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Climate change accounting and disclosure: A systematic literature review

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ABSTRACT

This study aims to explore the conceptual structure and evolution of accounting literature related to climate change accounting and disclosure. This study uses a systematic literature review (SLR) assisted by Bibliometric and NVivo tools to answer research questions through five stages and fulfill the requirements set out in the SLR. From the selection results, the sample used is 49 articles for the period of 2009 - 2022 obtained from the Scopus database. Climate change accounting is largely disclosed with a focus on reducing carbon emissions. Meanwhile, other areas such as financial impacts that are in line with IFRS directives are still rarely disclosed and researched. Theoretically, companies adapt and disclose climate change accounting because of internal and external incentives. Disclosure also reveals information regarding the company's adaptive capacity to climate change risks. The results of this study indicte that the climate change accounting disclosure have not been standardized. Therefore, it is recommended that the government or related agencies consider standardizing the disclosure of adaptive actions related to climate change.

ABSTRAK

Penelitian ini bertujuan untuk mengeksplorasi struktur konseptual dan evolusi literatur akuntansi yang terkait dengan akuntansi dan pengungkapan perubahan iklim. Penelitian ini menggunakan tinjauan literatur sistematis (SLR) yang dibantu oleh alat Bibliometrik dan NVivo untuk menjawab pertanyaan penelitian ulang melalui lima tahap dan memenuhi persyaratan yang ditetapkan dalam SLR. Dari hasil seleksi, kami menggunakan dan menganalisis 49 artikel dari tahun 2009 hingga 2022 dari database Scopus. Akuntansi perubahan iklim sebagian besar diungkapkan dengan fokus pada pengurangan emisi karbon, sedangkan area lain seperti dampak keuangan yang sejalan dengan arahan IFRS masih jarang diungkapkan dan diteliti. Secara teoritis, perusahaan melakukan adaptasi dan pengungkapan karena adanya insentif internal dan eksternal. Pengungkapan juga mengungkapkan informasi mengenai kapasitas adaptasi perusahaan terhadap risiko perubahan iklim, namun hasil ini menunjukkan bahwa pengungkapan akuntansi perubahan iklim belum terstandarisasi. Dari hasil penelitian ini, direkomendasikan kepada pemerintah atau pembuat standar untuk mempertimbangkan standarisasi pengungkapan-pengungkapan tindakan adaptif terhadap perubahan iklim.

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1. INTRODUCTION

The issue of global warming has become a concern throughout the world. Industrial activity and the accumulation of greenhouse gases have increased drastically. Ferrell et al. (2011) showed that for the first time in thousands of years, ships were able to pass through the previously ice-covered North Pole. The impact of global warming can also be seen from climate change which greatly influences the weather. Climate change makes countries in the Northern Hemisphere more vulnerable to floods and countries in the Southern Hemisphere more vulnerable to drought. Scientists worry that as the polar ice caps melt, rising sea levels will flood many coastal areas and submerge low-lying island nations. Climate change has had real impacts throughout the world, such as increasing earth temperatures, changing rainfall patterns, and rising sea levels. These changes can increase the risk of heat waves, floods, droughts and fires which in turn affect people's economic and social activities.

Climate change is a serious threat. Action needs to be taken as early as possible to minimize its negative impact. Companies can minimize this negative impact through economic and social activities and technology. From an economic perspective, companies can start using environmentally friendly raw materials. From a social perspective, companies should carry out reforestation by replanting plants in deforested forests and reducing deforestation in land use. Meanwhile, from a technological perspective, many companies can start switching to solar energy and reduce the use of fossil fuels. Any adaptations made at the earliest stages will result in reduced costs (Ou-Yang et al., 2013).

Climate change adaptation provides insightful information for shareholders and stakeholders. In this way, shareholders can predict a company's ability to survive in the long term amidst the issue of climate change, whether the company can continue to operate by producing products or services of optimal quality or even go bankrupt in the future because it is unable to adapt to climate change. Stakeholders can also find out the effect of climate change adaptation on the company's adaptation costs and the welfare of its shareholders. For stakeholders, the way companies adapt to climate change reflects social and environmental responsibility for their business activities which also contribute to carbon emissions. Companies need to consider strategies so that they can continue to operate economically, improve the welfare of shareholders, and maintain a balance between social and environmental aspects (Adger et al., 2003; Auerswald et al., 2018; Bosello et al., 2013; Galbreath et al., 2020; Gao et al., 2022; Ou-Yang et al., 2013; Rickards et al., 2014; Xu & Hyman, 2022).

Companies need to provide information to support climate change cost-benefit analysis, identify risks, vulnerabilities and liabilities, and design adaptation plans, adaptation performance forms and benchmarking metrics. The impact of climate change encourages the need to disclose and report any vulnerabilities to the impacts of climate change and how companies have adaptive capacity to the impacts of climate change. Climate change accounting analyses the effects of climate change and adaptation measures to changes. Bergmann et al., (2016) have built the natural resource dependence theory to investigate comprehensively how an extreme weather affects financial performance. The empirical analysis result reveals that extreme weather, which is part of climate change, has some effects on financial performance in general, and that such an event may result in decreased sales in certain cases. In addition to decreased sales, a considerable loss can also be experienced by companies. This has something to do with extreme weather, where storage might have not been conditioned to match the climate change and employees grow less productive. Furthermore, depreciation may increase if the climate changes or maintenance costs increase to avoid an accelerated depreciation. In addition to the effect on profit and loss statements, changes in balance sheet may also occur, for example, when land loses its value, buildings will need additional investment to allow the production to continue, and on the other hand loan facility and insurance may change due to the increased risks resulting from extreme climate condition.

In August 2020, the International Financial Reporting Standards (IFRS) Foundation issued standards for corporate financial reporting regarding the impact of climate change. IFRS requires companies to consider climate change issues when they have a material impact on financial statements. Therefore, companies throughout the world should consider, adapt and disclose matters related to climate change in their financial reports.

The impact of climate change on financial statements and other related risks include 1) depreciation of asset values, including goodwill; 2) changes in the useful life of assets; 3) changes in the fair valuation of assets; 4) influence on the calculation of impairment due to increased costs or decreased demand; 5) unfavorable changes in contract terms due to increased costs or decreased demand; 6) changes in conditions and contingent liabilities due to fines and penalties; and 7) changes in expected credit losses on loans and other financial assets.

Previous studies have examined a lot about climate change accounting with various perspectives and approaches. However, the existing literature on the topic is still scattered in terms of theory, research methods, implications etc. Therefore, there is a need for a study to map the forms of adaptation and corporate incentives to climate change. In this research, the researchers conduct a systematic literature review of climate change accounting for the period of 2009-2022, focusing on the articles published in Scopus Database. This study aims to explore the conceptual structure and evolution of accounting literature related to climate change accounting and disclosure which includes:

a. Relevant theoretical aspect
b. Company's adaptation to climate change aspect
c. Climate change adaptation disclosure aspect
d. Research opportunity on climate change

Until a few decades ago, accounting was traditionally understood as financial accounting or management accounting, which essentially focused on documenting a company's economic and financial performances (Gulluscio et al., 2020). The evolution in the stakeholders' needs for information leads to the expanded amount and type of information needed for the company's disclosure. Information on adaptation to climate change also needs to be disclosed because the form of adaptation carried out will affect the company's financial performance. In addition, IFRS require companies to consider matters related to the impact of climate change when preparing their financial statements.

The opportunity for research on climate change is identified by exploring the disclosure items related to climate change risks and material effects on financial statements, such as building Climate Change Disclosure Index as a standardization of climate change disclosure. Furthermore, several implications from climate change, such as asset value, contingency obligation, cost of adaptation, and firm value, can be investigated as the impacts of climate change.

2. THEORITICAL FRAMEWORK

Climate Change Accounting

In accounting realm, the climate change issue is deemed to affect the information quality as reflected in companies' reports. Climate change can quickly affect the values of assets in the financial statements since these assets have the potential to be depreciated faster. Additionally, the regulations and policies issued in response to this climate change make companies think how they need to do the adaptation. This adaptation will surely affect the costs. Climate change accounting analyses the impacts of climate change and the steps that companies take to adapt to them. The impacts of climate change may affect the costs and income at varied levels (Bergmann et al., 2016).

Brown (2009) explains that climate change accounting consists of coverage on climate change reporting, stakeholders' reaction to climate change information disclosure, a new accounting system designed to include climate change performance, discussion on the role of accounting in promoting or weakening climate change, environmental audit, discussion on climate change condition in general, climate change accounting policy, coverage of climate change from product- and process-related information, data related to climate change finance, sustainability, environmental aesthetics, development of theories to explain or inform climate change accounting practices, and discussion on the method and methodological issues related to this research.

Risk management of climate change is an important aspect for companies. Based on legitimacy theory, there is a correlation where companies will coexist with the surrounding community, giving rise to a social contract between them, either directly or indirectly. Therefore, the company's survival will depend greatly on the impact of the company's targets in allocating its economic resources to the surrounding community to fill social gaps and the company's efforts to reduce environmental damage resulting from its operations.

Disclosure of Climate Change Impact and Adaptation

According to Brown (2009), a review of climate change reporting and disclosure of climate change information is very important to provide information to stakeholders regarding matters revealed in climate change accounting. Voluntary disclosure (due to the absence of regulations that regulate and require companies to make climate change disclosures) can provide material and relevant information about companies beyond what is stipulated in regulations.

Disclosure with more information will attract more investors. In addition, it can increase the share liquidity and decrease cost of capital and make financing easier (Albarrak et al., 2019; Botosan, 1997; He et al., 2013). This indicates that companies need a higher-quality and more systematic disclosure. Diamond & Verrecchia (1991) also argue that the better the financial report disclosure, the lower the information asymmetry and the cheaper the cost of capital. Disclosure of climate change risk management will enable shareholders and stakeholders to know the extent to which the company has mitigated and adapted to climate change, so that they can analyze the company's performance and survival.

3. RESEARCH METHOD

This study uses a systematic literature review (SLR) method assisted by Bibliometric and NVivo tools to answer research questions through five stages and fulfill the requirements set out in the SLR. The five stages include: 1) Finding topics for potential study; 2) Building consistent criteria and selecting topics based on their relevance or quality; 3) Sorting and digitizing articles; 4) Processing and analyzing data; 5) Drawing conclusions based on findings (Djamba & Neuman, 2002).

From the selection results, the sample used in this study is 49 articles for the period of 2009 - 2022 obtained from the Scopus database. The research sample criteria are

a. Existing in Scopus database
b. Being research focusing on climate change accounting, climate change disclosure, and adaptation cost of climate change
c. All articles from any year belonging to business, management, and accounting categories
d. All contents of the articles are accessible to the researchers
e. Published in the form of journal articles
f. Written in English

Following the steps taken by Anggraini & Sholihin (2021), in conducting literature review, the researchers set consistent criteria such as accessibility, universality, publication quality, and relevance. Accessibility refers to how easy it is to obtain the article document to be reviewed. To minimize the number of non-searchable or non-downloadable documents, this research is limited to the published journal articles. Universality means that the articles are written in an international language, English. For publication quality criteria, this research uses journal ranking as provided in Scimago website. The articles published in non-ranked journals are excluded. As for relevance criterion, any article that has no keywords in their titles and keywords is also excluded. Details regarding sampling can be seen in Figure 1 below.

4. DATA ANALYSIS AND DISCUSSION

Publication by Year

Figure 2 shows the chronological distribution of a sample of articles processed using the Bibliometrix tool. Bibliometrix is used to descriptively analyze the bibliographical data.

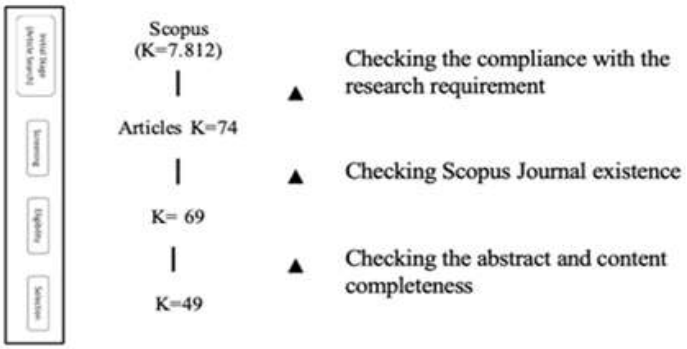

Figure 1
Flow of Article Selection (K = 49)

The publication timeline shows publication trends over 14 years (2009–2022), which indicates an increase in the number of articles published. From 2009 to 2022, the publication of articles on climate change accounting and disclosure, which specifically discuss adaptation costs, has increased by an average of 23.16%. A significant increase occurred in 2020. However, a sharp decline occurred in 2021. The number of studies increased again in 2022, indicating that this topic is an interesting issue to investigate.

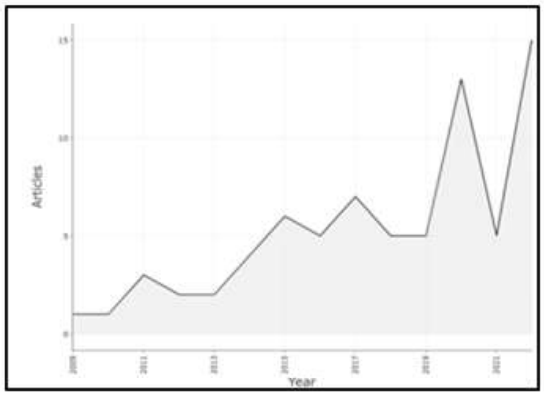

Figure 2
Number of studies on climate change accounting and disclosure: cost of adaptation published in Scopus database from 2009 to 2022

Source: Data Processed

Publication by Relevant Sources

Figure 3 shows the 10 most relevant journal sources (using bibliometrix terminology) where most of the analyzed articles were published. In this figure, articles regarding climate change accounting and disclosures related to adaptation costs are mostly published in the Journal of Business and Environmental Strategy, Accounting, Auditing and Accountability and the Journal of Cleaner Production. It is interesting to note that among all the relevant journals, some accounting journals discuss this issue of climate change from several perspectives such as adaptation, costs, and behavior in climate change.

Publication by Number of Citation

In Figure 3, the most published articles come from Business Strategy and the Environment Journal. However, based on the number of citations, not every most relevant source (Figure 3) matches the most cited source. Figure 4 shows that the most cited articles are accounting journals. This indicates that the impact of climate change has begun to be studied in terms of its effect on companies' financial statements and other financial aspects.

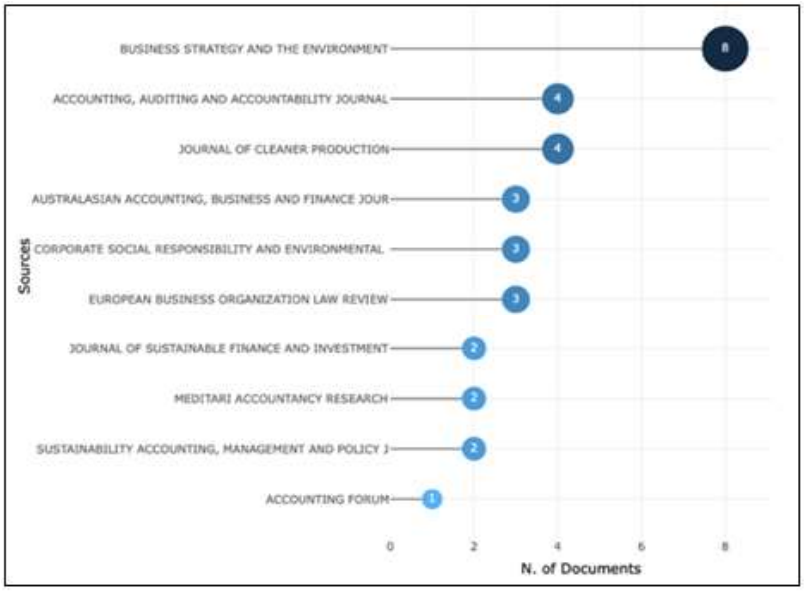

Figure 3
Most Relevant Sources

Source: Data Processed

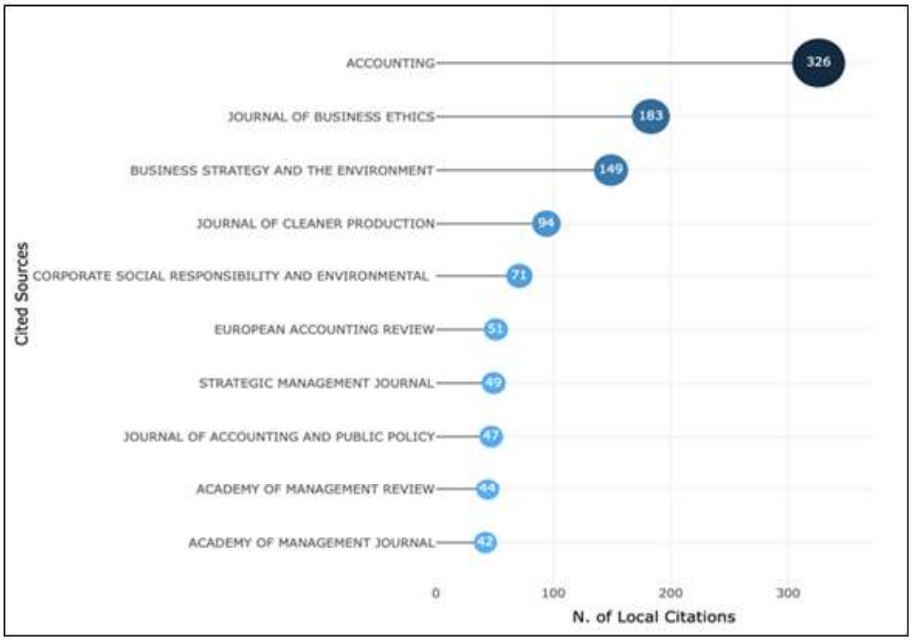

Figure 4
Most Local Cited Sources

Source: Data Processed

Table 1
Most Relevant Authors

Authors	Articles	Authors	Articles Fractionalized
Elnahass M	3	Haque S	1.50
Haque S	3	Ascui F	1.00
Salama A	3	Lovell H	1.00
Alsaifi K	2	Toffel Mw	1.00
Ascui F	2	Attenborough D	1.00
Bebbington	2	Bimha A	1.00
Cotter J	2	Caldecott B	1.00
De Silva Lokuwaduge Cs	2	Maaloul A	1.00
Figge F	2	Miglionico A	1.00
González-González JJm	2	Ngwakwe Cc	1.00
Ho M-T	2	Sehnem S	1.00
Liesen A	2	Yeadon-Lee A	1.00
Lovell H	2	Elnahass M	0.92
Mateo-Márquez Aj	2	Salama A	0.92
Nguyen	2	Cotter J	0.83
Patten Dm	2	De Silva Lokuwaduge Cs	0.83
Toffel Mw	2	Bebbington J	0.75
Zamora-Ramírez C	2	González-González Jm	0.67

Source: Data Processed

Publication by Most Relevant Authors

Table 1 shows the most relevant authors processed using bibliometrix. The authors are associated with articles and fractional articles (which are then obtained by assigning the publication number per author to the number of co-authors per publication). In terms of number of publications, the most active

author is Marwa Elnahass, who is affiliated to Newcastle University Business School, Newcastle University (United Kingdom), followed by Shamima Haque (Haque & Irvine, 2018) from School of Accountancy, Queensland University of Technology, Brisbane, (Australia) and Aly Salama from Newcastle University Business School, Northumbria University (United Kingdom). These three authors have published three articles in the samples in Scopus-indexed journals. Their latest articles were published in 2022 (Marwa Elnahass and Aly Salama) and 2018 (Shamima Haque). Considering the contribution of each author in writing articles (articles fractionalized), the ranking was led by Shamima Haque, the main author of the three articles published with two authors between 2010 and 2018.

In addition to the 3 (three) previously mentioned authors, 15 (fifteen) authors in the same sample published two articles on climate change accounting. Furthermore, the remaining authors only published one article on this topic. The low number of publications on climate change accounting per author is worth contemplating as the reason for this situation. It makes sense to assume that this is a field of study that has not developed well. Having analyzed the scientific background and affiliation of the 18 (eighteen) most productive authors, the researchers found that nearly half of them are accounting academicians who regularly conducted research on climate change within accounting context.

Publication by Country

Out of 49 (forty-nine) articles serving as the sample of this study, the bibliometrix analysis shows that United Kingdom is placed first in producing research on climate change accounting and disclosure: cost of adaptation, followed by Australia, the United States, Germany, and the Netherlands. This means that research on climate change accounting is highly dominated by European countries. This finding is consistent with the research conducted by Gulluscio et al., (2020).

Publication by Journal Ranking

Climate change accounting and disclosure: cost of adaptation is the most studied issue. This indicates that climate change adaptation and disclosure is a form of response from the researchers to the impact resulting from it and an attempt to contribute to the policy making, business practices, and behavior. Table 2 presents a summary of studies by the journal and publication ranking. Journal with the most sample sources (N = 49)

Table 2 presents the journals that published articles on sustainable behavior and climate change literature from 2009 to 2022. As many as 37 articles or 75.51% of the total number are those articles published in high-quality journals, indexed as Q1 by Scimago (SJR). Meanwhile, 8 (eight) articles or 16.33% are Scopus-indexed Q2 articles and sharing the same number, i.e., 2 (two) articles or 4.08%, are those articles published by middle-quality journals indexed as Q3 and Q4.

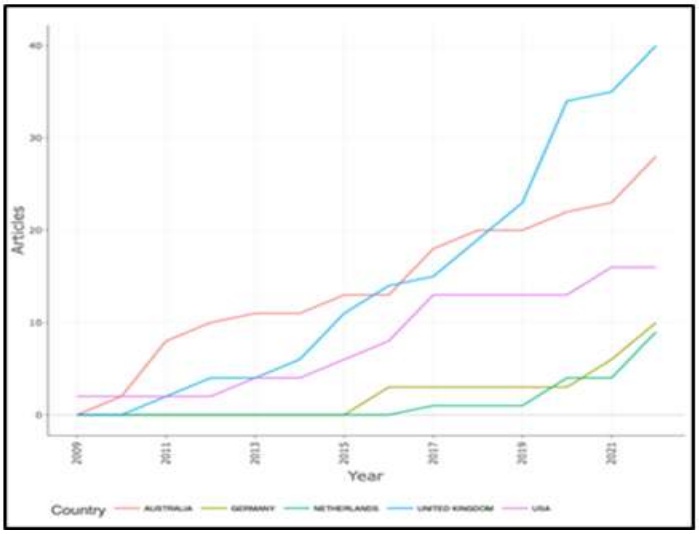

Figure 5
Number of Studies by the Most Productive Countries
Source: Data Processed

Table 2
Number of Studies Published on Climate Change Accounting and Disclosure: Cost of Adaptation by Journal Ranking (total N = 49)

Sources	Publication Ranking	Articles	%
Business Strategy and the Environment	Q1	8	16.33%
Accounting, Auditing and Accountability Journal	Q1	5	10.20%
Journal of Cleaner Production	Q1	4	10.20%
European Business Organization Law Review	Q1	4	8.16%
Journal of Sustainable Finance and Investment	Q1	2	4.08%
Sustainability Accounting, Management and Policy Journal	Q1	2	4.08%
British Accounting Review	Q1	1	2.04%
Business Horizons	Q1	1	2.04%
Critical Perspectives on Accounting	Q1	1	2.04%
Current Issues in Tourism	Q1	1	2.04%
Eurasian Business Review	Q1	1	2.04%
Journal of Business Research	Q1	1	2.04%
Journal of Business Ethics	Q1	1	2.04%
Journal of Real Estate Finance and Economics	Q1	1	2.04%
Review of Managerial Science	Q1	1	2.04%
Science And Engineering Ethics	Q1	1	2.04%
Social Responsibility Journal	Q1	1	2.04%
Technological Forecasting and Social Change	Q1	1	2.04%
Total Q1		37	
Australasian Accounting, Business and Finance Journal	Q2	2	4.08%
Accounting, Economics and Law: A Convivium	Q2	1	2.04%
Cogent Business and Management	Q2	1	2.04%
Engineering Economics	Q2	1	2.04%
European Journal of Management and Business Economics	Q2	1	2.04%
South African Journal of Economic and Management Sciences	Q2	1	2.04%
Uncertain Supply Chain Management	Q2	1	2.04%
Total Q2		8	
Banks and Bank Systems	Q3	1	2.04%
China Journal of Accounting Studies	Q3	1	2.04%
Total Q3		2	
International Journal of Professional Business Review	Q4	1	2.04%
Journal of Governance and Regulation	Q4	1	2.04%
Total Q4		2	
Total Number of Articles		49	100%

Source: Data Processed

Relevant Theories

Some theories are frequently used in research on climate change adaptation and its disclosure. Figure 6 shows the theories most frequently used in the studies on climate change in this research. Stakeholders Theory (Alsaifi et al., 2020, 2022; Bui et al., 2020, 2022; Chand et al., 2022; Nathalia & Setiawan, 2022) and Agency Theory (Alsaifi et al., 2020, 2022; Attenborough, 2022b; Hansen et al., 2022; Kordsachia et al., 2022) is ranked the top two of the most frequently used theories. This shows that the company management's actions in response to climate change issue is driven by 2 (two)

matters, namely the company's obligation to be responsible for providing values for its stakeholders, including minimizing the negative effects of its operations and agency theory as an incentive, the company performs preventive measure of rapid climate change due to their wish to increase the company's value and the manager's opportunistic measure to improve the company's performance. This result is consistent with the result of analysis conducted by Lakhani & Herbert's (2022) that both theories are among the most frequently used ones in disclosure and sustainable performance topics. Other than these two theories, previous studies view disclosure from the signaling aspect, usefulness of voluntary disclosure on decision-making and disclosure as a form of a company's accountability.

Analysis of Climate Change Accounting and Disclosure

Climate change accounting analyses the effects of climate change and the actions to adapt to climate change (Bergmann et al., 2016). The analysis of climate change measure refers to the IFRS standards that require companies to consider issues related to climate change when the effect is material on financial statements, such as: 1) Depreciated asset value, including goodwill; 2) Changes in asset useful life; 3) Changes in asset fair valuation; 4) Effect on impairment calculation as a result of the increased cost or the decreased demand; 5) Unfavourable changes in provisions for contract due to the increased cost or the decreased demand; 6) Changes in contingency terms and obligations resulting from fine and penalty; and 7) Changes in expected credit losses for loans and other financial assets.

Depreciated Asset Value, Including Goodwill

In line with the phenomenon revealed by IFRS regarding the effects of climate change on company's asset condition and valuation, Scholten et al., (2020) suggest that the valuation of production assets focusing on drilling rigs, windmill platform, heavy equipment and means of transportation used to support the production, and pipes and wires to transport the energy unit produced in their research, it is found that the change potential in the future (caused by climate change) regarding production asset valuation is not (yet) considered in companies' balance sheet. Climate change will possibly affect the future value of production assets used.

Moreover, the current financial reporting does not support renewable energy companies to provide meaningful and quantitative insight into the expected improvement of their future cash flow and financial potential and innovations. This hinders capitalists and investors from accurately and meaningfully valuate the business of renewable energy compared to that of the non-renewable energy companies. This result indicates that companies have not taken adaptation measure in relation to asset depreciation resulting from climate change, thus making the asset value less relevant.

Changes in Asset Useful Life

Depreciation may increase if the climate condition changes or the maintenance cost increases to avoid depreciation at a faster rate. In addition to the impact on profit and loss statement, changes in the balance sheet might occur such as land might lose its value, building might need additional investment to allow the production to continue (Bergmann et al., 2016). Scholten et al. (2020) add that innovation to production assets can increase the economic life and/or make them produce greater energy. Literature from Fujita (2022) on page KPMG, suggests that an asset useful life will be affected by the decisions made by companies as their response to climate-related issues. For example, the management might decide to change the strategy by revising the company's asset useful life as part of their asset management policy. The decreased useful life of an asset can also show that its recorded value decreases. Yet, in the research articles studied herein, no company has disclosed the revised useful life decrease resulting from climate change. This provides an interesting finding that the decrease in asset value as a result of extreme weather affects the relevance of information in financial statements.

Changes in Asset Fair Valuation

Increased costs can be from faster asset damage, resulting in maintenance cost for the asset. This asset maintenance leads to decreasing asset value. This can also occur due to the decreased demand, making the use of production assets less frequent, and thus, within a certain period of time, the asset function will decrease. Scholten et al. (2020) reveal that fixed assets that have depreciated will be submitted for valuation each year to determine whether the recovered amount is higher or lower than the

currently recorded value. In this case, the loss of value decrease is recovered (partly) and the asset's recorded amount increases.

Climate change as stated earlier can make assets more sensitive to extreme weather. This leads to the need for these assets to be valuated based on their fair value to give a more relevant asset value disclosure. Asset damage resulting from climate change can be minimized by utilizing technology for risk management of climate change (Caldecott, 2022; Miglionico, 2022). New technologies can be used to remove climate risk management process vulnerability, which needs data standardization to improve managerial decision-making and desired results. Technology is used to improve the evaluation of climate change effect on company exposure, and to promote transparency in reporting regulation for financial institutions. Technology application such as automatic language system offers an opportunity to synchronize companies' disclosure with the climate change policy targets, which in turn can improve the sustainability of companies' activity performance.

Meanwhile, such aspects as effect on impairment calculation as a result of the increased cost or the decreased demand, unfavourable changes in provisions for contract due to the increased cost or the decreased demand, changes in contingency terms and obligations resulting from fine and penalty, and changes in expected credit losses for loans and other financial assets have not been captured from the articles analysed in this literature review. This means that it is a future research opportunity to explore further how climate change affect contract value, contingency obligation, and credit value change. It is interesting to give contribution to banking policy and other financial institutions in relation to climate change adaptation. Scott (2019) suggest the role of accounting in providing a "level playing field" through full disclosure of useful and cost-effective information to investors and other users of financial statements, one of which is through climate change accounting disclosure.

The increasing number of research on climate change from one year to another shows that attempts to prevent the negative effects of climate change have been a concern of researchers in the world. This research result indicates that the financial impact of climate change adaptation has neither been optimally implemented by companies not investigated by researchers. So far, studies focus more on the mitigation measures of climate change risks in general, yet aspects related to costs have not been studied much.

Some companies have made adaptation measures, ranging from policy and regulation implementation to shift to more eco-friendly business process as their form of adaptation. For example, the private sector in South Africa has adopted "take position, wait and see approach" due to the main obstacle for voluntary climate change action in the form of the uncertain local and international policy framework. However, despite this uncertainty, the private sector keeps on going by taking voluntary actions, companies continue to improve their public sustainability reporting and disclosure quality. The challenge still lies in translating this strategy into daily sustainable operations and practices which exceed ad hoc mitigation measures (de Jongh & Möllmann, 2014). Huiskamp et al. (2022) suggest that the to lessen the complicatedness and urge companies to begin climate scenario analysis, companies develop a climate resilience cycle by improving their resilience (stability domain) and transforming a business model or chain of value towards climate change (change domain).

France is the first country to enforce the legal requirement for climate reporting to be translated into many other laws. As a result, more and more investors and banks ask companies to disclose more information on climate change risks to allow them to consider financially (Caby et al., 2020). The main finding in that research suggests that bank's strategies and economic and financial pattern of the country where the bank operates have a great impact on the level and quality of disclosure related to climate change in banking industry. The implication seems clear in the context of increased concern for financial industry in general and the activities they fund.

Another study suggests that the regulations related to climate change can reduce the possibility of organizations to get involved in green washing, i.e., "Deviation of two company behaviours: poor environmental performance and positive communication on environmental performance" (Mateo-Márquez et al., 2022). Kordsachia et al. (2022) add that sustainable institutional ownership increases company's environmental performance and willingness to respond to carbon disclosure project. This result shows higher carbon

risk awareness in companies with greater sustainable investor ownership. This indicates that the regulations will drive companies to improve their environmental performance. However, this is different from Attenborough's (2022a) finding who suggest that disclosure-related regulations fail to secure companies' behavioral changes since investors and other market actors, in certain sense, cannot easily evaluate the significance of probability of 'insurance steps' adopted by companies. Thus, the insurance advantages become artificial and underestimated in market.

In the United States, the response suggested to policymakers to decelerate the effects of climate change is to implement climate change adaptation technologies (CCAT) (Hötte & Jee, 2022). In addition to mitigating the effects of climate change, technology synergy will also be useful to adapt to climate change. In Australia, Broadbent et al. (2022) suggest that the efforts to decelerate climate change extremely is done by reducing emission, i.e., utilizing battery electric vehicles (BEV). Carbon emission reduction is important to minimize the negative effects of climate change (Dong et al., 2019; Sjörs et al., 2016; Talaei et al., 2020).

Disclosure of Climate Change

Some studies have tested the usefulness of voluntary disclosure of climate change adaptation in terms of the level of carbon emission use. Such disclosure is considered an important aspect of a company in providing additional information to reduce information asymmetry based on which its performance is appraised in the future. Although research results show that companies tend to report indicators that are required in their governance regulations, such as greenhouse gas emissions, occupational health and safety, so far voluntary reporting has not been popular even though such reporting is able to make companies more reputable as stated in legitimacy theory (de Silva Lokuwaduge & de Silva, 2020).

The role of corporate governance is also equally important in influencing the level of a company's willingness to disclose climate change (Grove et al., 2021; Johl et al., 2011; Nathalia & Setiawan, 2022). The higher the network, education and experience of a company's board of directors, the greater the increase in climate change disclosure (Nathalia & Setiawan, 2022). The board of directors has an important role in disclosing information regarding climate change. Therefore, it is very important for companies to pay attention to the quality of their board of directors. A board of directors with a broad network, higher education and good experience will increase the company's climate change disclosure. In addition, the diversity and transparency of the board of directors in governance and a gender diversity approach in a company can better meet stakeholder demands and legitimize its environmental performance (Liesen et al., 2015; Ben-Amar et al., 2017; Charumathi & Rahman, 2019; Tingbani et al., 2020). This result is supported by board capital theory which states that the presence of women on the board can increase the extent of board capital in various dimensions. In addition, in view of critical mass theory, a board consisting of three or more female directors is more likely to influence the decision-making process resulting in better environmental disclosure (Ben-Amar et al., 2017; Charumathi & Rahman, 2019; Hossain et al., 2017).

The disclosure of climate change risks is also tightly associated to companies' risk factors. Alsaifi et al., (2020, 2022) state that voluntary carbon emission disclosure will reduce companies' systematic risks, idiosyncratic risks, and companies' total risks, particularly for industries with high carbon emission use. Another research reveals that carbon information in the calculation of carbon emission has the highest disclosure, while climate change risks and opportunities have the lowest disclosure (Darus et al., 2020). Nevertheless, climate governance is associated with alignment between carbon disclosure and carbon performance (Bui et al., 2020, 2022). Climate governance also reduces over-recognition of good performance through extensive disclosure, while low-pollution communities reveal more to differentiate themselves. This means that climate governance reflects the company's commitment to addressing sustainability issues and transparent reporting. This is in accordance with signaling theory which states that companies with strong carbon performance tend to be driven by the desire to highlight their good performance to stakeholders so as to report climate change issues more extensively.

In line with Albarrak et al., (2019), disclosing information on carbon will lower cost of equity (COE) since such disclosure can improve investors' acknowledgment among many future investors and environmental

organizations, reduce information asymmetry between market actors, and enable investors to evaluate the potential companies' risks and obtain information on the companies at a lower acquisition cost, which in turn reduce COE and COC (Albarrak et al., 2019; He et al., 2013). Companies disclose their emission as a response to financial incentives, social pressure and/or regulatory pressure (Blanco et al., 2017; Tang & Demeritt, 2018). Ultimately, the underlying rationale determines what and how carbon reporting impacts internal business processes and performance. This shows that the company has an internal drive to improve its environmental performance, social responsibility and disclosure.

Hansen et al. (2022) reveal that if companies in food and beverage industry seriously wish to mitigate their impacts on climate change, they must be able to manage their greenhouse gas (GHG) emission well and improve its reporting. The research explains the importance of voluntary disclosure in climate change adaptation to minimize risks. Chand et al. (2022) add that larger companies have greater involvement in social aspect, hence they tend to be more willing to disclose their impacts on the community and environment. A previous study suggests that companies with short-term loan and joining in energy and material sectors have the highest carbon risk than other sectors. On the contrary, companies in health and financial sectors have the lowest carbon risk (Bimha, 2015).

From several aspects of climate change risk-related disclosure from previous studies, it can be said that not all forms of adaptation to and mitigation of climate change risks have been disclosed by companies, particularly in relation to disclosure of cost of adaptation as an impact of adaptation measures. This research finds that the greatest disclosure is in non-financial aspects such as carbon emission reduction attempt, use of renewable energy in some industrial activities, use of eco-friendly electric energy and a shift of technology. However, information regarding the amount of funds for this adaptation has not been revealed by companies. Even in the latest research in 2022, there has been no standardization of company disclosures and reports regarding several aspects of the impact of climate change and its management. Cotter et al. (2011) stated that no standardization of climate change disclosure has been made, while existing climate change reporting tends to be less technically detailed and more likely to focus on positive aspects of the impact and management of climate change.

Therefore, the opportunity to conduct research on standardizing disclosure and reporting related to climate change is still wide open. In addition, IFRS has highlighted the requirements contained in its standards that require companies to consider issues related to the impact of climate change when preparing financial statements, especially when they have a material impact on the financial statements.

5. CONCLUSION, IMPLICATION, SUGGESTION AND LIMITATION

This study aims to explore the conceptual structure and evolution of accounting literature related to climate change accounting and disclosure which includes: (1) relevant theoretical aspect; (2) company's adaptation to climate change aspect; (3) climate change adaptation disclosure aspect; (4) research opportunity on climate change.

The results of this research show that the forms of adaptation carried out by companies are getting better from year to year, starting from enforcing regulations and policies to implementing carbon disclosure projects to changing technology to manage the risks of climate change. From the disclosure aspect, it can be concluded that the disclosures made by the company are still not standardized and tend to only provide positive information for the company. The disclosure is mostly done by focusing on carbon emission reduction only. Meanwhile, other areas such as financial impact and disclosure related to adaptation cost are rarely disclosed. Thus, it can also be developed to be future research to provide recommendations for companies to extend their disclosure.

Theoretically, this research concludes that companies adapt and disclose climate change accounting because of internal and external incentives. Internally, disclosure is part of their strategy and opportunity to maximize their managerial performance. After adapting to climate change, they gain effectiveness and efficiency in the use of costs which has an impact on improving their performance. In terms of openness, this will reduce the cost of capital because investors' confidence in the company's survival and anticipatory steps increases. In addition, climate change accounting analysis is also driven by social responsibility. The company's obligation to be responsible for

providing value to its stakeholders, including minimizing the negative impacts of its operations, will prepare companies to make more climate change disclosures.

Despite the systematic and tight article selection, this research still has some limitations. It is limited to literature review for articles published in journals in Scopus database. The coverage is further limited to journal articles whose titles, abstracts, or keywords contain the terms climate change accounting, climate change disclosure, and adaptation cost of climate change with a focus on accounting, business, and management journals. This systematic review only presents insights into the topics with a focus on accounting, business, and management journal category. Extending the research by incorporating other relevant fields is recommended to make the findings more extensive.

The opportunity for research on climate change comes from exploring items of disclosure that is related to climate change risks and has material effects on financial statements, such as building climate change disclosure index as a standardization of climate change disclosure. In addition, several implications of climate change such as asset value, contingency obligation, cost of adaptation, and firm value can be investigated as an impact of climate change.

This research has several important implications for companies. First, companies can proactively integrate their climate change mitigation initiatives into their business strategy and apply high-quality business strategy through an adaptation to climate change and its disclosure mechanism. Second, with increased transparency and reduced information asymmetry, this voluntary disclosure provides a positive message to stakeholders regarding the company's proactive steps in dealing with climate change. Not only to comply with regulations issued by the government, this adaptation is also expected to become a company's awareness of minimizing the negative impacts of climate change.

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