unaccountable: Biodiversity Reporting and Impression Management	2016	Journal of Business Ethics	87
Rimmel G., Jonäll K.	Biodiversity reporting in Sweden: Corporate disclosure and preparers' views	2013	Accounting, Auditing and Accountability Journal	79
van Liempd D., Busch J.	Biodiversity reporting in Denmark	2013	Accounting, Auditing and Accountability Journal	71
Tregidga H.	Biodiversity offsetting: Problematisation of an emerging governance regime	2013	Accounting, Auditing & Accountability Journal	70
Cuckston T.	Bringing tropical forest biodiversity conservation into financial accounting calculation	2013	Accounting, Auditing & Accountability Journal	57
Siddiqui J.	Mainstreaming biodiversity accounting: Potential implications for a developing economy	2013	Accounting, Auditing and Accountability Journal	52
Samkin G., Schneider A., Tappin D.	Developing a reporting and evaluation framework for biodiversity	2014	Accounting, Auditing and Accountability Journal	51

Source: Scopus www.scopus.com

Most studies share some commonality in publication platforms and the audience. Hence, we can classify these articles into related buckets, such as biodiversity reporting versus biodiversity accounting. Approximately 60% of the articles are focused on accounting frameworks and methods/techniques within the application of accounting for biodiversity (Verdianty et al., 2024). Jones and Solomon (2013), with the highest citation count of 100, examined the issues and current role accounting plays in enhancing biodiversity. Published in the same year, Siddiqui (2013) examined the application of the accounting inventory method to enhance biodiversity accounting within the context of a developing country.

Similarly, Cuckston (2013) explored biodiversity in financial accounting calculations through a market construction accounting framework. Jones (1996) explored accounting for natural assets and extended this study to invoke the natural inventory model years later (Jones, 2003). Meanwhile, Tregidga (2013) studied biodiversity offset to account for biodiversity effectively. The other 40% of articles are explored from the standpoint of reporting standards and biodiversity reporting related to accounting. Boiral (2016), with the second-highest citation count of 87, contributed to the emergence of articles in reporting by examining impression management and greenwashing when producing biodiversity reports. Before the study, Samkin et al. (2014) evaluated the biodiversity disclosure statements to help develop reporting guidance in biodiversity reporting. Rimmel and Jonall (2013) and Van Liempd and Busch (2013) took a different approach in their studies by narrowing the spotlight on specific countries in Europe and evaluating biodiversity reporting practices from Sweden and Denmark, respectively.

Keywords Occurrence and Network. In this section of the bibliometric analysis, the author's keyword occurrences and co-occurrences are evaluated to identify and give perspective to the keywords frequently seen when researching biodiversity reporting in accounting (Maharani et al., 2024). The frequently used keywords will give a general perspective to new researchers working in the field (Deveci, 2022). The keywords analysis was carried out using VOSviewer, and the results are reported in Table 4 with a visual depiction in Figure 6.

As seen in Figure 6, the keywords are grouped into clusters from 1 through 4. The most prevalent keywords in each of the clusters based on size are "biodiversity," "sustainable development," "sustainability," "accountability," and "biodiversity accounting." The most significant and frequent keyword is "biodiversity," with an occurrence of 29 located in cluster 3 (blue). Based on this information, we can infer that this keyword is the current most emerging key concept from the network and is being studied heavily compared to the other keywords. This keyword has strong relationships (based on link strengths) with "biodiversity" (link strength = 55), "sustainability" (link strength = 25), "sustainable development" (link strength = 23), and "accounting" (link strength = 18).

Furthermore, cluster 3 (blue) has the most overall occurrences and strongly correlates with cluster 1 (red), which also contains the second-highest number of occurrences. The second and third most repeated keywords are "sustainable development" and "sustainability," with occurrences of 11 and 10, respectively. It shows that most studies are developed around biodiversity from a sustainability angle. On the contrary, biodiversity from the angle of the field of accounting is seen in the lower ranks of keyword occurrences. The first set of occurrences from Table 4 is more closely related to the nature of biodiversity and sustainability.

Meanwhile, the second set is related to actual accounting and reporting. Another critical observation from Table 4 is that "accounting for biodiversity" is the lowest occurrence among the top 10. Most accounting-related concepts are ranked lower than others and not represented as the top occurrence.
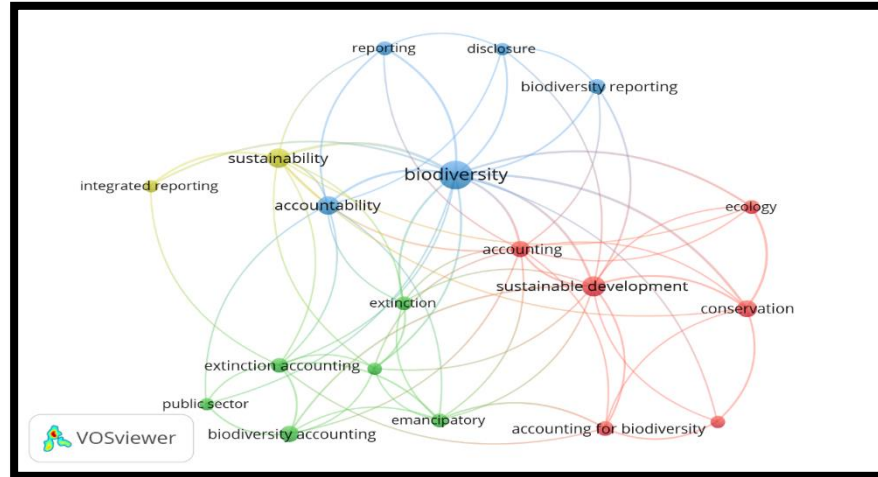
Notes: Visual output is based on all keywords co-occurrence (minimum number of occurrences is 3).

Source: VOSviewer www.vosviewer.com

Figure 6. Visual Depiction of Author Keywords Co-Occurrence Network on Biodiversity Reporting in Accounting.

Table 4. Author Keywords Occurrences of the Top 10 on Biodiversity Reporting in Accounting

Author keywords	Occurrences
Biodiversity	29
Sustainable development	11
Sustainability	10
Accountability	9
Conservation	7
Accounting	6
Biodiversity accounting	6
Accounting for biodiversity	5
Biodiversity reporting	5
Extinction accounting	5

Source: VOSviewer www.vosviewer.com

Table 4 and Figure 6 offer insightful information on biodiversity reporting in accounting. We can infer from the examination that accountability and sustainable development are the themes explored the most from a sustainability standpoint. The main themes emerging from the accounting field are biodiversity reporting,

biodiversity accounting, and extinction accounting. From a careful examination of the various colors of clusters, one can see that there is a balance in both environmental key concepts and accounting key concepts. Accounting is a trending and emerging topic within biodiversity. There is room for more growth and the introduction of new critical concepts from accounting to biodiversity and vice-versa. All four clusters bring out an environmental keyword supplemented with an accounting keyword. Combining and merging those two fields reveals the immense potential for future research.

      Most Cited Authors. Table 5 presents the ranking of the top 10 most cited authors based on total citations. This data is presented with the total number of documents, average article citations, and the h-index per author. According to Hirsch (2005), the h-index measures the broad impact of an individual's work and is a valuable measurement of a researcher's output. Therefore, the h-index, along with the total citations, is incorporated into analyzing the output of each of the authors in Table 5.

Table 5. Ranking of Top 10 Most Cited Authors on Biodiversity Reporting in Accounting.

Author(s)	Total Citations	Total Documents	Total Average Article Citation	h-index
Jones, Michael	217	4	54.25	2
Cuckston, Thomas	137	5	27.40	8
Maroun, Warren	120	10	12.00	18
Atkins, Jill	110	7	15.71	11
Solomon, Jill	100	1	100.00	1
Jones, Michael and Solomon, Jill	100	1	100.00	3;1
Boiral O.	88	2	44.00	41
Rimmel, Gunnar	80	2	40.00	5
Jonäll, Kristina	79	1	79.00	3
Rimmel G., Jonäll K.	79	2	39.50	5;3

Source: VOSviewer www.vosviewer.com

     The most cited and influential author is Michael Jones, who has 217 total citations and the fourth-highest number of publications on biodiversity reporting in accounting. Cuckston takes second place with 137 total citations and a total of 5 documents published. Maroun boasts a high h-index of 18 compared to the top two most-cited authors with the highest number (10) of publications. Atkins is the fourth most cited author, with 110 citations and seven publications, averaging an article citation of 15.71. There is a tie for the fifth and sixth ranking spot in total citations (100) between Frances Solomon and Michael Jones. These two authors have published one article together, the most influential one since its first circulation in 2013. This article was one of the first published articles on biodiversity in accounting and has garnered much influence in the research field. Following these two authors is Boiral, with a citation index of 88, and only two publications related to this topic. Although Boiral is sixth in citations, it is interesting that Boiral has the highest h-index of 41 with only two publications. Based on this information, Boiral has proven exceptionally impactful in the research field. Rimmel and Jonäll, and a

collaboration between the two, followed with the lowest citation scores with one publication each and h-index falling below 10. Nevertheless, these impactful authors have contributed to biodiversity reporting since 1996.

Bibliographical Coupling Network. Figure 7 displays the bibliographical coupling analysis. Bibliographic coupling is a visual analysis of a knowledge network and occurs when two articles reference a joint third paper (Varma et al., 2021; Zhao & Strotmann, 2008). The output was generated from VOSviewer software and carried out to examine the commonalities in the studies conducted by the authors. Upon careful examination of this network, it is clear that different clusters of colors represent five groups. Cluster 1 (red), cluster 2 (blue), cluster 3 (green), cluster 4 (gold), and cluster 5 (purple). These clusters encapsulate the connections and relationships among the authors in this bibliometric study.

Cluster 1 (red) in the middle includes 6 authors and the highest number of authors per cluster. These authors collectively study different angles of reporting and accounting for biodiversity. Cuckston has the most vital link strength to the other clusters, the highest total citations, and leads with five publications. This cluster is the most diverse among the clusters and is centered on a common bond with the surrounding clusters. It is noteworthy that Jones (1996) found the oldest article in this cluster, which paved the way for many other studies today.

Cluster 2 (blue) on the lower left includes four authors. These authors represent those who examined the theme of framework and guidance for reporting on biodiversity and extinction. From this cluster, Maroun, W. is the most connected and influential author with the highest citation count of 120, sharing 19 links with other authors, ten documents produced, and a total link strength of 6336. Maroun, W. is followed by Atkins, J. from the same cluster with 19 links, 7 documents, and a link strength of 4735. Though both authors share the same number of links as other authors, Maroun has a more significant link strength than the other researchers.

Cluster 3 (green), located at the top right, includes four authors. These authors studied a common theme in studies related to company reporting practices and threatened species reporting. Mansi, M. and Pandey, R. share the most vital connections with authors from the cluster (red), with 19 links, four documents each, and a tie-in total strength link of 2702.

Cluster 4 (gold) on the lower right includes three authors. These authors explored integrating biodiversity practices into organizational plans and strategic goals. Furthermore, these studies are all methodologically carried out using a qualitative approach and employ content analysis. The two most connected authors from this cluster are Azim, M.I. and Barut, M., who share the most vital link with other researchers and produce two documents each.

Finally, cluster 5 (purple) on the far left includes three authors. These authors and their studies center on impression management and underlying motives for companies to report on biodiversity. These publications have approached biodiversity reporting from angles related to society and companies' cultural and psychological aspects. Roberts, L. has produced the most papers from cluster 5 (purple) with 19 links, four documents, and a link strength of 2328. Hassan, A. follows from the same cluster with three documents but a median link strength to the other researchers.
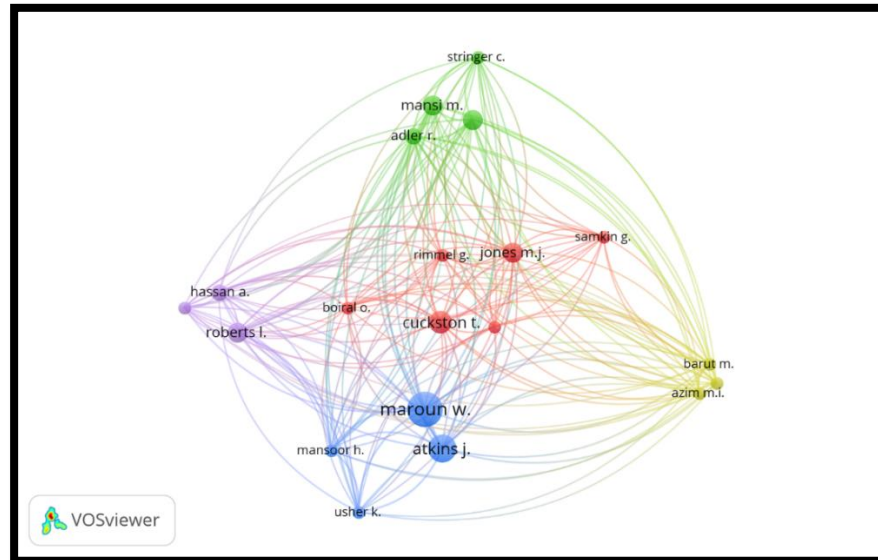
Notes: The bibliographic coupling analysis with a complete counting method under the authors' unit was applied. The thresholds of 2 and 0 were selected for the minimum number of documents and the minimum number of citations, respectively. The network output generated 20 connected authors.

Source: VOSviewer www.vosviewer.com

Figure 7. Visual Depiction of Bibliographic Coupling.

This paper provides comprehensive research on biodiversity reporting in accounting adopting the bibliometric analysis approach. The data was extracted using Scopus and Web of Science (WoS), and VOSviewer software was utilized to examine the collected data. This paper presents future directions for scholars interested in biodiversity reporting in accounting by looking at the topic's past, present, and future trends. The findings of the existing literature will be discussed according to the research questions and objectives outlined in the research introduction.

What is the trend over the years based on publications worldwide? The field of biodiversity reporting in accounting is developing and growing. Based on the results in this paper, there have been a total of 57 articles published between 1996 through 2021 in the sub-discipline of business management and accounting. The number of publications in mainstream accounting is expanding. Since the first publications in 1996, these have paved the way and emerged interest among scholars. The uptake and production of articles in 2013, 2018, and 2020 led to even more breaking grounds for biodiversity in accounting. This is especially evident in 2021, with the highest recording of publications to date, a total of 13 publications, and we expect this trend to continue through the coming years. Hence, there is a need for more contributing studies and research to continually increase the uptake within the accounting field.

Which countries are pioneers in biodiversity reporting in accounting? The pioneers in the field at this moment are the United Kingdom. The United Kingdom currently boasts a contribution of 30 documents at the time of this bibliometric analysis, with South Africa, New Zealand, and Australia following, with 11, 8, and 6 publications, respectively. Most of the studies were collectively carried out in the Western regions of the world and more developed countries. Hence, this highlights the need for more collaboration among researchers from other regions of the globe. It will add and develop more perspectives on the treatment and framework utilized in biodiversity reporting in various regions.

Furthermore, this data highlights the need for continued flourishment of studies among other European countries, as the studies have been conducted in a small portion thus far. There is also a need for more studies in large and developed economies such as the United States, Canada, and Brazil. This would increase the pool of knowledge for more inclusive collaboration between countries and future contributions to the research field.

Which journals are paving the way? The number of publications in accounting-related journals shows that biodiversity reporting is breaking strides and is relevant in accounting management. The bibliometric analysis showed that biodiversity reporting from the accounting discipline has grown with most publications in the Accounting, Auditing, and Accountability Journal. This journal accounted for most (24) published documents, amassing the highest citation count. Three other notable journals are the British Accounting Review, Social and Environmental Accountability Journal, and Business Strategy and the Environment, all of which pave the way for publications on this research topic. It shows that the uptake in the accounting field is emerging and relevant now and in the coming years as more scholars get involved with this topic.

What are the most cited articles? The authors Michael Jones and Jill Solomon published the most influential and most cited paper. The paper "Problematising Accounting for Biodiversity" was one of the first publications on the topic and has been circulating since 2013. The article boasts a total citation count of 100 and was published by Accounting, Auditing & Accountability Journal. The author, Michael Jones, followed it, accounting for the subsequent two publications "Accounting for Biodiversity: A Pilot Study "and "Accounting for Biodiversity: Operationalising Environmental Accounting." These studies were the first emergence of articles on the research topic, and they paved the way for a slew of publications related to biodiversity reporting and adaptation of the natural inventory model. From analyzing the results of all the top 10 cited articles, we noticed a widespread of articles, 40%, that studied the theme of reporting standards and biodiversity reporting. On the other hand, 60% was centrally focused on the theme of accounting framework and studying the methods/techniques used in accounting for biodiversity. Hence, the most significant and prevalent focus was ascertaining biodiversity in accounting and finding its place in accounting, as demonstrated through this bibliometric analysis.

Who are the most prominent scholars in the research field, and what is their citation network? Based on the findings of this research, the most influential scholars are Michael Jones and Thomas Cuckston, who have 217 and 137 citations. Other notable mentions are Warren Maroun, Jill Solomon, and Olivier Boiral, who have all contributed significantly to breaking ground in the area of biodiversity reporting in accounting. The total citations of all these authors collectively depict their influence and the growing interest in more studies within the field. The bibliographic coupling network visualization agrees with the previously mentioned authors. This analysis showed the most vital connection between the other authors and Warren Maroun. Maroun, W. has collaborated on ten publications and is one of the most influential authors. Furthermore, the bibliographical coupling results revealed an ongoing collaborative synergy among the researchers and a sharing of resources. A great pool of resources is available to future scholars, but it also gives rise to the need to continue further developments and underexplored areas in the field.

What do the keywords tell us about future topics in the research field? As the research community grows, more concepts are being explored and integrated into biodiversity reporting in accounting. Based on the results, the top vital concepts dominating the area of research are "biodiversity," "accountability," "sustainable development," and "biodiversity reporting." The network analysis revealed that reporting, disclosures, accounting for biodiversity, and integrated reporting were all underexplored. It brings immediate attention to the need to conduct more studies on these areas in biodiversity reporting, especially concerning accounting. From the accounting perspective, more studies are necessary to contribute to the existing bodies of knowledge and are a promising area for further research. This bibliometric analysis helped to identify some underexplored issues and calls for future articles to address the following research areas.

- Biodiversity and technology: What is the extent of technology/artificial intelligence application in biodiversity reporting?
- Developed versus underdeveloped countries: What can underdeveloped countries learn from countries with evidence of more excellent biodiversity reporting?
- Reporting standards: What reporting standards are most evident in developed countries with more excellent reporting on biodiversity?
- COVID-19 impacts biodiversity reporting: What is the trend in biodiversity reporting pre and post-COVID-19 pandemic?
- Risk-sensitive reporting: To what extent do high-risk sectors disclose more about biodiversity than low-risk sectors?
- Species reporting: Do companies indulge in impression management by providing disclosures about popular/exotic species?
- The role of accountants: Can accountants be the ultimate mechanism to help organizations with biodiversity reporting?
- EU reporting: Assessing the extent of biodiversity reporting of companies on the EU stock exchange and their biodiversity reporting.

Limitations. This study was subjected to some limitations that future research could build on. Firstly, the findings for this analysis were drawn from Scopus and Web of Science (WoS) databases. Though these two databases are credible and widely used for bibliometric analyses, we acknowledge that other databases and library resources could have been integrated to produce additional results. Incorporating multiple smaller databases could have yielded more results in the data collection process and potentially increased the final output in the selection of documents.

Nevertheless, we deemed Scopus and Web of Science (WoS) comprehensive coverage sufficient to collect the relevant documents for examination. Secondly, this study did not include the metrics of Web of Science (WoS) and solely used that of Scopus. It is a possible study that could be carried out as future work. Thirdly, the keywords selected and utilized to search for records could have been a limitation. Other keyword combinations could have retrieved more publications. However, the keywords used across both databases were produced from the main topic and combined in various ways to increase the number of retrieved records. Finally, only some of the existing articles related to biodiversity reporting in accounting are included in this research. When the search was conducted, 223 results were extracted across Scopus and Web of Science (WoS). Scopus yielded the most records, with a total of 94 documents. However, the final sample of 57 documents was selected based on our steps applied in PRISMA and the inclusion criteria. This limitation is justified based on the scientific field being studied, accounting, and the research objectives.

CONCLUSION

This study aimed to examine the body of knowledge on biodiversity reporting in accounting by carrying out a bibliometric analysis. This paper examined 57 publications after data synthesis from 1996 to 2021 across Scopus and Web of Science (WoS). However, the analysis defaulted to the Scopus database, considered the most comprehensive repository. Furthermore, we used VOSviewer and various visual depictions to present all the results. We analyzed the dimensions of publication patterns and citation trends, publications and collaboration trends by country, journal rankings, most cited authors and articles, keywords occurrence, and bibliometric coupling of authors.

This study provides more information about the leading authors and journals, the key concepts explored, and the collaboration of the authors. We found that the most influential authors and papers were all published in

high-ranked journals. Moreover, a positive correlation exists between the citation counts and the journals where the articles were published. Hence, the a need to publish in high-ranking journals. In examining the connections between keywords and authors, we found that the most common themes were biodiversity reporting standards and the examination of accounting framework and methods applied in biodiversity.

Additionally, the result of this study shows that essential accounting concepts like accounting systems, tax, and auditing have yet to be explored in greater detail in the domain of biodiversity reporting in accounting. This analysis gives future scholars a better view of the current resources, knowledge, and emerging areas for crucial research. Furthermore, as the field continues to evolve, there will likely be more emergence in themes on biodiversity reporting in accounting.

Furthermore, evaluating the policies and making a positive impact can guide other countries in propelling biodiversity to the forefront. Though the relationship between nature and organizations is quite complex, investigating disclosures can provide insights into the ownership characteristics and understanding of their motivations for reporting on biodiversity conservation. In addition, there remain abundant opportunities to evaluate the biodiversity actions implemented by companies and how these are monitored and measured for successes and failures. Other areas that can provide fruitful yield are investigations into different sectors and industries to evaluate the level of biodiversity reporting and the strategies employed by these sectors to alleviate and reduce their direct and indirect activities that negatively impact biodiversity. Increasing research on biodiversity reporting in accounting can help organizations understand their impacts on nature and improve their efforts on conservation.

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