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Article

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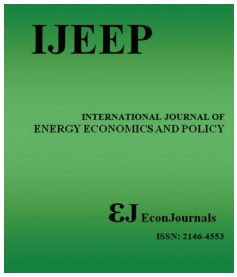

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Twelve Years Research Journey of Carbon Accounting

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ABSTRACT

This study systematically reviews the journey of carbon accounting research published in international journals ranging from 2011 to 2022 to provide future directions of research. This paper aims to provide an overview of key themes in carbon accounting development over the past 12 years. This study analyzed 62 articles from Scopus database research journal from 9 countries published in 21 journals. This bibliometric study uses content analysis with QSR Nvivo software. Carbon accounting research development starts from counting to accounting field, but no one studied the accountability of carbon emission. Most of the samples studied carbon emission in corporate level compared with city, national, product, or project level. More than half of the samples use qualitative method, especially case study. Research on Carbon Accounting still allows a lot of development, especially in the measurement and disclosure of carbon emission. The accountability of carbon accounting also needs further analysis. This study contributes to the existing literature of carbon accounting research stream and provides suggestions for future research. Accounting standards setter can start to regulate the recognition, measurement, presentations, and disclosure of carbon emissions. Auditing standards setter also can start to regulate the auditing procedure of carbon accounting.

Keywords: Carbon Accounting, Literature Review, Bibliometric, Content Analysis
JEL Classifications: F23, M14, Q56

1. INTRODUCTION

Climate change is raising awareness and is already affecting communities around the world. With concerns about climate, there is an increasing need to counting and disclose GHG-related emissions from industrial companies (Csutora and Harangozo, 2017). The complexity of the issue and the difficulties encountered in trying to adequately estimate the total carbon or climate costs associated with business activities. Carbon dioxide (CO_2) payments due to emissions trading must be included in the annual financial statements.

Carbon accounting is an emerging field of business economics and covers a wide range of activities, including the measurement, calculation, monitoring, reporting, and auditing of greenhouse gas emissions at organizational, process, product, or supply chain levels (Csutora and Harangozo, 2017). Corporate carbon accounting for environmental sustainability dimensions has also been studied by Ascui and Lovell (2011), Bowen and Wittneben (2011), and Schaltegger and Csutora (2012).

Corporate carbon reporting is important for external stakeholders to obtain a true and fair representation of a company's carbon footprint and mitigation efforts, so it requires comparable and accurate accounting of similar carbon emissions under financial reporting regulations (Schaltegger and Sisutora, 2012). On the other hand, the accounting standard setters does not set a clear standard regarding accounting treatment (recognition, measurement, presentation, and disclosure) of carbon emissions. It is important to know the research journey regarding carbon accounting in past years.

Zheng et al. (2022) studied the bibliometric analysis of carbon accounting and concluded that "international trade" is the most discussed word in the paper samples, especially regarding calculation of carbon emission in international trade. Ascui and

Lovell (2011) founds that in the natural and technical sciences, the emphasis is primarily on the accuracy of carbon quantification. On the other hand, research on carbon accounting in the social is concern about the measurement, collection, and comparison of CO_2 data (Bowen and Wittneben, 2011).

There have been some research studies on carbon accounting in the social sciences with focus on one specific subject with different level of analysis and research field (counting, accounting, or accountability). Some research focus on the accuracy of carbon emission calculation and other research focus on the presenting and disclosing carbon emission in corporate report.

Many researchers have studied the issue of carbon disclosure because it is considered very important for the development of accounting. However, there has been no mapping of carbon accounting research articles. So, the systematic literature review of these carbon accounting theme is needed to be done.

According to Littell (2008), a systematic literature review aims to comprehensively locate and synthesize research that bears on a particular question, using organized, transparent, and replicable procedures at each step in the process.

We use bibliometric analysis in this research. Bibliometrics are the study and measurement of the publication patterns of all forms of written communication and their authors (Potter, 1981). Bibliometric method will provide an overview of the author's mapping, source, impact, frequently occurring words, affiliations, etc.

Section 2 presents literature review regarding carbon accounting; section 3 presents methodology used in this research. We continue with section 4 to discuss the results and discussions and finally we end up with section 5 for conclusions and recommendations.

2. LITERATURE REVIEW

2.1. Carbon Emissions

Carbon emissions are gases released into the atmosphere from the combustion of carbon compounds, such as CO_2,, diesel, and other fuels. Ecolife (2011) confirms that the release of carbon into the atmosphere is directly correlated with the release of carbon dioxide. Gullison et al. (2007) explained that the countries that produce the largest carbon dioxide (CO_2) emissions in the world are China, the United States, and Indonesia.

Carbon emissions are a contributor to climate change along with greenhouse gas emissions. Excessive gas emissions can cause global warming or the greenhouse effect. This results in a significant increase in Earth's temperature. Therefore, an entity needs to understand its business activities' impact on the surrounding environment. So that the entity needs to communicate its activities to the community for its business that results in global warming due to carbon emissions (Choi et al., 2013). The Kyoto Protocol emphasizes the importance of carbon accounting because companies are obliged to document and disclose their carbon emissions (Irwhantoko and Basuki, 2016).

2.2. Carbon Accounting Definitions

Carbon accounting is an emerging fi eld of business economics and covers a wide range of activi- ties, including the measurement, calculation, monitoring, reporting and auditing of greenhouse gas emissions at organizational, process, product or supply chain levels (Csutora and Harangozo, 2017). According to Csutora and Harangozo (2017, carbon accounting covers a wide range of activities related to the calculation, measurement, verification, reporting, etc. of carbon emissions (Burritt and Tingey-Holyoak, 2012).

Carbon accounting comprises the recognition, the non-monetary and monetary evaluation and the monitoring of greenhouse gas emissions on all levels of the value chain and the recognition, evaluation and monitoring of the effects of these emissions on the carbon cycle of ecosystems (Stechemesser and Guenther, 2012).

Carbon accounting defines as the discussion on the integration of aspects of climate change mitigation into accounting is often called carbon accounting(KPMG, 2008; Hespenheide et al., 2010). carbon accounting comprises the recognition, the non-monetary and monetary evaluation and the monitoring of greenhouse gas emissions on all levels of the value chain and the recognition, evaluation and monitoring of the effects of these emissions on the carbon cycle of ecosystems (Stechemesser and Guenther, 2012).

Carbon accounting clearly means different things to different people. To scientists, it is "the practice of making scientifically robust and verifiable measurements of GHG [greenhouse gas] emissions." To political negotiators, it implies "the rules for comparing emissions and removals as reported with commitments" at a national level (IPCC, 2005, p. 265). To practitioners in the United Nations Clean Development Mechanism (CDM) market, it involves the measurement of reductions in emissions relative to a hypothetical baseline, and other processes associated with the subsequent creation of a new tradable commodity: a carbon credit (Ministry of the Environment, Japan, 2009). To the International Accounting Standards Board (IASB), it concerns the accounting of tradable emission rights and obligations arising under emissions trading schemes (IASB, 2008). (Ascui and Lovell, 2011).

Carbon accounting is a report that discusses climate change mitigation into accounting (KPMG, 2008; Hespenheide et al., 2010). Disclosure of carbon emissions or calculating carbon costs is a part that must be reported in the company's business activities. Carbon accounting is part of accounting, as is the calculation of environmental costs that arise from the calculation itself (Schaltegger and Burritt, 2000). However, carbon accounting is more specific to carbon disclosure.

Schaltegger and Burritt (2000) define environmental accounting as part of accounting that discusses the impact of a company or factory on the environment. In addition, environmental accounting discusses financial aspects and non-financial aspects (Burritt et al., 2002), so that environmental accounting is more general in nature. In financial accounting, costs related to the environment will be included in the components of the financial statements, so that they become part of environmental accounting. In management

accounting, the company will identify and report information on management activities related to product lines, divisions, and systems used (Stechemesser and Guenther, 2012). All of them can have a relationship with the environment.

3. RESEARCH DESIGN

3.1. Sample and Data Description

This paper uses bibliometric analysis to mapping carbon accounting research. Bibliometric is "the study and measurement of the publication patterns of all forms of written communication and their authors" (Potter, 1981). Bibliometric method will provide an overview of the author's mapping, source, impact, frequently occurring words, affiliations, etc.

Fink (2010) proposes four steps for a systematic review, which we used as a foundation and which we enriched by using the structure proposed by Tranfield et al. (2003). In the first step, we selected our research questions, the bibliographic article databases and websites, as well as the appropriate search terms. Then, we used practical review criteria for the inclusion or exclusion of the relevant literature. In the third step, we developed and applied methodological review criteria. Finally, we synthesized our findings (Stechemesser and Guenther, 2012).

The data was collected from the Scopus database ranging from 2011 until 2022. Only journal articles published in English were collected for analysis in this study. Journals with titles, keywords, and abstracts containing "carbon accounting" are selected as the data with category of journal is Business and Economics. The search resulted in 62 journal articles. Since carbon accounting is taken as a focus in this study, we have manually screened 10 articles to exclude those which are irrelevant. After screening, 55 publications are identified for further bibliometric analysis.

A systematic review "aims to comprehensively locate and synthesize research that bears on a particular question, using organized, transparent, and replicable procedures at each step in the process." Fink (2010) proposes four steps for a systematic review, which we used as a foundation and which we enriched by using the structure proposed by Tranfield et al. (2003). In the first step, we selected our research questions, the biblio- graphic article databases and websites, as well as the appropriate search terms. Then, we used practical review criteria for the inclusion or exclusion of the relevant literature. In the third step, we developed and applied methodological review criteria. Finally, we synthesized our findings (Stechemesser and Guenther (2012). Table 1 shows the articles analyzed in this research.

4. RESULTS AND DISCUSSION

Based on the articles collected, we present data by year of publication, the number of articles published at that time, and the name of the journal. Table 2 presents the number of articles published according to the year. Table 1 shows that the most publications of papers related to the theme of Carbon Accounting are in 2019 with 9 documents published.

3 shows the number of articles published based on journal name. The Table 3 shows that Journal of cleaner production is the most relevant source regarding carbon accounting theme with 31 journals published.

Table 4 shows the number of articles published based on country. It shows that researcher in Australia concerned with carbon accounting theme with 16 articles published, followed by United Kingdom with 12 articles and China with 10 articles.

Bowen and Wittneben (2011) classify carbon accounting research into 3 categories: counting, accounting, and accountability. The counting carbon field have molecular level of analysis and calibration purpose. While accounting carbon field have plant, corporate or product level of analysis and industrial and disclosure purposes. Accountability carbon field have global level and allocation of emission purposes. Table 5 shows the research sample field categorization according to Bowen and Wittneben (2011).

There is no research that analyzes up to the level of accountability. Existing research studies a lot of carbon in terms of counting and accounting. The accounting field is more on disclosure of carbon emission. There is only 1 research that examines audits on carbon disclosure reports. For the method of measuring carbon itself, there has not been an agreed upon measurement that is used as a reference throughout the world. Carbon emission measurements consist of life cycle assessment methods, project-level accounting, and policy-level accounting (Brander, 2016).

The International Accounting Standard Board (IASB) has not regulated rigidly how to recognize and measure the company's carbon emissions. Global Reporting Initiatives (GRI) makes the disclosure standards which regulate the disclosure of carbon emissions. For companies in Indonesia, this disclosure is still voluntary.

Level of analysis of the research are divided into 4 levels, namely: national, corporate, product, project, city. Table 6 shows the level of analysis of the samples.

Most research analyzes Carbon Emission at the company level followed by the city level. Only a few analyzed Carbon Emission at the level of National, Project, Product, and University.

Figure 1: Word Cloud (processed with NVivo)

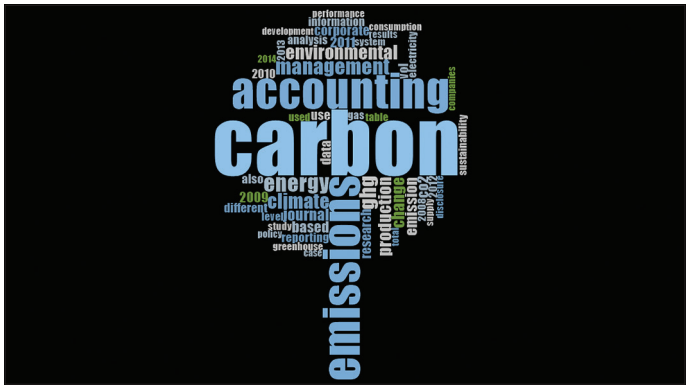

Table 1: Article analyzed in the paper

S. No.	Title	Authors	Year	Source
1.	National accounting systems as a foundation for embedded emissions accounting in trade-related climate policies	Reeve and Aisbett	2022	Journal of cleaner production
2.	Carbon-neutral cities: Critical review of theory and practice	Huovila et al.	2022	Journal of cleaner production
3.	Assessing spatially multistage carbon transfer in the life cycle of energy with a novel multi-flow and multi-node model: A case of China's coal-to-electricity chain	Li et al.	2022	Journal of cleaner production
4.	The Surge of Environmental Social and Governance Reporting and Sustainable Development Goals: Some Normative Thoughts	De Silva Lokuwaduge et al.	2022	Australasian accounting, business and finance journal
5.	Corporate carbon accounting: a literature review of carbon accounting research from the Kyoto Protocol to the Paris Agreement	He et al.	2022	Accounting and finance
6.	Professional financial statement users' perceived value of carbon accounting disclosures and decision context	Coram et al.	2022	Meditari accountancy research
7.	Spatial variability and temporal patterns of internal price of carbon: a transitional management perspective	Chen et al.	2022	Meditari accountancy research
8.	Assessing economic and environmental performance of multi-energy sharing communities considering different carbon emission responsibilities under carbon tax policy	Li et al.	2021	Journal of cleaner production
9.	CEO characteristics: do they matter for carbon performance? An empirical investigation of Australian firms	Elsayih et al.	2021	Social responsibility journal
10.	A systems perspective analysis of an increased use of forest bioenergy in Canada: Potential carbon impacts and policy recommendations	Giuntoli et al.	2021	Journal of cleaner production
11.	The effect of national culture on corporate green proactivity	Wang et al.	2021	Journal of business research
12.	On the fair accounting of carbon emissions in the global system using an exergy cost formation concept	Khajehpour et al.	2021	Journal of cleaner production
13.	Impact of foreign directors on carbon emissions performance and disclosure: empirical evidence from France	Mardini and Lahyani	2021	Sustainability accounting, management and policy journal
14.	Accounting for biogenic carbon and end-of-life allocation in life cycle assessment of multi-output wood cascade systems	Garcia et al.	2020	Journal of cleaner production
15.	Institutional work in the birth of a carbon accounting profession	Gibassier et al.	2020	Accounting, auditing and accountability journal
16.	Tourism carbon footprint inventories: A review of the environmentally extended input-output approach	Sun et al.	2020	Annals of tourism research
17.	Ac-counting for carbon emissions: simulating absence through experimental sites of material politics	Revellino	2020	Sustainability accounting, management and policy journal
18.	The emergence of carbon accounting: How instruments and dispositifs interact in new practice creation	Le Breton and Aggeri	2020	Sustainability accounting, management and policy journal
19.	When carbon accounting systems make us forget nature: from commodification to reification	Martineau and Lafontaine	2020	Sustainability accounting, management and policy journal
20.	Carbon accounting approaches and reporting gaps in urban emissions: An analysis of the Greenhouse Gas inventories and climate action plans in Brazilian cities	de Souza Leão et al.	2020	Journal of cleaner production
21.	Carbon dioxide emissions evaluations and mitigations in the building and traffic sectors in Taichung metropolitan area, Taiwan	Chang et al.	2019	Journal of cleaner production
22.	Greenhouse gas emissions and net carbon sequestration of the Beijing-Tianjin Sand Source Control Project in China	Liu et al.	2019	Journal of cleaner production
23.	An integrated carbon footprint accounting and sustainability index for palm oil mills	Jamaludin et al.	2019	Journal of cleaner production
24.	Life-cycle assessment of timber frame constructions – The case of rooftop extensions	Wijnants et al.	2019	Journal of cleaner production
25.	Forestry carbon budget models to improve biogenic carbon accounting in life cycle assessment	Head et al.	2019	Journal of cleaner production
26.	Does carbon accounting have an impact on decision-making in building design?	Wong et al.	2019	International journal of construction management
27.	Unpacking carbon accounting numbers: A study of the commensurability and comparability of corporate greenhouse gas emission disclosures	Wegener et al.	2019	Journal of cleaner production
28.	Hybrid life-cycle assessment for robust, best-practice carbon accounting	Kennelly et al.	2019	Journal of cleaner production
29.	Carbon accounting framework for decarbonisation of European city neighbourhoods	Pulselli et al.	2019	Journal of cleaner production
30.	The unpaid social cost of carbon: Introducing a framework to estimate "legal looting" in the fossil fuel industry	Linnenluecke et al.	2018	Accounting research journal
31.	Corporate greenhouse gas inventories, guarantees of origin and combined heat and power production – Analysis of impacts on total carbon dioxide emissions	Nordenstam et al.	2018	Journal of cleaner production

(Contd...)

Table 1: ***(Continued)***

S. No.	Title	Authors	Year	Source
32.	Review of modifications to indirect land use change modeling and resulting carbon intensity values within the California Low Carbon Fuel Standard regulations	Leland et al.	2018	Journal of cleaner production
33.	Local strategies for China's carbon mitigation: An investigation of Chinese city-level CO2 emissions	Cai et al.	2018	Journal of cleaner production
34.	Implementing city-level carbon accounting: A comparison between Madrid and London	Andrade et al.	2018	Journal of cleaner production
35.	Pinch analysis of GHG mitigation strategies for municipal solid waste management: A case study on Qingdao City	Jia et al.	2018	Journal of cleaner production
36.	Counting before acting? The performativity of carbon accounting called into question - Calculation acts and dispositifs in a big French construction company	Le Breton and Aggeri	2018	Management (france)
37.	20 years of carbon accounting and auditing - A review and outlook	Csutora and Harangozo	2017	Society and economy
38.	Corporate carbon footprint analysis in practice – With a special focus on validity and reliability issues	Harangozo, G., Szigeti, C.	2017	Journal of cleaner production
39.	Low carbon innovation and practice in Caohejing High-Tech Industrial Park of Shanghai	Huang et al.	2016	International journal of production economics
40.	Determinants of the Quality of Corporate Carbon Management Systems: An International Study	Luo and Tang	2016	International journal of accounting
41.	Accounting for urban carbon dioxide: A review	Zhang et al.	2016	Journal of environmental accounting and management
42.	The use of environmental accounting to determine energy saving in mpumalanga hotels, South Africa	Machete et al.	2016	Journal of environmental accounting and management
43.	Strong structuration and carbon accounting: A position-practice perspective of policy development at the macro, industry and organizational levels	Moore and McPhail	2016	Accounting, auditing and accountability journal
44.	Transposing lessons between different forms of consequential greenhouse gas accounting: Lessons for consequential life cycle assessment, project-level accounting, and policy-level accounting	Brander	2016	Journal of cleaner production
45.	Does stakeholder pressure influence corporate GHG emissions reporting? Empirical evidence from Europe	Liesen et al.	2015	Accounting, auditing and accountability journal
46.	Carbon management accounting and reporting in practice: A case study on converging emergent approaches	Gibassier and Schaltegger	2015	Sustainability accounting, management and policy journal
47.	Creating numbers: Carbon and capital investment	Vesty et al.	2015	Accounting, auditing and accountability journal
48.	Life cycle carbon benefits of aerospace alloy recycling	Eckelman et al.	2014	Journal of cleaner production
49.	The complex issues of carbon sink: A critical overview	Ciasullo et al.	2014	International Journal of Environment and Health
50.	Carbon sequestered in the trees on a university campus: A case study	de Villiers et al.	2014	Sustainability accounting, management and policy journal
51.	Carbon accounting: Challenges for research in management control and performance measurement	Hartmann et al.	2013	Abacus
52.	Decarbonising product supply chains: Design and development of an integrated evidence-based decision support system-the supply chain environmental analysis tool (SCEnAT)	Koh et al.	2013	International journal of production research
53.	A consumption-based approach to carbon emission accounting-sectoral differences and environmental benefits	Mózner	2013	Journal of cleaner production
54.	Forging cleaner production: The importance of academic-practitioner links for successful sustainability embedded carbon accounting	Burritt and Tingey-Holyoak	2012	Journal of cleaner production
55.	Carbon accounting for supply chain management in the automobile industry	Lee	2012	Journal of cleaner production
56.	Carbon accounting and the construction of competence	Ascui and Lovell	2012	Journal of cleaner production
57.	Carbon accounting: A systematic literature review	Stechemesser and Guenther	2012	Journal of cleaner production
58.	Carbon accounting for sustainability and management. Status quo and challenges	Schaltegger and Csutora	2012	Journal of cleaner production
59.	Climate change accounting research: keeping it interesting and different	Milne and Grubnic	2011	Accounting, auditing and amp; accountability journal
60.	Carbon accounting: Negotiating accuracy, consistency and certainty across organisational fields	Bowen and Wittneben	2011	Accounting, auditing and accountability journal
61.	As frames collide: Making sense of carbon accounting	Ascui and Lovell	2011	Accounting, auditing and accountability journal
62.	Intelligent sustainable design: Integration of carbon accounting and building information modeling	Stadel et al.	2011	Journal of professional issues in engineering education and practice

We divide research into quantitative and qualitative research (Table 7).

Research that uses qualitative methods is more than quantitative methods. The qualitative method that is mostly used is a case study method in calculating the carbon emissions of a project, product, city, or corporation.

Table 2: Number of publications by year

Year	Count of title
2011	4
2012	5
2013	3
2014	3
2015	3
2016	6
2017	2
2018	7
2019	9
2020	7
2021	6
2022	7
Total	62

Table 3: Journal names of articles published

Journal	Count of title
Abacus	1
Accounting and finance	1
Accounting research journal	1
Accounting, auditing and amp; accountability journal	1
Accounting, auditing and accountability journal	6
Annals of tourism research	1
Australasian accounting, business and finance journal	1
International journal of accounting	1
International journal of construction management	1
International journal of environment and health	1
International journal of production economics	1
International journal of production research	1
Journal of business research	1
Journal of cleaner production	30
Journal of environmental accounting and management	2
Journal of professional issues in engineering education and practice	1
Management (France)	1
Meditari accountancy research	2
Social responsibility journal	1
Society and economy	1
Sustainability accounting, management and policy journal	6
Total	62

Table 4: Number of articles published based on country

Country	Number of articles
Australia	16
United Kingdom	12
China	10
France	7
United States	6
Germany	4
Hungary	4
Italy	3
Total	62

Most studies (75%) were examined at all industrial levels and the rest (25%) examined samples in specific industries, namely Automobile, Building and Traffic, Coal to Electricity Chain, Construction, Construction Design, Forestry, Fossil Fuel, Hotels, Industrial Park, Oil gas, Palm Oil, Sand Source Control Project, Timber, and Tourism.

In terms of the coverage of carbon accounting in practice, it is interesting to compare the focus of the papers in this sample with the five frames identified by Ascui and Lovell (2011): physical, national, market-enabling, financial and social/environmental carbon accounting. Figure 1 provides a subjective classification of the reviewed papers according to the frame of main emphasis. It is immediately apparent that most of the literature concerns the "social/environmental" framing of carbon accounting, mainly concerned with either internal carbon management accounting, or external carbon disclosure, and with organisations or their products and supply chains as the main unit of analysis. This should not be surprising, given that the scope of the review was limited to carbon accounting in the SEA literature. However, it does suggest considerable scope for SEA researchers interested in carbon accounting to broaden their engagement with other forms of carbon accounting.

Many of the papers reviewed here have called for greater interdisciplinary cooperation, for example, between accountants, natural scientists and engineers, as well as between academic researchers and practitioners.

Most frequent word shown in Figure 1 (Word Cloud). Word Cloud shows the most frequent word discuss in the journals collected. Size of the words represents the frequency of that words. The bigger the size, the more frequent the word to be discussed. Based on Figure 1, the word Carbon (8740 words) is the one that appears the most in the carbon accounting theme, while in second place is the word Emissions (4757 words), and the third is the word accounting (4625 words).

Table 5: Research sample field categorization

	Counting	Accounting	Accountability	Total
Count of authors	23	39	0	62

Table 6: Level of analysis of the samples

Level of analysis	Count of title
All level	1
City	10
Corporate	41
National	6
Product	1
Project	2
University	1
Total	62

Table 7: Analysis methods

Method	Count of title
Qualitative	33
Quantitative	29
Total	62

5. CONCLUSION

The most publications of papers related to the theme of Carbon Accounting are in 2019 with 9 documents published. Journal of Cleaner Production is the most relevant source regarding carbon accounting theme with 31 journals published. Researcher in Australia concerned with carbon accounting theme with 16 articles published, followed by United Kingdom with 12 articles and China with 10 articles. Word Cloud shows the most frequent word discuss in the journals collected. Size of the words represents the frequency of that words. The bigger the size, the more frequent the word to be discussed. Based on Figure 1, the word Carbon (8740 words) is the one that appears the most in the carbon accounting theme, while in second place is the word Emissions (4757 words), and the third is the word accounting (4625 words). Carbon accounting research development starts from the synthesis of "carbon accounting" definitions. It develops with carbon counting, carbon accounting, and carbon accountability. Carbon counting has been researched many times in specific industries. But carbon accounting (includes recognition, measurement, presentations, and disclosure) and carbon accountability (audit of carbon accounting) still need further analysis.

Research on Carbon Accounting still allows a lot of development. The current research mostly examines the Carbon Emission (Counting) calculation method. Research on Carbon Disclosure has also been done a lot, but research on Carbon Accountability is still not much done. This can be an opportunity for further research.

Coordination between academics and practitioners (be it accountants and practitioners at Midwives Carbon/Engineer Emissions) are needed so that Carbon Emission can be measured reliably.

For standard setter, special standards are needed that regulate the recognition, measurement, presentation, and disclosure of company carbon emissions. This is because there is currently no special standard that regulates this. The company is still voluntary presenting and expressing carbon emissions in their respective ways so that they cannot be assessed as comparative. It takes standard standards throughout the world to be more comparable. The audit regarding the Carbon Emission report also needs to be done considering that stakeholders are currently not only concerned about profit aspects, but also people and planets.

REFERENCES

Andrade, J.C.S., Dameno, A., Pérez, J., de Andrés Almeida, J.M., Lumbreras, J. (2018), Implementing city-level carbon accounting: A comparison between Madrid and London. Journal of Cleaner Production, 172, 795-804.

Ascui, F., Lovell, H. (2011), As frames collide: Making sense of carbon accounting. Accounting, Auditing and Accountability Journal, 24(8), 978-999.

Bowen, F., Wittneben, B. (2011), Carbon accounting: Negotiating accuracy, consistency and certainty across organisational fields. Accounting, Auditing and Accountability Journal, 24(8), 1022-1036.

Brander, M. (2016), Transposing lessons between different forms of consequential greenhouse gas accounting: Lessons for consequential life cycle assessment, project-level accounting, and policy-level accounting. Journal of Cleaner Production, 112, 4247-4256.

Burritt, R.L., Tingey-Holyoak, J. (2012), Forging cleaner production: The importance of academic-practitioner links for successful sustainability embedded carbon accounting. Journal of Cleaner Production, 36, 39-47.

Burritt, R. L., Hahn, T., & Schaltegger, S. (2002), Towards a comprehensive framework for environmental management accounting—Links between business actors and environmental management accounting tools. Australian Accounting Review, 12(27), 39-50.

Cai, B., Guo, H., Cao, L., Guan, D., Bai, H. (2018), Local strategies for China's carbon mitigation: An investigation of Chinese city-level CO2 emissions. Journal of Cleaner Production, 178, 890-902.

Chang, C.T., Yang, C.H., Lin, T.P. (2019), Carbon dioxide emissions evaluations and mitigations in the building and traffic sectors in Taichung metropolitan area, Taiwan. Journal of Cleaner Production, 230, 1241-1255.

Chen, H., Shan, Y.G., Tang, Q., Zhang, J. (2022), Spatial variability and temporal patterns of internal price of carbon: A transitional management perspective. Meditari Accountancy Research, 31, 729-761.

Choi, B. B., Lee, D., & Psaros, J. (2013), An analysis of Australian company carbon emission disclosures. Pacific Accounting Review.

Ciasullo, R., Simone, C., Conti, M.E. (2014), The complex issues of carbon sink: A critical overview. International Journal of Environment and Health, 7(2), 171-195.

Coram, P., Potter, B., Soderstrom, N. (2022), Professional financial statement users' perceived value of carbon accounting disclosures and decision context. Meditari Accountancy Research. DOI: 10.1108/MEDAR-02-2021-1193

Csutora, M., Harangozo, G. (2017), Twenty years of carbon accounting and auditing-a review and outlook. Society Economic, 39, 459-480.

De Silva Lokuwaduge, C., Smark, C., Mir, M. (2022), The surge of environmental social and governance reporting and sustainable development goals: Some normative thoughts. Australasian Accounting, Business and Finance Journal, 16(2), 3-11.

de Souza Leao, E.B., do Nascimento, L.F.M., de Andrade, J.C.S., de Oliveira, J.A.P. (2020), Carbon accounting approaches and reporting gaps in urban emissions: An analysis of the Greenhouse Gas inventories and climate action plans in Brazilian cities. Journal of Cleaner Production, 245, 118930.

De Villiers, C., Chen, S., Jin, C., Zhu, Y. (2014), Carbon sequestered in the trees on a university campus: A case study. Sustainability Accounting, Management and Policy Journal, 5(2), 149-171.

Ecolife. 2011. Definition of Carbon Emission. Available from: http://www.ecolife.com/define/carbon-emission.html. [Last accessed on 2023 Jan 27].

Eckelman, M.J., Ciacci, L., Kavlak, G., Nuss, P., Reck, B.K., Graedel, T.E. (2014), Life cycle carbon benefits of aerospace alloy recycling. Journal of Cleaner Production, 80, 38-45.

Elsayih, J., Datt, R., Hamid, A. (2021), CEO characteristics: Do they matter for carbon performance? An empirical investigation of Australian firms. Social Responsibility Journal, 17(8), 1279-1298.

Fink A (2010), Conducting research literature reviews: From the internet to paper, 3rd ed. Los Angeles: SAGE.

Garcia, R., Alvarenga, R.A., Huysveld, S., Dewulf, J., Allacker, K. (2020), Accounting for biogenic carbon and end-of-life allocation in life cycle assessment of multi-output wood cascade systems. Journal of Cleaner Production, 275, 122795.

Gibassier, D., El Omari, S., Naccache, P. (2020), Institutional work in the birth of a carbon accounting profession. Accounting, Auditing and Accountability Journal, 33(6), 1447-1476.

Gibassier, D., Schaltegger, S. (2015), Carbon management accounting

and reporting in practice: A case study on converging emergent approaches. Sustainability Accounting, Management and Policy Journal, 6(3), 340-365.
Giuntoli, J., Searle, S., Pavlenko, N., Agostini, A. (2021), A systems perspective analysis of an increased use of forest bioenergy in Canada: Potential carbon impacts and policy recommendations. Journal of Cleaner Production, 321, 128889.
Gullison, R. E., Frumhoff, P. C., Canadell, J. G., Field, C. B., Nepstad, D. C., Hayhoe, K., and Nobre, C. (2007), Tropical forests and climate policy. Science, 316(5827), 985-986.
Harangozo, G., Szigeti, C. (2017), Corporate carbon footprint analysis in practice-with a special focus on validity and reliability issues. Journal of Cleaner Production, 167, 1177-1183.
Hartmann, F., Perego, P., Young, A. (2013), Carbon accounting: Challenges for research in management control and performance measurement. Abacus, 49(4), 539-563.
Hespenheide, E., Pavlovsky, K., & McElroy, M. (2010), Accounting for sustainability performance: Organizations that manage and measure sustainability effectively could see benefits to their brand and shareholder engagement and retention as well as to their financial bottom line. Financial Executive, 26(2), 52-57.
He, R., Luo, L., Shamsuddin, A., Tang, Q. (2022), Corporate carbon accounting: A literature review of carbon accounting research from the Kyoto Protocol to the Paris Agreement. Accounting and Finance, 62(1), 261-298.
Head, M., Bernier, P., Levasseur, A., Beauregard, R., Margni, M. (2019), Forestry carbon budget models to improve biogenic carbon accounting in life cycle assessment. Journal of Cleaner Production, 213, 289-299.
Huang, B., Jiang, P., Wang, S., Zhao, J., Wu, L. (2016), Low carbon innovation and practice in Caohejing high-tech industrial park of Shanghai. International Journal of Production Economics, 181, 367-373.
Huovila, A., Siikavirta, H., Rozado, C.A., Rökman, J., Tuominen, P., Paiho, S., Ylén, P. (2022), Carbon-neutral cities: Critical review of theory and practice. Journal of Cleaner Production, 341, 130912.
Irwhantoko, I., & Basuki, B. (2016). Carbon emissions' disclosure: Studi pada perusahaan manufaktur Indonesia. Jurnal Akuntansi dan Keuangan, 18(2), 92-104.
Intergovernmental PanelonClimateChange(IPCC). (2005), IPCC Special Reporton Carbondioxide Capture and Storage. Available from: http://www.ipcc.ch/pdf/specialreports/srccs/srccs_wholereport.pdf
IASB.(2008), International AccountingStandards Board (IASB) - Information for Observers: Emissions Trading Schemes; Board meeting 20May 2008. Available from: http://www.iasb.org/NR/rdonlyres/92B01EDC-E519-431F-915F0F33505D7DFD/0/ETS0805b03obs.pdf
Jamaludin, N.F., Ab Muis, Z., Hashim, H. (2019), An integrated carbon footprint accounting and sustainability index for palm oil mills. Journal of Cleaner Production, 225, 496-509.
Jia, X., Wang, S., Li, Z., Wang, F., Tan, R.R., Qian, Y. (2018), Pinch analysis of GHG mitigation strategies for municipal solid waste management: A case study on Qingdao City. Journal of Cleaner Production, 174, 933-944.
Kennelly, C., Berners-Lee, M., Hewitt, C.N. (2019), Hybrid life-cycle assessment for robust, best-practice carbon accounting. Journal of Cleaner Production, 208, 35-43.
Khajehpour, H., Saboohi, Y., Tsatsaronis, G. (2021), On the fair accounting of carbon emissions in the global system using an energy cost formation concept. Journal of Cleaner Production, 280, 124438.
Koh, S.L., Genovese, A., Acquaye, A.A., Barratt, P., Rana, N., Kuylenstierna, J., Gibbs, D. (2013), Decarbonising product supply chains: Design and development of an integrated evidence-based decision support system-the supply chain environmental analysis tool (SCEnAT). International Journal of Production Research, 51(7), 2092-2109.
KPMG (2008), KPMG International Survey of Corporate Responsibility Reporting 2008, Amstelveen: KPMG.
Le Breton, M., Aggeri, F. (2018), Counting before acting? The performativity of carbon accounting called into question-Calculation acts and dispositifs in a big French construction company. Management, 21(2), 834-857.
Le Breton, M., Aggeri, F. (2020), The emergence of carbon accounting: How instruments and dispositive interact in new practice creation. Sustainability Accounting, Management and Policy Journal, 11(3), 505-522.
Lee, C.Y., Chong, H.Y., Liao, P.C., Wang, X. (2018), Critical review of social network analysis applications in complex project management. Journal of Management in Engineering, 34(2), 04017061.
Leland, A., Hoekman, S.K., Liu, X.V. (2018), Review of modifications to indirect land use change modeling and resulting carbon intensity values within the California Low Carbon Fuel Standard regulations. Journal of Cleaner Production, 180, 698-707.
Li, J., Tian, Y., Zhang, Y., Xie, K. (2022), Assessing spatially multistage carbon transfer in the life cycle of energy with a novel multi-flow and multi-node model: A case of China's coal-to-electricity chain. Journal of Cleaner Production, 339, 130699.
Li, L., Zhang, S., Cao, X., Zhang, Y. (2021), Assessing economic and environmental performance of multi-energy sharing communities considering different carbon emission responsibilities under carbon tax policy. Journal of Cleaner Production, 328, 129466.
Liesen, A., Hoepner, A.G., Patten, D.M., Figge, F. (2015), Does stakeholder pressure influence corporate GHG emissions reporting? Empirical evidence from Europe. Accounting, Auditing and Accountability Journal, 28(7), 1047-1074.
Linnenluecke, M., Smith, T., Whaley, R.E. (2018), The unpaid social cost of carbon: Introducing a framework to estimate "legal looting" in the fossil fuel industry. Accounting Research Journal, 31(2), 122-134.
Littell, J.H. (2008), Systematic Reviews and Meta- Analysis. USA: Oxford University Press.
Liu, B., Zhang, L., Lu, F., Deng, L., Zhao, H., Luo, Y., Yuan, Y. (2019), Greenhouse gas emissions and net carbon sequestration of the Beijing-Tianjin sand source control project in China. Journal of Cleaner Production, 225, 163-172.
Luo, L., Tang, Q. (2016), Determinants of the quality of corporate carbon management systems: An international study. The International Journal of Accounting, 51(2), 275-305.
Machete, F., Hongoro, C., Nhamo, G., Mearns, K.F. (2016), The Use of Environmental Accounting to Determine Energy Saving in Mpumalanga Hotels, South Africa. Available from: http://researchspace.csir.co.za/dspace/handle/10204/9590
Mardini, G.H., Lahyani, F.E. (2022), Impact of foreign directors on carbon emissions performance and disclosure: Empirical evidence from France. Sustainability Accounting, Management and Policy Journal, 13(1), 221-246.
Martineau, R., Lafontaine, J.P. (2020), When carbon accounting systems make us forget nature: From commodification to reification. Sustainability Accounting, Management and Policy Journal, 11(3), 487-504.
Milne, M.J., Grubnic, S. (2011), Climate change accounting research: Keeping it interesting and different. Accounting, Auditing and Accountability Journal, 24(8), 948-977.
Moore, D.R., McPhail, K. (2016), Strong structuration and carbon accounting: A position-practice perspective of policy development at the macro, industry and organizational levels. Accounting, Auditing and Accountability Journal, 29(7), 1204-1233.
Mózner, Z.V. (2013), A consumption-based approach to carbon emission

accounting-sectoral differences and environmental benefits. Journal of Cleaner Production, 42, 83-95.
Nordenstam, L., Ilic, D.D., Ödlund, L. (2018), Corporate greenhouse gas inventories, guarantees of origin and combined heat and power production-Analysis of impacts on total carbon dioxide emissions. Journal of Cleaner Production, 186, 203-214.
Potter, W.G. (1981), Introduction to bibliometrics. Library Trends, 30(5), 5-7.
Pulselli, R.M., Marchi, M., Neri, E., Marchettini, N., Bastianoni, S. (2019), Carbon accounting framework for decarbonisation of European city neighbourhoods. Journal of Cleaner Production, 208, 850-868.
Reeve, A., Aisbett, E. (2022), National accounting systems as a foundation for embedded emissions accounting in trade-related climate policies. Journal of Cleaner Production, 371, 133678.
Revellino, S. (2020), Ac-counting for carbon emissions: Simulating absence through experimental sites of material politics. Sustainability Accounting, Management and Policy Journal, 11(3), 613-640.
Schaltegger, S., Csutora, M. (2012), Carbon accounting for sustainability and management. Status quo and challenges. Journal of Cleaner Production, 36, 1-16.
Schaltegger, S., & Burritt, R. L. (2010). Sustainability accounting for companies: Catchphrase or decision support for business leaders?. Journal of World Business, 45(4), 375-384.
Tranfeld D, Denyer D, Smart P (2003) Towards a methodology for developing evidence-informed management knowledge by means of systematic review. Br J Manag 14:207–222.
Stadel, A., Eboli, J., Ryberg, A., Mitchell, J., Spatari, S. (2011), Intelligent sustainable design: Integration of carbon accounting and building information modeling. Journal of Professional Issues in Engineering Education and Practice, 137(2), 51-54.
Stechemesser, K., Guenther, E. (2012), Carbon accounting: A systematic literature review. Journal of Cleaner Production, 36, 17-38.
Sun, Y.Y., Cadarso, M.A., Driml, S. (2020), Tourism carbon footprint inventories: A review of the environmentally extended input-output approach. Annals of Tourism Research, 82, 102928.
Vesty, G.M., Telgenkamp, A., Roscoe, P.J. (2015), Creating numbers: Carbon and capital investment. Accounting, Auditing and Accountability Journal, 28, 302-324.
Wang, H., Guo, T., Tang, Q. (2021), The effect of national culture on corporate green proactivity. Journal of Business Research, 131, 140-150.
Wegener, M., Labelle, R., Jerman, L. (2019), Unpacking carbon accounting numbers: A study of the commensurability and comparability of corporate greenhouse gas emission disclosures. Journal of Cleaner Production, 211, 652-664.
Wijnants, L., Allacker, K., De Troyer, F. (2019), Life-cycle assessment of timber frame constructions-The case of rooftop extensions. Journal of Cleaner Production, 216, 333-345.
Wong, P.S., Holdsworth, S., Crameri, L., Lindsay, A. (2019), Does carbon accounting have an impact on decision-making in building design? International Journal of Construction Management, 19(2), 149-161.
Zhang, Y., Li, J., Liu, G. (2016), Accounting for Urban carbon dioxide: A review. Journal of Environmental Accounting and Management, 4(3), 339-351.
Zheng, Y., Yu, H., Zhang, Y. (2022), A bibliometric review on carbon accounting in social science during 1997–2020. Environmental Science and Pollution Research, 29(7), 9393-9407.