



Carbon Management Accounting: A Systematic Literature Review

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Abstract. Climate change occurs due to the increasing concentration of carbon dioxide gas and other gasses in the atmosphere which causes the greenhouse gas effect. It is the integration of financial, social and environmental accounting that is then given the name Green Accounting. A derivative of Green Accounting or Environmental Management Accounting is Carbon Management Accounting. The purpose of this study is to determine the application of carbon management accounting based on the literature available in Scopus indexed journals. This paper uses a qualitative method with the type of Systematic Literature Review by entering the keywords "Carbon Management Accounting " and "Carbon Accounting" in three databases, namely E-Perpusnas, Emerald, and ScienceDirect. The results of this paper present the analysis in the form of a literature review, location, year, and research methods as well as a discussion of the Synthesis of Research Results, Theories, and Research Gaps. This paper suggests further research, namely by developing a better number of samples and research methods used

Keywords: Carbon Management Accounting, Carbon Accounting, Management Accounting, Systematic Literature Review.

1 Introduction

One of the most threatening environmental problems in the world is the impact of climate change [1, 2]. The Paris Agreement, signed on Earth Day, 22 April 2016, is a commitment from the world community to unite together to reduce the rate of global warming. A total of 103 countries adopted or ratified the Paris Agreement into law to participate in aiming to restrict the increase in global temperatures to less than 2°C compared to pre-industrial levels, and striving to keep it even lower, below 1.5°C. The multitude of regulations concerning carbon performance serves as a catalyst for the accounting profession to embrace a more environmentally conscious approach. This transformation demands accountants to adapt their traditional practices to meet

the evolving demand for information from stakeholders, which now extends beyond purely financial data. Consequently, the scope of accounting expands to encompass not only financial aspects but also social and environmental concerns. This holistic integration of financial, social, and environmental dimensions is commonly referred to as green accounting or Green Accounting.

Disclosure of carbon emissions provides added value for investors because it has a positive effect on company value and finances [3]. Investors will be attracted to companies that care about environmental aspects because they can increase the company's profitability. Carbon performance can improve financial performance [4, 5] and the quality of sustainability reports [6, 7]. Carbon management accounting research has a positive effect on financial performance [8, 9]. However, empirical research found that Carbon Management Accounting has no effect on financial performance [10].

Starting from this background, we want to know the application of carbon management accounting based on the available literature in Scopus indexed journals. By synthesizing definitions, theories and mapping of carbon management accounting based on available literature in Scopus indexed journals, our research will assist researchers in empirical studies as well as increase understanding regarding carbon management accounting. For practical fields, this article can be a reference for planning and mitigating carbon performance prior to deciding to adopt carbon management accounting.

2 Literature Review

A variation of Green Accounting or Environmental Management Accounting is Carbon Management Accounting. Carbon accounting involves tallying the carbon emissions generated by industrial activities, defining reduction objectives, implementing strategies and initiatives to decrease carbon footprints, and monitoring and reporting the advancements of these efforts. The significance of carbon accounting lies in the necessity for various fields to collaborate in addressing the intricate sustainability challenge, especially regarding companies' CO₂ emissions. Carbon accounting primarily aims to diminish carbon footprint through the assessment and surveillance of companies' carbon emissions, placing emphasis on monitoring these emissions [11]. Disclosure of environmental information (environmental disclosure) is the disclosure of information related to the environment contained in a company's annual report [12]. Carbon performance metrics are influenced by the scope and efficiency of the accounting methodologies utilized, the quality of input data, and the adherence to established standards. Currently, organizations facing challenges in developing carbon measurement and accounting systems can choose from various approaches in carbon management accounting [13].

3 Research Methods

This research is qualitative research with systematic literature review (SLR) research. Regarding technical procedures, this research can be classified as a bibliography

because the materials used are materials that have been developed and published like scientific papers. Based on the purpose of this paper, namely to find out the application

of carbon management accounting based on the literature available in Scopus indexed journals, a literature review is the most appropriate approach.

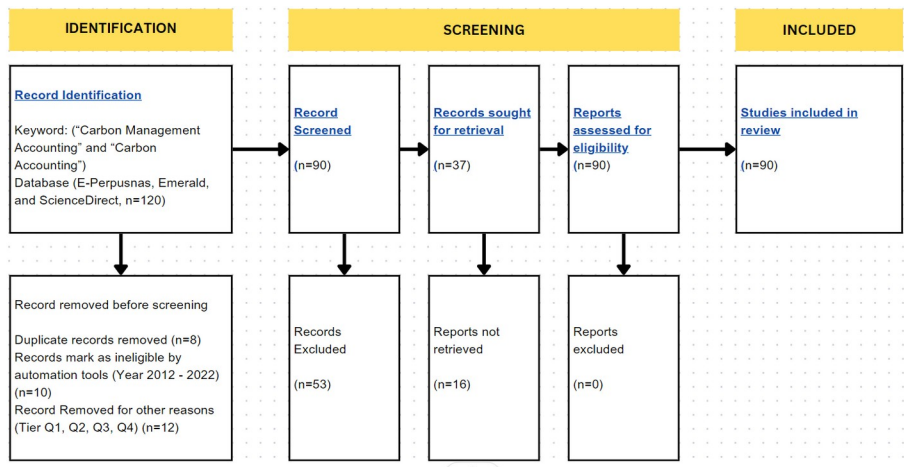


Fig. 1. PRISMA Model of Systematic Literature Review.

At the article identification stage, searches were carried out by entering the keywords "Carbon Management Accounting" and "Carbon Accounting" in three databases, namely E-Perpusnas, ScienceDirect, Emerald, and with titles and abstracts containing keywords, 120 articles were obtained. Documents retrieved are documents with the type of Article. Documents such as books, conferences, and so on are not taken. At this stage, 10 articles were eliminated that did not meet the criteria, namely the first elimination other than articles published in 2012-2022 as many as 10 articles and the second elimination other than articles indexed Q1, Q2, Q3 and Q4 in the Scopus database of 12 articles, so that 90 articles that have been identified will go to the article screening stage.

At the article screening stage, elimination was also carried out, namely the first elimination was carried out manually by filtering accurately whether the keywords were included in the title and abstract and there were 53 articles that did not have keywords in the title and abstract. And second, elimination of articles for which data is not available, namely 16 articles. The analysis phase of the final article results found 21 articles that had keywords in the title and abstract, publications during the 2012-2022 period, indexed Q1, Q2, Q3, and Q4 in the Scopus database, and available article data.

4 Results and Discussion

4.1 Results of Literature Review

The first step is to look for literature related to carbon management accounting. We do not restrict the conduct of research in any country. We collected twenty-one Articles through various online databases with Scopus indexed journal criteria. Some keywords are our interpretation based on the explanation of the article because more keywords are needed to facilitate processing and analysis. Here we present the results of a preliminary analysis of the literature related to carbon management accounting:

Table 1. Reference Article Table.

N o	Author	Index
1	Fereshteh Mahmoudian, Jing Lu, Irene M. Herremans [14]	Q1
2	Wen-Hsien Tsai, Yu-Shan Shen, Chi-Chou Huang [15]	Q1
3	Stefan Schaltegger, Maria Csutora [13]	Q1
4	Francisco Ascui, Heather Lovell [16]	Q1
5	Maria Csutora [13] Ki-Hoon Lee [17]	Q1
6	Kristin Stechemesser, Edeltraud Guenther [18]	Q1
7	Roger L. Burritt, Joanne Tingey Holyoak [19]	Q1
8	Peter S. P. Wong, Aiden Lindsay, Sarah Holdsworth [20]	Q1
9	Wei Qian, Jacob Hörisch, Stefan Schaltegger [21]	Q1
10	Charl De Villiers, Sile Chen, Chenxing jin and Yiner Zhu [22]	Q4

Based on the articles we have selected using the Systematic Literature Review method, then we identify prominent articles based on the number of citations to the article. Here's a table of articles by number of citations.

Table 2. Reference Article With Number of Sites Table.

Article Code	Journal	Number of Sites / cited by
3	Journal of Cleaner Production	174
6	Journal of Cleaner Production	166

Article Code	Journal	Number of Sites / cited by
5	Journal of Cleaner Production	96
19	Abacus	85
9	Journal of Cleaner Production	52
4	Journal of Cleaner Production	51
11	Sustainability Accounting, Management and Policy Journal	46
2	Journal of Cleaner Production	40
7	Journal of Cleaner Production	35
12	Accounting, Auditing & Accountability Journal	34

4.2 Research Location

We have done the mapping based on the research country. Mapping the country of study or the country of researchers can provide a picture of related research interests regarding carbon management accounting in countries around the world. We found that the countries with the most research on carbon management accounting were Australia (23.8%), France (9.5%), Germany (9.5%), and the United Kingdom (9.5%).

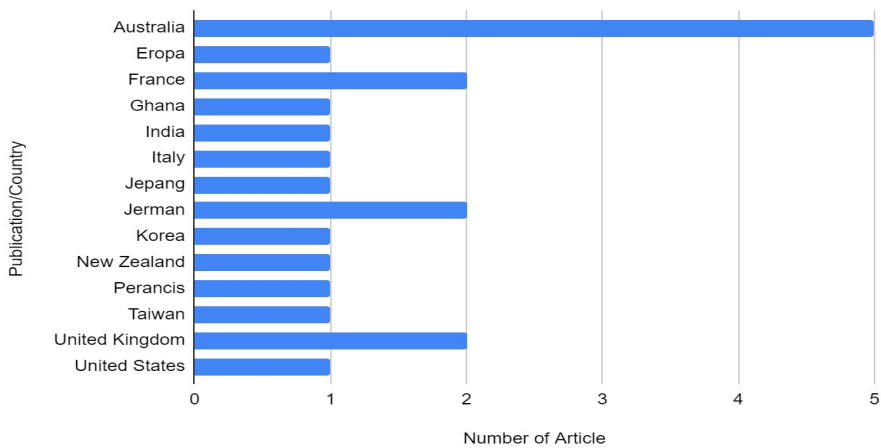


Fig. 2. Publication Country Graph

4.3 Research Years

We have done a mapping based on the year of the article that became a reference in the range of 2012 to 2022. Mapping to the year of the article can provide an overview of the increase or decrease in research trends in the field of carbon management accounting. Based on the data we obtained, the largest number of articles, namely 6 articles published in 2012, then as many as 4 articles in 2020, 3 articles in 2015 and two articles each in 2018 and 2021.

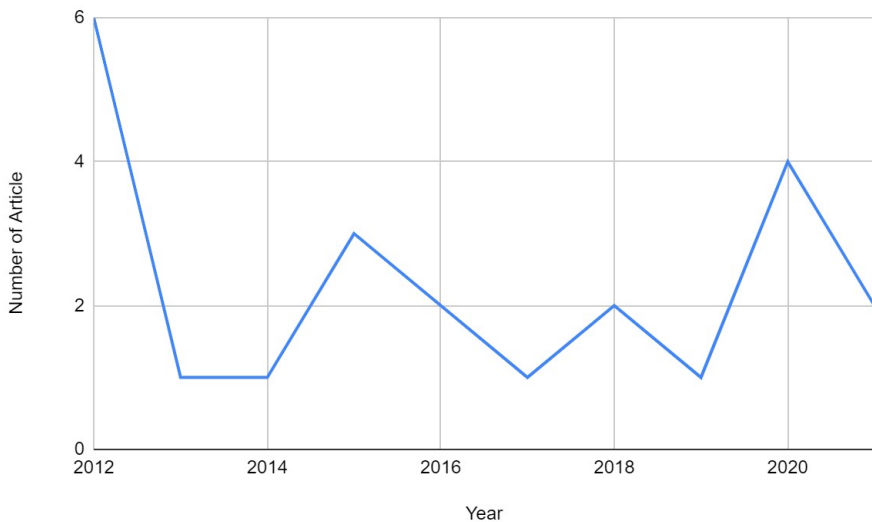


Fig. 3. Publication Year Graph.

4.4 Research Methods

We have done mapping based on the selection of research methods. Mapping to the research method of the article can provide an overview of the selection of the most widely chosen method in conducting research on carbon management accounting. We found that the majority of research conducted using qualitative methods was as much as 76 percent, while quantitative research methods conducted as much as 24 percent of the total research.

Based on the data, the majority of articles use qualitative methods in research methods. These results indicate that most of the research on this topic is preliminary research which is still looking for a definition of the topic of carbon management accounting. The concept of carbon accounting is a relatively recent development in

the field of accounting that has emerged in the last 10-20 years and has not been broadly defined. [23].

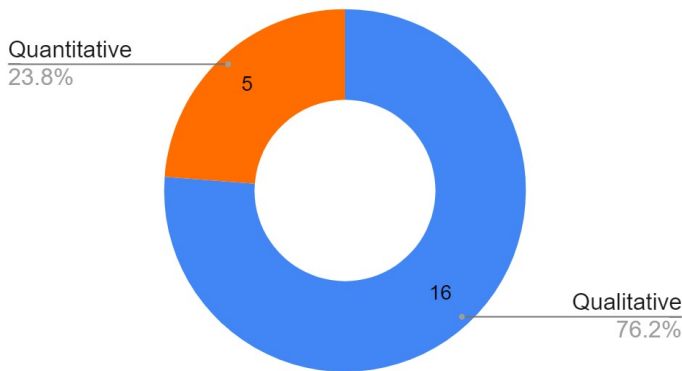
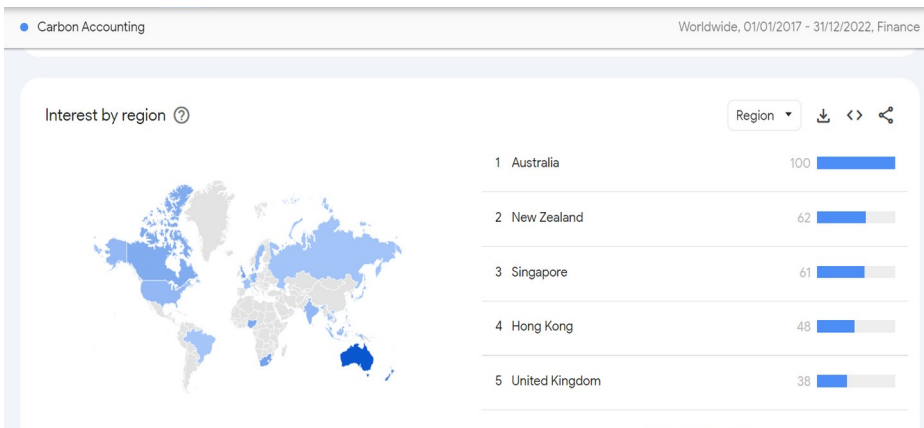


Fig. 4. Research Methods Graph.

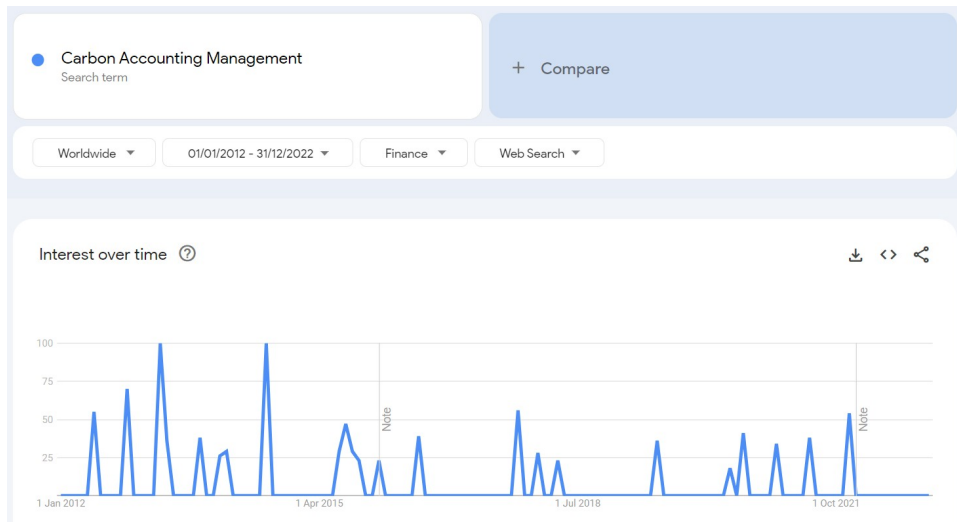
Research Locations. We found that research on carbon management accounting is most prevalent in developed countries. In developing nations, institutions possess distinct attributes set apart from those in developed nations. These disparities encompass cultural dimensions like individualism and competition, alongside variations in educational and labor frameworks. Moreover, developed nations boast robust environmental regulations, influential trade unions, and substantial consumer demand, thereby incentivizing companies to embrace environmentally-friendly practices, a pressure less pronounced in developing countries [24].



Data source: Google Trends (<https://www.google.com/trends>).

Fig. 5. Research Location.

Years of Research. Based on the data obtained, there are fluctuations in the number of articles published related to the topic of carbon management accounting. In general, an increase in the number of articles related to this topic occurs in 2012, 2015, and 2020. Based on data on Google Trends, interest in this topic has also fluctuated and experienced a significant increase in 2012, 2015, 2018, and 2020.



Data source: Google Trends (<https://www.google.com/trends>).

Fig. 6. Years of Research.

The increase in the number of articles related to carbon management accounting is directly affected by changes in policies and regulations related to the topic. The increase in articles in 2012 was an effect of the end of the Kyoto protocol and The Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG- LCA). The increase in articles in 2015 was the effect of the UNFCCC COP21/CMP11 Meeting in Paris on 30 November – 12 December 2015 which agreed to adopt a series of decisions including Decision 1/CP.21 on Adoption of the Paris Agreement as the main result. Then the increase in articles in 2020 is the effect of the 3rd International Conference on Sustainable Development of Water and Environment (ICSDWE2020) on 13-14 January 2020 in South Korea.

4.5 Synthesis of Research Results, Theories, and Research Gaps

Carbon management accounting is a component of carbon accounting aimed at aiding companies in effectively managing and executing their carbon management strategies. It encompasses various tools for gathering, processing, and communicating carbon-related data, serving as a vital aspect of carbon management and policies within both private and public entities [13]. The roots of the concept of carbon management accounting are from environmental management accounting in the 1990s, but then

carbon accounting has developed rapidly as its own area in corporate environmental management [25]. Schaltegger and Csutoramn propose that Carbon management accounting encompasses a range of information management instruments aimed at aiding decision-making concerning carbon initiatives, in line with the principles of sustainability[13]. Certain empirical studies refer to this concept as 'strategic carbon management accounting' when directed inward, and as 'disclosure of climate risks, opportunities, and governance' when directed outward [11, 16, 18].

In his bibliographical analysis, K. Stechemesser, E. Guenther states the assumption that there are various disciplines discussing carbon accounting and that carbon accounting is being researched by various types of academics and scientists [18]. Thus, in his article, attempts to provide a definition of carbon accounting at various levels: national, project, organizational and product. However, it can be stated that a comprehensive and detailed definition of "carbon accounting" that covers various scales (national, project, organization, and product) has not yet been found. This limitation arises because studies conducted at both national and project levels have primarily concentrated on accounting for non-financial carbon emissions. This is unfortunate because from a carbon management perspective, monetary or financial aspects will drive the adoption of carbon management accounting by companies.

Environmental management accounting (EMA) has gained significant traction in recent decades as a means to assess a company's environmental footprint, encompassing factors like carbon emissions. Various EMA methodologies, such as material flow cost accounting, eco-control, and the sustainability balanced scorecard, have emerged and are being more widely adopted to mitigate a company's environmental impact. Research by W. Qian et al. demonstrate that the utilization of EMA instruments correlates positively and significantly with carbon management and the caliber of carbon disclosure [21]. According to research by W. Qian et al., the efficacy of audit and control instruments in enhancing carbon management hinges not only on a company's engagement with these tools but also on the thoroughness and excellence of their implementation [21]. Their findings indicate that EMA tools effectively oversee carbon emissions, providing managers with a valuable resource to tackle climate change and streamline carbon emission monitoring.

Still related to the tools used in EMA, W.-H. Tsai et al. proposed a new approach, namely Activity Based Costing for estimating environmental costs [15]. By following expenses across various activities, an Activity Based Costing method not only generates more precise assessments of the ecological expenses associated with the end product, but also delineates a distinct environmental cost framework applicable in policy formation, pricing strategies, and enhancements in processes. For instance, managers can leverage ABC to pinpoint the carbon expenses within their products, facilitating enhanced carbon management initiatives.

Changes in global climate policy have spurred the advancement of corporate carbon accounting guidelines and criteria, encompassing aspects like supply chain and product considerations (e.g., the Greenhouse Gas protocol). [25]. Schaltegger and Cusutura categorize different aspects of carbon footprint measurement into three tiers: direct emissions, emissions stemming from purchased energy, and supply chain emissions [13]. Assessing carbon emissions in business typically follows three primary methods: Bottom-Up, Top-Down, and a combination of both known as the Hybrid Approach. K. -H. Lee describes a supply chain carbon

management (SCCM) initiative utilizing eco-control, a method crafted to foster synergy among corporate strategy, environmental management strategy, and performance evaluation by furnishing relevant accounting data [17]. At the external level, especially between organizations, F. Mahmoudian et al. found that stakeholder engagement has a positive effect on carbon management accounting [14].

From a theoretical point of view, Lee has shown the factors that determine the development or implementation of EMA using various theoretical approaches such as institutional theory / Institutional Theory [17], diffusion theory and contingency theory [19]. Carbon management accounting, which is a development of Environmental Management Accounting (EMA), and its information characteristics are theoretically anchored in contingency theory by considering environmental strategy as an EMA contingency factor [17].

Although various studies emphasize the benefits of carbon management accounting among others, Carbon management accounting allows these companies to limit carbon emissions associated with various types of energy and identify how carbon enhancement can be achieved most economically [13, 17], Application EMA has a significant positive impact on corporate carbon management and disclosure quality [21]. However, there are also several articles that provide criticism regarding carbon management accounting. Among them Schaltegger, and Csutora argue that, the carbon management accounting information utilized by these entities primarily focuses on tangible data from the past, lacks significant future-oriented aspects, and is predominantly employed for long-term objectives [13]. It is therefore an accounting practice that attempts to uncover “undesired adverse effects and problems and is designed to help them develop unsustainable corporate carbon accounts”. Implementation of a carbon accounting system contributes to the commodification of nature, turning it into a “fictional” equivalent commodity (by measuring GHG emissions in tons of CO₂) whose exchange rate is fixed (through the operation of a carbon market).

5 Conclusion

In general, our systematic literature analysis research is the first step to synthesizing and mapping literature related to carbon management accounting. We realize that this research still has many shortcomings due to various reasons, such as sample limitations, search locations, and time. We suggest a better development of the sample size and research methods used. We also suggest conducting mapping and research from other aspects of the available literature, for example in terms of its relationship with financial accounting and alternatives through quantitative methods so that it can provide more confidence and become a follow-up development of this research

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