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Literature Review on Ecological Accounting in Academic Research

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Abstract

Ecological accounting applies the fundamentals of management accounting to environmental information systems through the systematic analysis, reporting, and recording of activities. Through ecological accounting, information about natural resources will be transparent, and corporate social responsibility requirements will be implemented with the aim of preserving resources from depletion. This article aims to evaluate ecological accounting research trends in businesses based on

documents in the Google Scholar database in the years 2010–2023. The results show a growing interest in information about ecological accounting; the highest number of publications is 15 articles in one year, and many journals have published many publications on this issue. Finally, the keyword analysis identified much of the content that was of interest to the authors in the previous period, and this will be an important research point for future research.

Keywords: Ecological Accounting, Systematic Literature Review, VOSview

1. Introduction

Gray and Beddington (1993) ^[1] defined ecological accounting as “a deliberative approach to accounting for addressing environmental problems within a defined economic system”. It is a rigorous and integrated approach to environmental assessment through measuring ecosystems and measuring the flow of services from ecosystems into economic and other human activities. Schategger (2000) ^[9] believes that ecological measurements (kilo, energy consumption, etc.) are limited by physical terms, so they need a way to measure through monetary units. Ecological accounting applies the basic principles of management accounting to environmental information systems through ecological accounting's concern with analyzing and reporting activities and recording activities in a systematic way economic system.

Through ecological accounting, information about natural resources will be clarified and the company's social responsibility requirements will be fulfilled with the aim of preserving resources from depletion. Eco-accounting makes a company's environmental costs more visible through its accounting and reporting systems. Then, the company's benefits and costs are recorded according to the best quantitative assessment in both monetary and in-kind measures. Monetary estimates can inform decision-makers, for example in economic policy planning, cost-benefit analysis, and raising awareness of the relative importance of nature to society.

Therefore, in recent years, general studies have often chosen ecological accounting in businesses for synthesis and analysis. Providing a comprehensive picture of research on ecological accounting in businesses in the period from 2010 to the present is necessary to fill previous research gaps.

The article clarifies the following research questions, including Q1: What is the number of articles on ecological accounting in businesses published from 2010 to 2023? Q2: And which articles have the most citations? Q3: What topics are the keywords used grouped into? Q4: And have these keywords changed and gained strength over time?

To answer the above questions, the study reviewed 94 articles published in the period 2010-2023. Research conducted through bibliometric analysis makes a great contribution to the research community because, through bibliometrics, a valuable amount of information can be collected about a topic. By reflecting on what has been done and what needs to be researched in the future, the article aims to add to the literature on different methods and contexts to support researchers on eco-accounting in business. The research is divided into parts: Defining the conceptual foundation, applied methods, research results, and concluding remarks.

2. Theoretical Basis

The United Nations Statistical Commission adopted an ecological accounting system in 2021 to offer specific guidelines for gauging the size and condition of ecosystems as well as the economic value of ecological services. According to the United Nations, an ecological accounting system is a statistical framework that combines biophysical data about ecosystems, measures ecosystem services, tracks changes in ecosystem size and condition, evaluates ecosystem assets, and links this data to indicators of economic and human activity. According to Maes *et al.* (2016) ^[5], ecological accounting gauges how much nature and ecosystems contribute to the growth of the economy and society. Ecological accounting is a discipline that is quickly expanding. It uses a structured methodology to evaluate how dependent we are on the environment and how our actions affect it.

By highlighting the significance of ecosystems and ecological services to policymakers, ecological accounting provides information to promote economic and environmental policy. Ecological accounting connects data on various ecosystem types and a variety of ecosystem services with other macro-level data to enable policy decision-making at the macro level. Ecological accounting can help with decision-making at the local level for a variety of local and environmental issues, including water basins, forest reserves, marine conservation, etc. According to Hein *et al.* (2020) ^[3], data from ecological accounting is helpful data that highlights the economic contributions of ecosystems and provides data linked to natural resource management.

At the corporate level, ecological accounting attempts to satisfy social responsibility standards while preserving natural resources to prevent their depletion. Radneantu *et al.* (2010) ^[8] claim that eco-accounting aims to increase the transparency of a company's environmental costs through accounting and reporting systems. Then, companies' advantages and disadvantages are recorded in a form that enables the best quantitative evaluation in terms of both money and physical attributes. Eco-accounting aims to increase companies' environmental transparency and accountability, reduce the environmental harm caused by traditional accounting, ascertain how a company's position in society relates to environmental issues, and give companies a competitive edge.

The first step in the eco-accounting process is to integrate eco-accounting functions into the business' environmental strategy. From there, the process moves on to defining the proper framework for accounting and data gathering. The initial step is to gather, catalog, and combine environmental data with an assessment of its relative influence. The next step is to describe the environmental effects in order to assign blame for any environmental damage caused by the production of the product. To guarantee successful and positive continual improvement, eco-accounting needs to be integrated with conventional accounting and environmental management systems.

Internal ecological accounting, external ecological accounting, and other ecological accounting were all part of the ecological accounting system identified by Schaltegger *et al.* in (2000) ^[9]. Internal ecological accounting is the process of gathering data on an ecological system with the

aim of giving management internal information. Management choices must take into account methods for assessing how a company's products and manufacturing processes affect the environment. External ecological accounting provides Data about environmental issues to shareholders and other outside parties. The environmental reports of firms are made available to the public through external ecological accounting. In addition to measuring data in physical units, other ecological accounting gives information to regulatory agencies with the aim of verifying conformity with legislation.

3. Research Methods

This study uses the systematic literature review method SLR (Systematic Literature Review) of Tranfield *et al.* (2003) ^[7]. Sample selection for the study was based on PRISMA (priority items for systematic reviews and meta-analyses), originally proposed by Liberati *et al.* (2009) ^[4] and updated in 2021 by Page *et al.* (2021) ^[6]. The PRISMA flow diagram is based on three steps: identification, screening, and study inclusion.

Step 1: The author synthesizes previously published overview documents related to ecological accounting in businesses and introductory documents on the nature and role of ecological accounting in businesses from sources data on Google Scholar. This collection aims to explain the urgency of the research, overview the research, and point out research gaps. Data were collected on October 12, 2023, with the use of the following keywords "eco-accounting". A total of 94 results were found from Google Scholar from 2010 to 2023.

Step 2: The author group has screened to remove inappropriate documents through technical screening and content screening. For technical screening, documents in the form of an encyclopedia, editorials, short communications, mini-reviews, and book chapters would be eliminated. For content screening, documents are pre-read to eliminate documents with irrelevant content, even if they contain search keywords. The results after filtering showed that all 94 results met the filtering conditions for inclusion in the study.

Step 3: The number of remaining documents after the two steps is analyzed by the SLR (systematic literature review) document system and put into VosViewer software to analyze keywords and co-citation analysis. The results of the SLR analysis are presented in tables and graphs. The results of the bibliometric analysis will be presented in visual form. From the analysis results, the study finds popular research directions, names the research directions, and suggests future research directions.

4. Results

4.1 Statistics on the Year of Publication

From 2010 to 2023, a total of 94 articles on ecological accounting in business were indexed in Google Scholar with an average of 6.7 articles published per year. The number of articles was lowest in 2010 and 2013 (3 articles published each year). And in 2014, 2021, and 2022 are the years with the highest number of articles published, respectively 15 articles, 11 articles, and 10 articles. Statistical results of the year of publication show that researchers are paying more attention to ecological accounting in businesses over time.

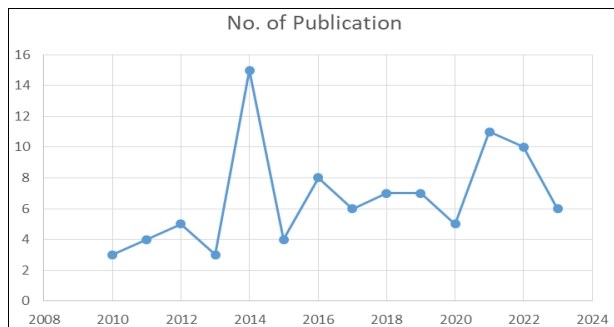


Fig 1: Chart of the number of studies over the years

Regarding citation statistics, articles published within 14 years were cited 918 times. Articles with the highest number of citations are in 2013 (150 citations), 2014 (322 citations), and 2017 (116 citations). Articles from 2018 onwards have not had many citations, like in 2022, 10 articles were published but only 11 citations. Thus, later-stage research often focuses on learning about research conducted in the years 2013 and 2014.

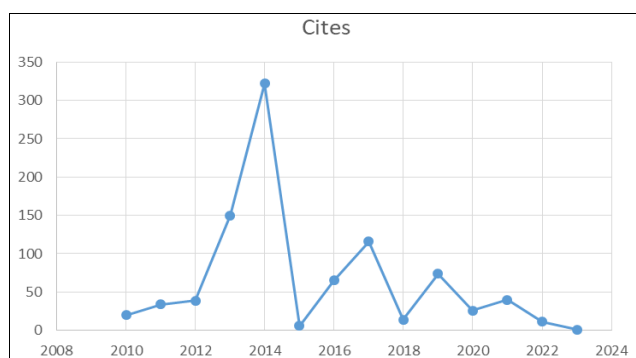


Fig 2: Chart of number of citations over the years

4.2 Results of Keyword Analysis

In the keyword analysis section, research and select keywords that appear 5 times or more. Keywords are evaluated by the software based on the number of occurrences and total link strength. Keyword analysis results can be exported into files as images. The keyword analysis results are as follows:

Selected	Term	Occurrences	Relevance
<input checked="" type="checkbox"/>	ecological accounting system	8	3.57
<input checked="" type="checkbox"/>	accountability	5	1.40
<input checked="" type="checkbox"/>	historical root	5	1.16
<input checked="" type="checkbox"/>	environmental accounting	7	1.04
<input checked="" type="checkbox"/>	ecological accounting	121	0.96
<input checked="" type="checkbox"/>	extended exergy	7	0.78
<input checked="" type="checkbox"/>	development	14	0.47
<input checked="" type="checkbox"/>	application	9	0.44
<input checked="" type="checkbox"/>	china	11	0.44
<input checked="" type="checkbox"/>	paper	13	0.42
<input checked="" type="checkbox"/>	sustainability	7	0.33

Fig 3: Keywords repeated many times

Out of 539 keywords, only 11 met the criteria to appear at least five times. The keyword “ecological accounting” has appeared the most, 121 times. The keywords China, paper, and development appeared 11 times, 13 times, and 14 times, respectively.

Related keywords are grouped into groups, each group is a separate color. Note that the larger the circle, the more times it appears; the thicker the line connecting the two keywords, the greater the frequency of occurrences. Related keywords are grouped into groups, each group is a separate color. Looking at the image, it can be seen that the keywords are divided into 6 groups with 13 items, 22 links, and a total link strength of 131. Group 1 is represented by red links with the keyword ecological accounting, the key ecological accounting chair, and french experience. Group 2 is represented by green links with the keywords ecological accounting system, management, and role. Group 3 is represented by green links with keywords China, and extended exergy. Group 4 is represented by yellow links with the keywords accountability and historical root. Group 5 is represented by purple links with the keyword environmental accounting. Group 6 is represented by blue links with the keyword mathematic. With 6 research directions and 13 popular keywords, the results show that the research content on ecological design in businesses is of interest. Future studies can base on that to choose research directions to fill the gap or analyze more deeply.

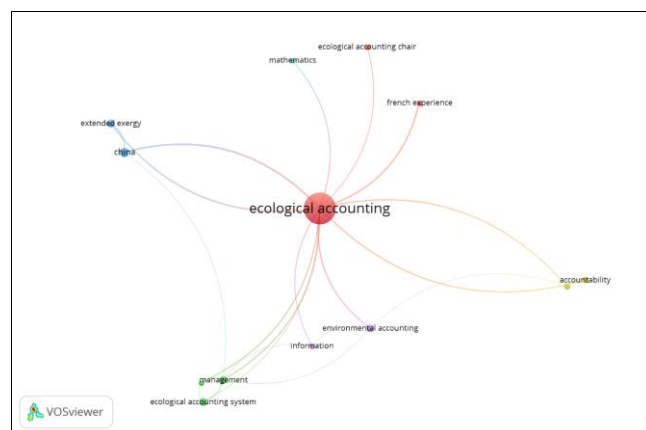


Fig 4: Co-occurrence networks

In addition, the results from the VOSviewer tool have shown the time of keywords appear. Dark colors represent keywords researched from the first years (2010), in recent studies, keywords have appeared in brighter colors. The keyword appearance time chart shows that ecological accounting is the keyword with the most interest, and assessing the level of interest over time, this keyword received a lot of attention in the period 2017-2018.

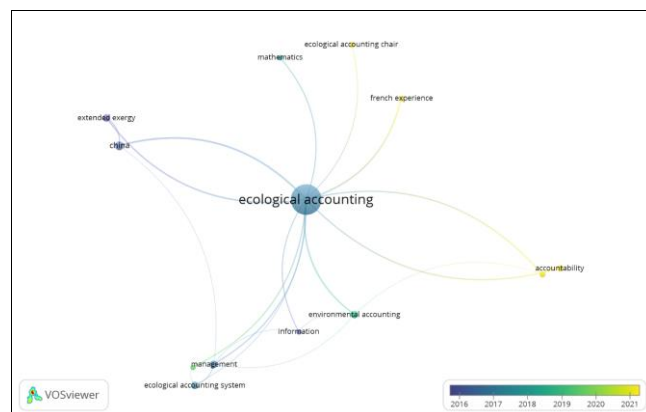


Fig 5: Time of keyword appearance

4.3 Co-Authorship Analysis

To explore the tendency to collaborate in research using ecological accounting in businesses, this study conducted an analysis of co-authorship relationships between individual authors. According to Benoit *et al.* (2018) [2], the analysis results help improve understanding of research collaboration and help discover influential researchers. Out of a total of 94 publications reviewed, 149 authors contributed to the article. Among them, 7 authors have participated in writing 4 or more articles. Fig 6 presents the co-authorship network map. The link between the two nodes represents the collaborative relationship between the two authors, and the thickness of the link represents the intensity of the collaboration. Author A Rambaud participated in writing 7 articles, followed by author B Chen who participated in writing 6 articles during the research period from 2010 - 2023.

Verify selected authors				
Selected	Author	Documents	Total link strength	
<input checked="" type="checkbox"/>	chen, b	6	9	
<input checked="" type="checkbox"/>	dai, j	5	8	
<input checked="" type="checkbox"/>	sciubba, e	5	8	
<input checked="" type="checkbox"/>	doni, f	4	4	
<input checked="" type="checkbox"/>	mcbride, k	4	4	
<input checked="" type="checkbox"/>	feger, c	4	3	
<input checked="" type="checkbox"/>	rambaud, a	7	3	

Fig 6: Statistics of authors with many articles

Related authors are grouped into groups, each group is a separate color. Note that the larger the circle, the greater the relationship between the authors; the thicker the line connecting two keywords, the greater the intensity of appearance. Related authors are grouped into groups, each group is a separate color. Looking at the image, it can be seen that the authors are divided into 2 groups with 8 items. Group 1 with red link includes 5 items (Gv Brent, Sj Cooke, Se Doke, Ck Minns, and Bg Valere). Group 2 with blue link includes 3 items (S Doka, A Rose, and B Valere).

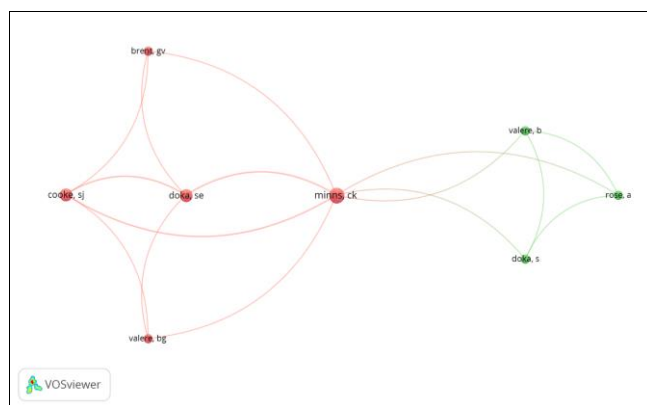


Fig 7: Co-authorship analysis by units of authors

In addition, the results from the VOSviewer tool have shown the time the authors spent writing the article. The author appearance time chart shows that authors with many articles on ecological accounting in businesses focus on publishing articles in the period from 2018- 2022.

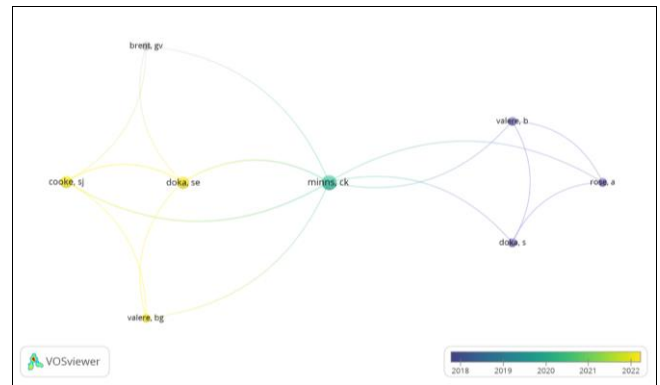


Fig 8: Time of Co-authorship analysis

5. Conclusion

In this study, we evaluated global publications on corporate eco-accounting indexed in the Google Scholar database published between 2010 and 2023 to provide insights into the number publication volume, publishing journal, keyword network, and co-authorship network. This study used bibliometric methods with the help of several statistical and data visualization applications to explore research trends in the content of ecological accounting in business.

Research results show that there have been a total of 94 articles on ecological accounting in businesses indexed in Google Scholar from 2010 to 2023. The results of journal publication statistics show that there are many journals that have published many articles with content about ecological accounting in businesses. In terms of quantity, 2014, 2021, and 2022 are the years with the highest number of articles published, respectively 15 articles, 11 articles, and 10 articles. In terms of keywords, out of 539 keywords, there are 11 keywords that meet the criteria to appear at least 5 times. Regarding authors, out of a total of 94 publications reviewed, 149 authors participated in writing the articles. Among them, 7 authors have participated in writing 4 or more articles.

The research results have contributed to the general theoretical basis, serving as a basis for reference studies on ecological accounting in businesses. Data collected from richer sources such as Scopus or Web of Science are suggestions for further research on ecological accounting in businesses, in addition, future studies can evaluate existing documents. Ecological accounting systems in businesses in separate fields.

6. References

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