Carbon Disclosure: A Systematic Literature Review and Bibliometric Analysis using Biblioshiny

Sakshi Raghuvanshi[1*], Prof. Ram Milan[2]

[1*]Research Scholar, Department of Commerce, University of Lucknow, Lucknow, U.P.
Email: raghuvanshis824@gmail.com
[2]Head, Department of Commerce, University of Lucknow, Lucknow, U.P.
Email: milanlko@rediffmail.com

Abstract
Carbon Disclosure has emerged as a pivotal topic in the sustainability researches. It has forced the involved stakeholders to have conversations and take it into consideration while making decisions about the organizations. This study employs bibliometric analysis using biblioshiny to gain insights about this practice and also its impact on the organizations. Using PRISMA technique, the scholarly resources have been properly screened and assessed which has led to nearly 400 articles left in the end for proper analysis. Through the analysis, various dimensions like clustering, co-occurrence network, Bradford Law, Lotka Law, etc. The results so obtained after the analysis clearly directs toward the fact that carbon disclosure by companies is not a façade but a means toward sustainability. The results so obtained also highlights key research trends, collaborations, and emerging topics in carbon disclosure practices, providing opportunities to academicians and researchers to explore and reach new heights in environmental research.

Keywords: Carbon Disclosure, Carbon Disclosure Project, Carbon Information Disclosure, Corporate Carbon Performance, Voluntary Carbon Disclosure

Introduction
With the advent of several climate change related issues various countries of the world has adopted frameworks so as to combat those changes. These frameworks exist in the form of several regulations and policies. As a result of the implementation of these changes, businesses, especially those in carbon- intensive industries, face increased pressure from the public (Liesen, Hoepner, Patten, & Figge, 2015) and are giving more attention to issues related to their carbon emissions (Griffin, Lont, & Sun, 2017; Huang, Kerstein, & Wang, 2017; Matsumura, Prakash, & Vera-Munoz, 2014). Companies can benefit in many ways from the recording and subsequent disclosure of their GHG emissions (Hahn, Reimsbach, & Schiemann, 2015). In a meta-analysis, Albertini (2013) confirmed a positive relationship between environmental disclosure and corporate financial performance. Proactive climate-related measures and carbon disclosures, as well as the development of climate-friendly products, can improve a company's image (Sullivan & Gouldson, 2012) as cited in an article titled, "Organizations, climate change, and transparency: Reviewing the literature on carbon disclosure."
Ooi and Amran (2018) suggested that, in Malaysia, the majority of companies revealed minimal climate-change-related information, and nearly all of them disclosed less than half of the measurement indicators. This is similar to the reporting practices in other markets, such as Europe (2009), Australia (2020), and Canada (2018). The non-disclosing behavior of companies might be attributed to several factors, such as limited knowledge and awareness among firm executives and directors regarding environmental disclosure, a scarcity of resources, a lack of legal regulations, underperformance, apprehension about negative publicity, a lack of monitoring and instruction from advisors/consultants, and a lack of clear guidance, which may lead to many companies choosing not to publicly disclose

their political accounting decisions in full or to only disclose a few of their accounting treatments (Dilling, P.F.A. & Sobhan, N.; Hassan, A.; Fletcher, M., 2018).

But with time, things have changed in this regard, now more and more companies are disclosing their Co2 emissions through various sustainability reports. Like, in India companies are supposed to disclose their emissions using Business Responsibility and Sustainability Reports. Under these reports, companies must disclose their Scope 1 (direct emissions) and Scope 2 (indirect emissions from purchased electricity) greenhouse gas emissions. This information is essential for understanding a company's carbon footprint and forms a baseline for measuring and managing emissions over time. And this has led to numerous researches under themes like carbon accounting, ESG accounting, sustainable finance, etc. But no research has been systematically conducted to explore the academic research landscape on these practices. This study aims to fulfil that informational gap.

Aligning with the research gap found, the key objective of this study has been identified which connects carbon disclosure with terms like ESG and sustainability. Keeping in mind this information, some research questions has been developed which are enumerated below:

RQ1: What are the relationships between certain fields like authors, keywords or journals? What are the average citations per year?

RQ2: What are the most relevant and local cited resources when it comes to research on carbon disclosures? What are the core journals?

RQ3: Who are the most relevant authors and affiliations?

RQ4: Which are the most global cited documents and local cited references?

RQ5: What are the current publication trends in carbon disclosures?

RQ6: What are the identifiable similarities between documents?

RQ7: What is the conceptual structure so found using network and factorial approach?

RQ8: What are the intellectual and social structure of current research?

The reasons why this research paper is behind answering these questions have been pretty much explained in Appendix B.

The current study used data from 1372 articles which were carefully screened using the PRISMA technique, to answer the above enumerated research questions and conducted an in-depth review utilizing scientometric analysis through R. As a result, this article serves a one-stop destination for a comprehensive overview and mapping of carbon disclosure.

The review is organized as follows:

Section 1 presents the introduction, and Section 2 presents the methodology that includes data sources and data collection methods. It also includes the key strings, information about the software and the techniques used in the study. Section 3 covers the results along with its interpretation. The results have been divided into several categories like overview, sources, conceptual structure, intellectual structure, etc. And finally, Section 4 highlights the conclusion and the findings associated with it. It also focuses on the limitations of this research.

The contribution of this study is that it does not only performs bibliometric analysis on this particular topic but also explores various intellectual dimensions that hasn't been explored vividly before.

Data Sources and Analysis Method
Data Sources and Time Frame
Following the methodology of various research articles, the Web of Science database was selected along with several sustainability reports. The reports will be discussed later. The Web of Science database yielded 1372 results as on 17th of February, 2025 when the required keywords were entered. These papers along with the reports found were later screened and sorted using the PRISMA flow diagram explained below:
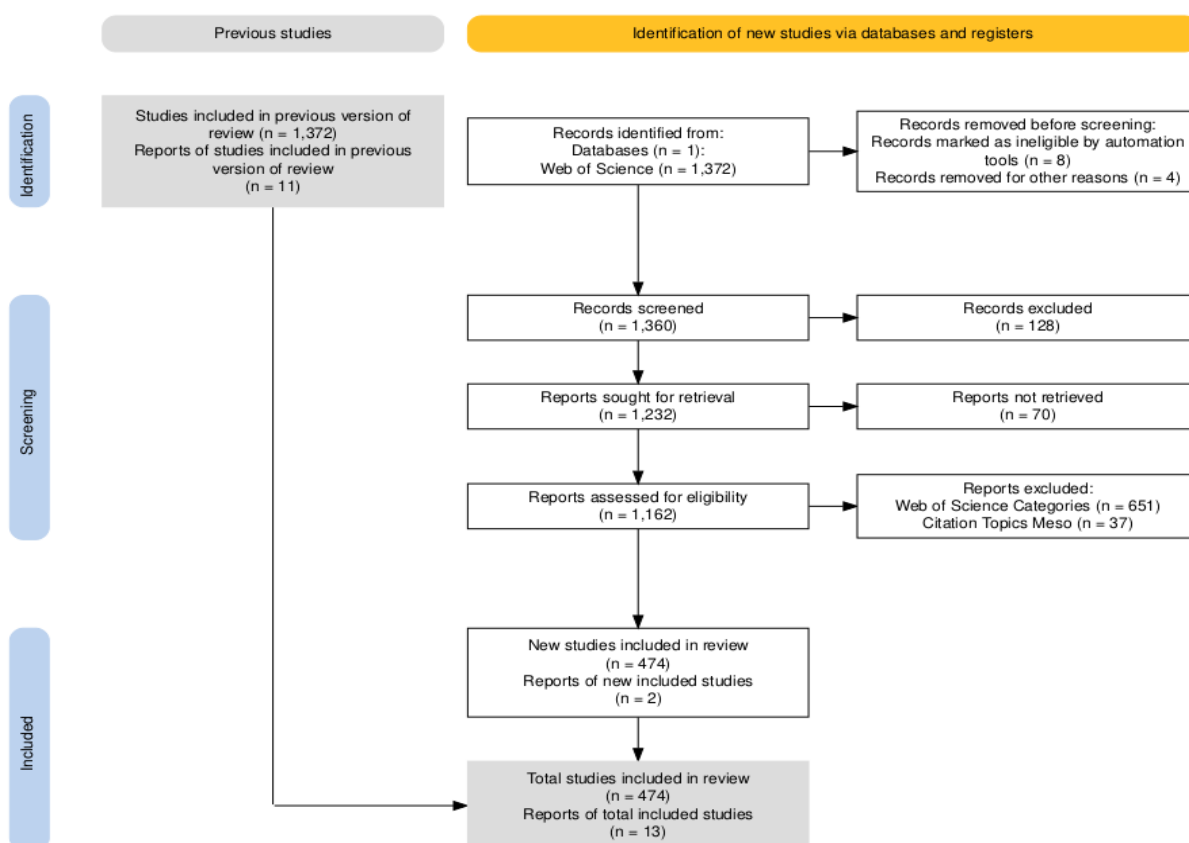
Source: Authors' Computation

Rather than going for a random selection of articles, the PRISMA (Preferred Reporting Items for Systematic Reviews) flow chart was used which took data from a single database which was the Web of Science. The rationale behind choosing this database was the fact that it is one of the oldest databases, produced in 1997, that covers articles, reviews and periodicals from all across the world.

The articles so collected from the Web of Science and the reports passed through three phases which were identification, screening and inclusion. After passing through these phases, 474 research articles and 13 reports were taken into consideration.

The research articles included articles, review articles, editorial materials, open access articles from the set time-frame that was from 2015 to 2025 inclusive of both 2015 and 2025. The reason why these years were taken into consideration are to ensure that the data is updated or consistent with changing scenario. The reports were accessed from various companies' websites and also from working papers made available in the archives of the sites of international reporting programs and initiatives like the Carbon Disclosure Project (CDP), the Global Reporting Initiative (GRI), the Task Force on Climate Related Financial Disclosures (TCFD), Climate Disclosures Standard Board (CDSB) Framework, etc.

Method of Analysis

For analysis of data extracted from the Web of Science we used the R Studio File Version 2024.12.0.0, developed by Posit Software, PBC for analysis and visualization of the data.

Visualization was based on different kinds of nodes which have been illustrated in the following manner:

The Overview category consists of the main information about the extracted data as well as the annual scientific production and citations per year. It also consists of a three-field plot. The Sources' category consists of the most relevant as well as the most local cited sources. It also consists of sources' local impact and production over time. The Authors' category is divided into three parts i.e. the authors,

affiliations and countries. The next category is Documents which have been bifurcated into three categories documents, cited references and words.

The subsequent category is clustering by coupling followed by various types of structures i.e. conceptual, intellectual and social which forms an essential part of this analysis.

Methodological Framework

After the selection of a suitable methodology for the purpose of analysis, the present study has been conducted using a suitable selection criterion so as to narrow the number of documents. These documents were processed through different stages as mentioned before. For the purpose of identification, screening and inclusion, several categories were utilized that are mentioned in the PRISMA Diagram.

After passing these three stages, the data was meticulously reviewed and the data was analyzed using R Biblioshiny Application.

Analysis of Findings
Overview

According to the software, the analysis has been conducted using the data from 2015 to 2025. There were 124 sources i.e. the books and journals found. In those unique sources, 474 documents were identified and included in the dataset. It has been observed that there has been a negative growth in the number of publications over the years. The number of authors identified during the said duration were 1233. Out of all the documents gathered, 27 documents were written by a single author. Nearly, 207 documents involved international collaborations. 1458 unique keywords were identified and 22,532 references were cited. The average age of the documents were 3.2 years and document was cited 35.75 times. This was the main information gathered in the analysis.

The following paragraphs answer **Research Question (RQ) 1**.

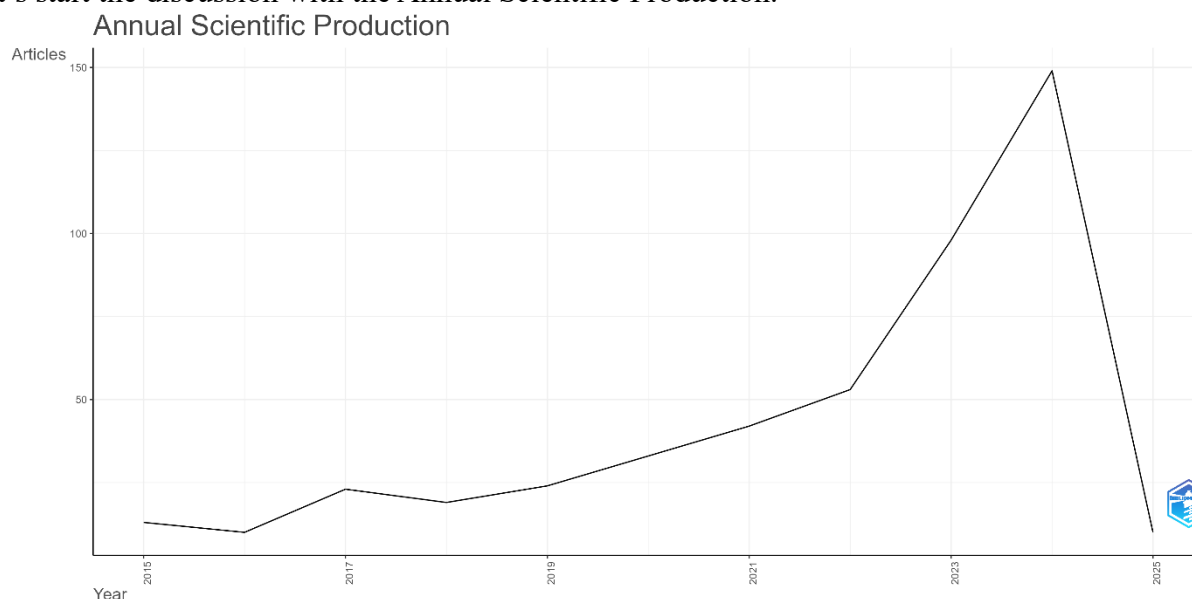Let's start the discussion with the Annual Scientific Production.

Figure 1: Annual Scientific Production
Source: *Author's Computation using R*

Figure 1 shows the graphical representation of the annual scientific production related to carbon disclosure over the years. If we carefully interpret this diagram, the following observation can be made: From the year 2015 to 2025, there has been a consistent increase in the articles produced. The

increase has nearly doubled from 24 articles in 2019 to 53 articles in 2022. This shift has possibly been due to the increase in the disclosure practices by institutions and corporations following the outbreak of Covid-19 pandemic.

After discussing annual scientific production, let us ponder over the average citations per year which has been shown in the following figure:
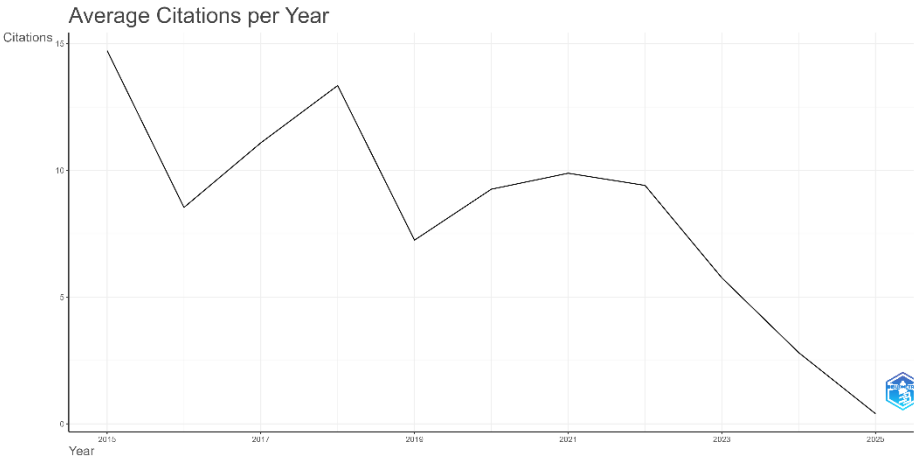

Figure 2: Average Citations per Year
Source: Author's Computation using R

The data in the chart reflects that there has been a significant increase in the number of articles but average citations rate has reduced over time. This decline has probably been due to 'Citation Aging Effect' in which older articles garner more attention from the authors than the newer ones.

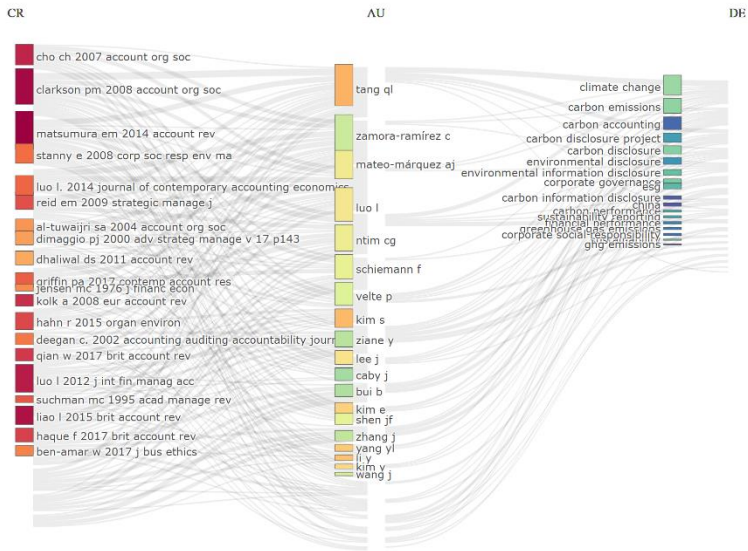After carefully analyzing the average citations, the three-field plot was generated:

Figure 3: Three-Field Plot
Source: Author's Computation using R

The three-field plot developed in this study helped visualize connections between three key variables which are Cited References (CR), Authors (AU) and Keywords (DE).

It basically draws attention towards heavily focused topics and cited references. It also helps to identify influential manuscripts, dominant themes and key contributors.

For example: Tang QL has cited Cho CH in his work and constantly interacted with topics like climate change and carbon accounting.

The following paragraphs answer **Research Question (RQ) 2**.
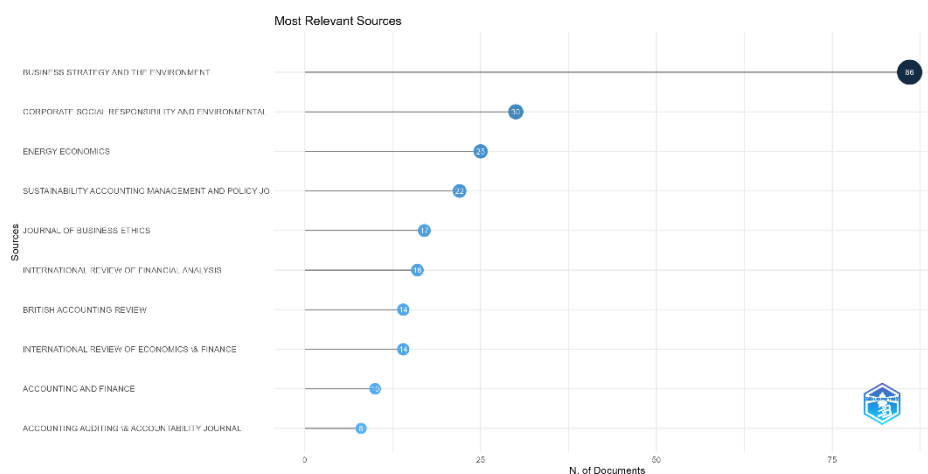The bar graph displays the most relevant sources in the area of carbon disclosure:

Figure 4: Most Relevant Sources
Source: *Author's Computation using R*

According to the graph, it can be interpreted that the journal "Business Strategy and the Environment" has the highest number of articles i.e., 86 followed by Corporate Social Responsibility and Environmental Management with 30 articles and Energy Economics with 25 articles. Overall, with this analogy we capture the most influential journals in the concerned area.

After considering the most relevant sources, we ought to discuss the most local cited sources were studied and the following observations were made: According to the study, Business Strategy and the Environment is the most locally cited source with 1740 articles, followed by Journal of Business Ethics with 1649 articles and Journal of Cleaner Production with 1222 articles. This was how the most dominant sources within the domain of carbon disclosure were identified.

Now let's discuss Bradford's law.

The core sources were denoted by Bradford's Law which is used to identify key sources within a research interest area.
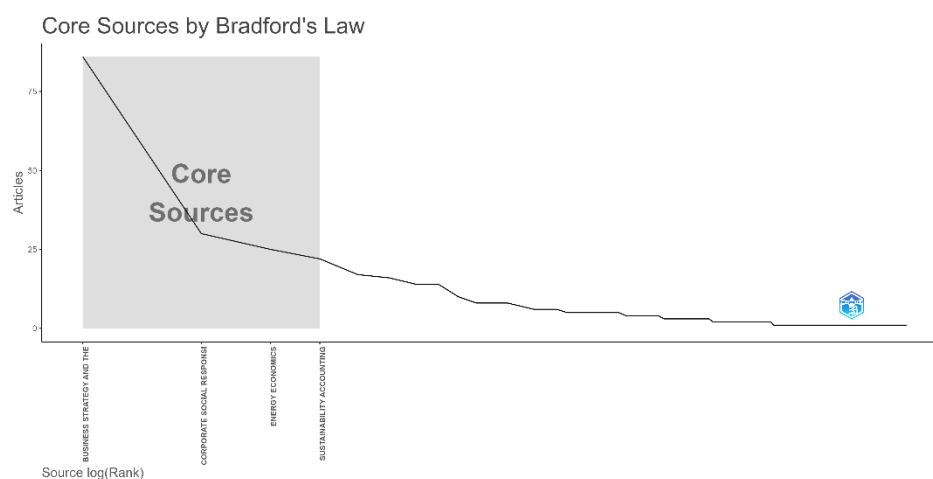

Figure 5: Core Sources
Source: *Author's Computation using R*

The shaded region as shown in Figure 5 indicates those sources that contributes to the field in majority. These sources are very productive in nature. The core sources include journals like the Business Strategy and the Environment, Corporate Social Responsibility and the Environmental Management, Energy Economics and Sustainability Accounting Management and Policy Journal.

The Sources' Local Impact was assessed after the Bradford's Law as indicated by the following figure:
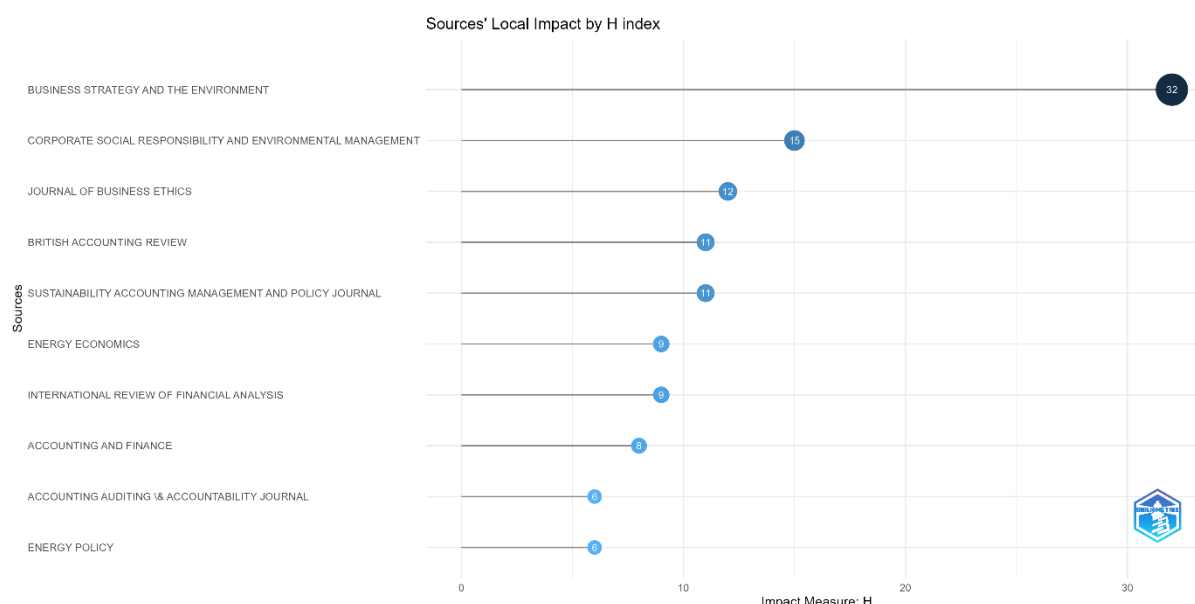

Figure 6: Sources' Local Impact
Source: *Author's Computation using R*

The local impact of the sources is generally measured using H-index which is a metric that helps in the evaluation of a sources' productivity and its citation impact. If we observe the graph carefully, we will find that the source "Business Strategy and the Environment" has the H-index of 32 followed by Corporate Social Responsibility and Environmental Management with H-index of 15 and Journal of Business Ethics, an index of 12 and British Accounting Review and Sustainability Accounting Management and Policy Journal, both having an H-index of 11 each. Remaining sources haven't had a significant H-index.

This suggests that the above-mentioned journals have dominated this research interest area. Now let us analyze sources' production over time.
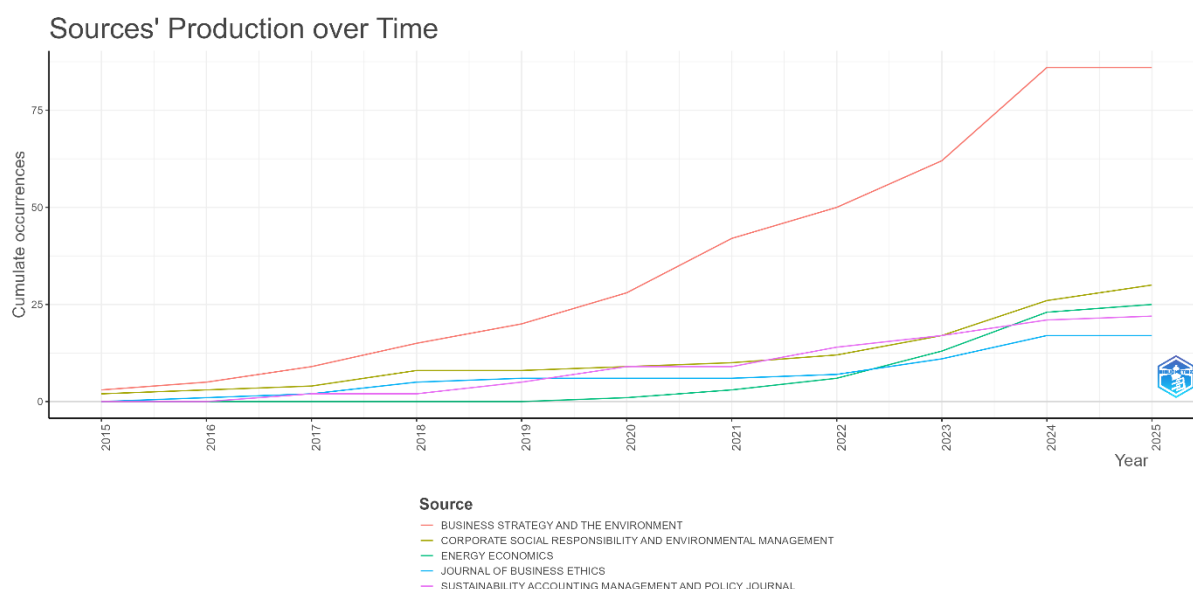
Figure 7: Sources' Production over Time
***Source:** Author's Computation using R*

The chart revealed top 5 sources in the recent years and their overall production in the duration '2015-2025'. The top 5 distinct sources that appear in the chart are: Business Strategy and the Environment, Corporate Social Responsibility and Environmental Management, Energy Economics, Journal of Business Ethics and Sustainability Accounting Management and Policy Journal.

After going through these sources, we found that the Journal "Business Strategy and the Environment" shows the highest growth after 2020. This is indicated by the red line in the graph. The teal and green lines used represent the journals "Corporate Social Responsibility and Environmental Management" and "Energy Economics", which indicates moderate growth whereas the blue and purple lines used for the "Journal of Business Ethics" and "Sustainability Accounting Management and Policy Journal" point towards minimal growth. The chart reflects that there has been exponential growth in the number of publications after 2020 owing to few reasons which can be increased interest of the researchers as well as of the bodies that promote practices of carbon disclosure by institutions, aftermath of the pandemic resulting in implementation of several policies that back sustainability, etc.

After analyzing the Sources involved, we try to understand the analysis regarding the Authors in sync with RQ 3 involved in the study.

The following paragraphs answer **Research Question (RQ) 3**.

The Authors' section of the study is categorized into three parts, which are authors, affiliations and countries. In the first part, i.e., the authors, we will first discuss the most relevant authors: When the graph related to it was assessed it was found that Luo L has made the greatest number of contributions followed by Tang Q, Li Y and Ben-Amar W.

After analyzing the most relevant authors let us find out the most local cited authors which has shown in the following figure:

According to the graph which was assessed, it was observed that Luo L has been cited the greatest number of times in the papers, i.e., 238 times followed by Tang Q, 168 times and Haque F, 103 times. This helps us to identify the most influential authors.

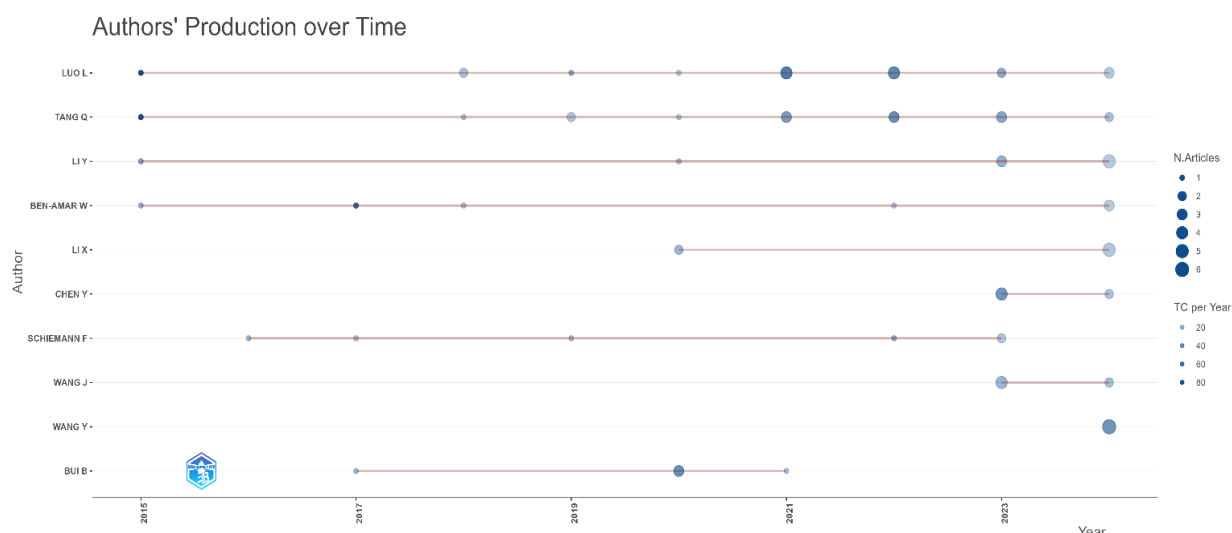After the analysis of the most local cited authors, authors' production over time was discussed.

Figure 8: Author's Production over Time
Source: *Author's Computation using R*

In the above figure, the size of the dots is positively related to the number of articles. Luo L and Tang Q have been consistently getting articles published over time whereas Chen Y has published in specific years in concentrated numbers.

Now let us move on to the Lotka's Law which has been defined as the existence of a vast proportion of scientific literature written by a small group of authors. On the other hand, the production of many authors that write few papers matches the publications of the small number of prolific writers; this gives rise to the law of inverse squares: $yx = 6/p2\ xa$, where yx is the frequency of authors that publish an x number of papers, and a is a constant value for each scientific field (Alvarado, 2002).
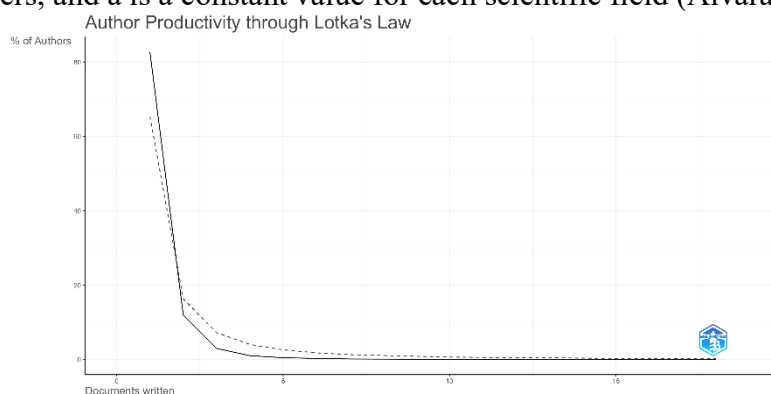

Figure 9: Lotka's Law
Source: *Author's Computation using R*

The following figure shows the application of Lotka's Law in this study.

According to the figure, 1020 authors have contributed only 1 article followed by 148 authors, 2 articles; 37 authors, 3 articles; 13 authors, 4 articles and finally 6 authors, 5 articles.

It is interpreted from the above analysis that there are only few authors that have made multiple contributions.

The final variable to be discussed in this category is author's local impact which resulted in the following observations:

The author's local impact has been assessed by H-index, according to which the most impactful research has been conducted by Luo L with an H-index score of 15 and least impactful by Jiang Y with an H-index score of 4.

The second part of the study are affiliations which has been studied using two dimensions: Most relevant affiliations and Affiliations' Production over time.

According to the analysis made on the most relevant affiliations, it was observed that the Western Sydney University leads with the greatest number of articles, i.e., 29 followed by Macquarie University, 27; University of Otago 21 and the remaining with somewhat less than 20 articles. This observation helped us in determining the most notable institutions involved in this particular domain.

After studying the most relevant affiliations, we will analyze affiliations' production over time which has been depicted in the following graph:
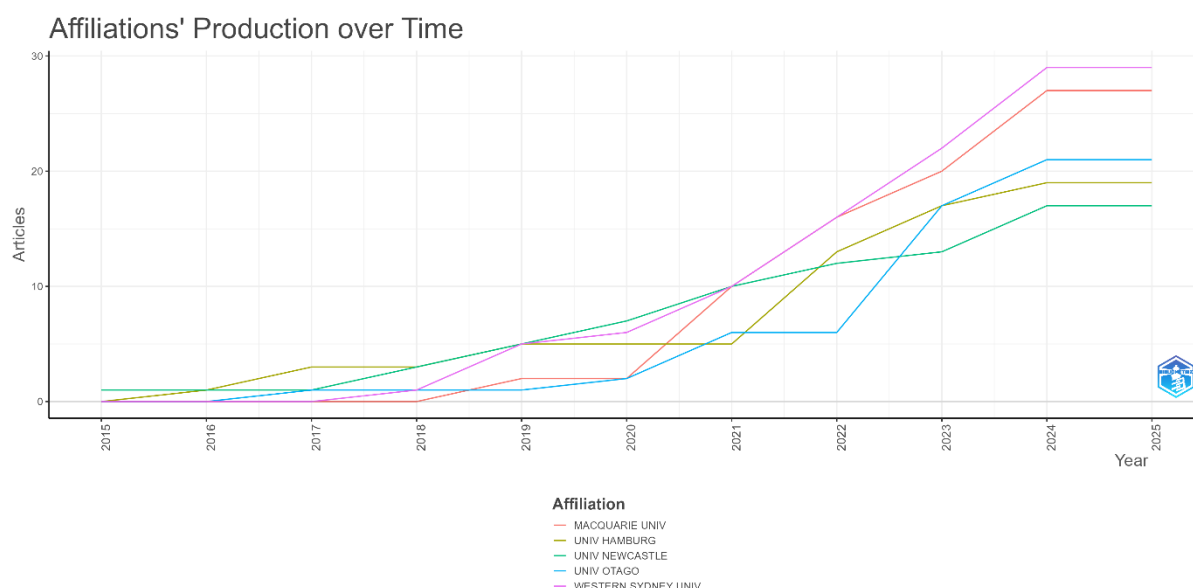

Figure 10: Affiliations' Production over Time
Source: *Author's Computation using R*

It has been observed from the graph that Western Sydney University has been producing the greatest number of publications since 2014. The remaining institutions have at most produced 15 articles. The rise in the production of articles after 2020 suggests increased research in topics associated with sustainability.

The third and final part of the study are countries which have been divided into four dimensions which have been discussed below:

The first dimension to be studied is corresponding author's countries which have been shown in the following figure:
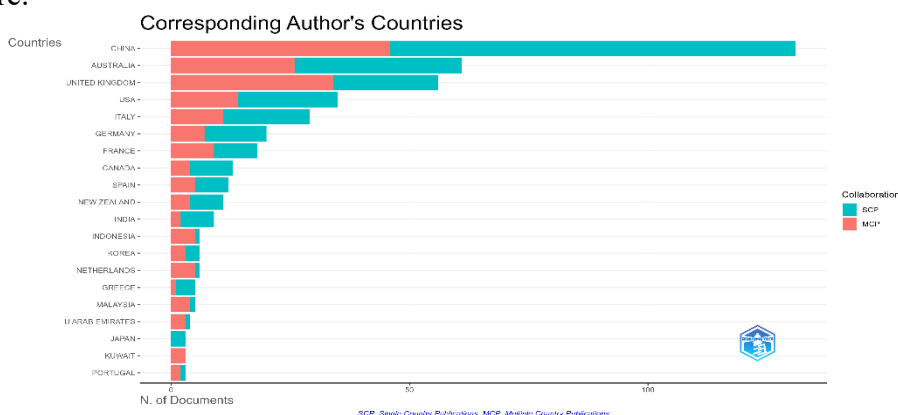

Figure 11: Corresponding Author's Countries
Source: Author's Computation using R

The chart alongside portrays the distribution of corresponding authors across the world along with the number of articles they publish. For this study, two variables were set, i.e., SCP which is a single country publication and MCP which are multiple country publications. In the figure, SCP is represented by the color teal and MCP is represented by the color red. It is observed from the graph that China holds the highest number of MCP and SCP followed by the United Kingdom indicating that researchers from China are good at making international as well as domestic collaborations whereas the ones from the United Kingdom are good at international collaborations.

After studying corresponding author's countries, Country Scientific Production will be taken into consideration as shown in the following figure:
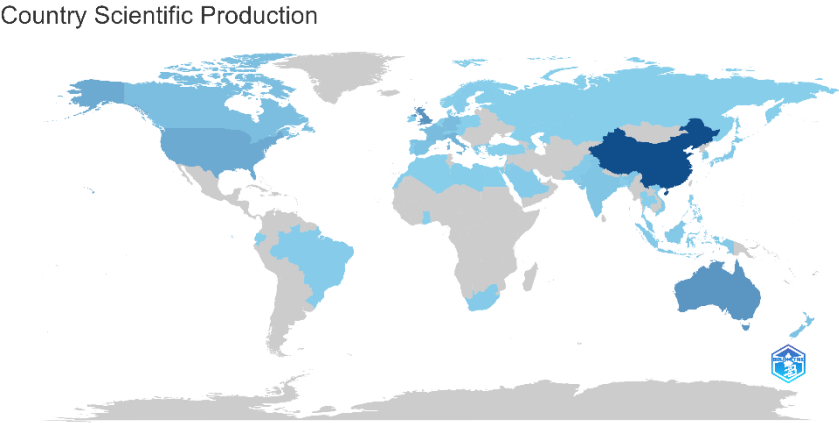

Figure 12: Country Scientific Production
Source: *Author's Computation using R*

According to the map besides, we get to know the level of intensity by which countries across the world are contributing to the carbon disclosure research. If we carefully observe the map, it can be gathered that China and some of its neighboring countries have been contributing the most. The U.K. is also at the same level as China while countries from the North American continent are also contributing consistently.

Let's move to the Country Production over time to understand the production capabilities of these countries better.
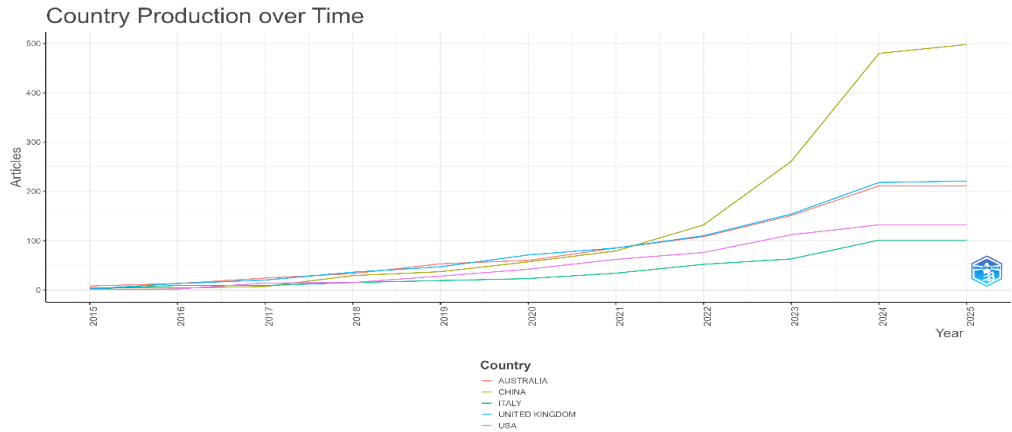

Figure 13: Country Production over Time
Source: *Author's Computation using R*

Above figure depicts country production over time, according to which after 2020, China's production increased exponentially followed by the United Kingdom. Australia and the U.S.A. followed a similar trail whereas Italy contributed the least. After discussing country production over time, we move to the final variable of this part of the study, i.e., the most cited countries.

According to the analysis made on it, it was observed that Australia is the most cited country followed by China, United Kingdom, the U.S.A., Canada and Italy. This chart highlights the impact these countries have in this kind of research. After analyzing all these parts, we move on to the next section, i.e., documents.

Documents

This section has been divided into three parts which are documents, cited references and words. Let's analyze the first part, i.e., the documents. The documents will be analyzed using the global and local cited documents. These key variables answer **Research Question (RQ) 4.** The most global cited documents have been the following as observed during the analysis:

According to the analysis, the top document is Liao L, 2015, with the highest number of citations, i.e., 904 followed by Ben-Amar W, 2017, with 597 citations. Li D, 2018 has a similar trend with 456 citations and Jung J, 2018 with 380 citations. If we move down the chart, it can be observed that with every addition, the citations decrease.

After the analysis of the most globally cited documents, the most locally cited documents are needed to be taken into consideration. The following observations have been made after the analysis:

The following documents that have been cited the greatest number of times: Liao L, 2015 has been cited 82 times. Clarkson PM, 2015 and Jung J, 2018, both have been cited 62 times each followed by Griffin PA, 2017, 61 times and Haque F, 2017, 52 times. These are the documents frequently cited by the authors.

This was the documents' part of the study, now cited references would be analyzed. The first variable to be discussed in cited references are the most local cited references. Matsumura EM, 2014 has the greatest number of citations, i.e., 156 followed by Clarkson PM, 2008, 115. Liao L, 2015 has 82 and Luo L, 2012, has 78 citations so far. It can also be observed from the graph that all the references have crossed minimum 60 citations. After the analysis of locally cited references, reference spectroscopy was taken into consideration.

Reference Spectroscopy represents the relationship between the publication years of the references cited in the articles and the number of citations in terms of references made in those years.
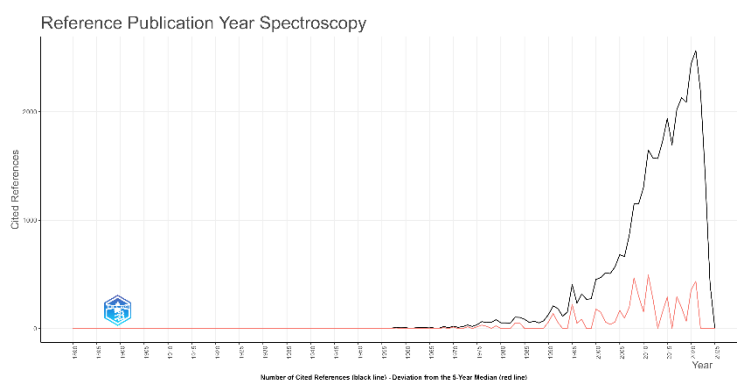

Figure 14: Reference Spectroscopy
Source: *Author's Computation using R*

The red line represents the deviation from the 5-Year Median and the black line represents the number of cited references. It can be observed from the graph that the references have increased after 2000. Specifically, after 2010 there has been exponential growth in the number of references made.

This was all about cited references. Now we get to analyze the third and final part of the section, i.e., words, Words will be analyzed using five dimensions, which are most relevant words, word cloud, tree map, words' frequency over time and trend topics which answers **Research Question (RQ) 5.**

The most relevant words used in this kind of research have been analyzed and the following observations have been made: Words like performance has appeared 152 times, disclosure 134 times and impact 90 times pointing towards their usage in today's academia.

Now that we've known the most relevant words, let's analyze the word cloud which is presented below:

Figure 15: Word Cloud
Source*: Author's Computation using R*

This word cloud represents the frequency and significance of keywords used in a study. In the cloud, we can observe that some words have been written bigger than the others indicating their level of significance. Terms like climate-change, disclosure and performance have taken the biggest spot. Other than these, corporate social responsibility, greenhouse gas emissions and environmental performance indicates that focus of academia have shifted towards environmental accounting and sustainability.

After the word cloud, the tree map was considered and the following observations were made: The tree map indicates that words like performance holds 7% of it, disclosure 6%, impact, governance, corporate social responsibility and climate-change 4% each have had a significant role in the carbon disclosure related study.

There were three categories of words found which are corporate related, performance related and finally environmental.

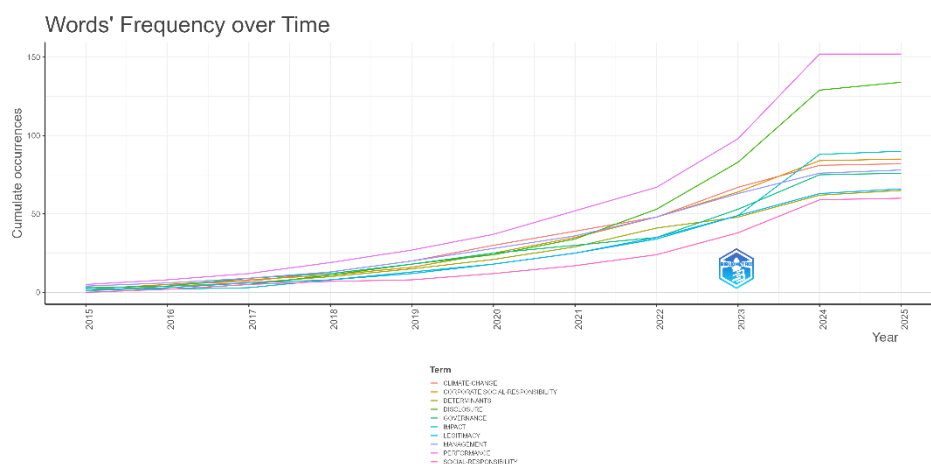The tree map and word cloud go hand in hand together.

Figure 16: Words' Frequency over Time
Source*: Author's Computation using R*

After the study of the tree map, words' frequency was looked forward as portrayed in the following graph:

If we observe the graph below, it would appear that over the years some words have been increasingly used in the carbon disclosure research.

Words like climate change, performance and disclosure have been used highly after 2020 owing to the pandemic and changes in the disclosure policies of institutions.

It can also be attributed to the fact that these terms have frequently over time. Now that we've understood the frequency of words used in the research, let's follow some of the trending topics as presented in the following chart:
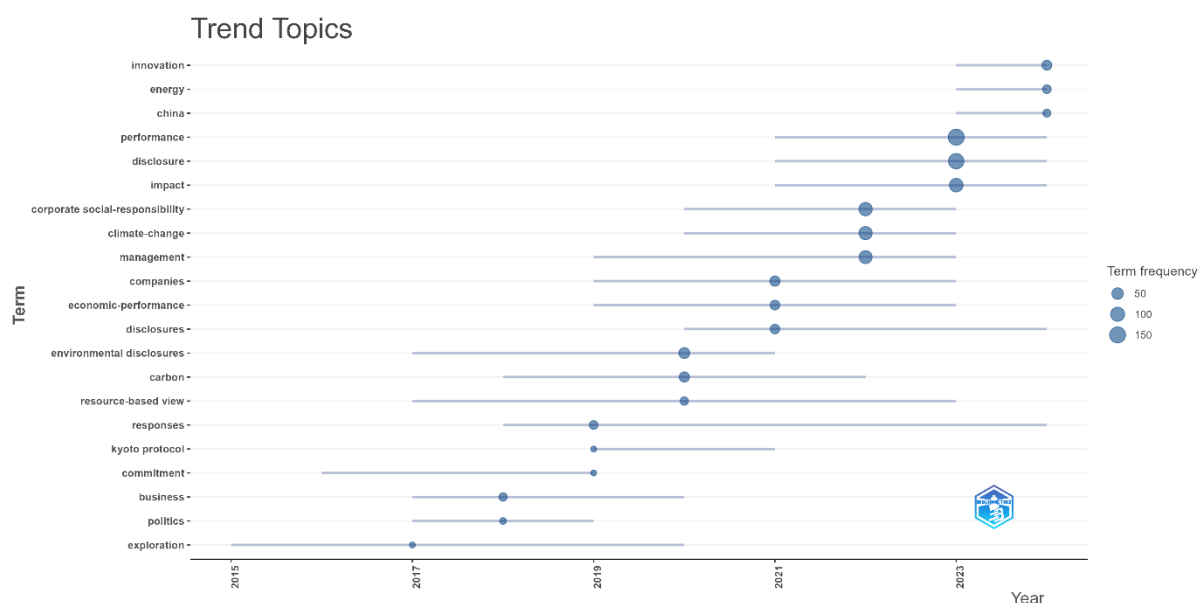

Figure 17: Trend Topics
Source: *Author's Computation using R*

As visualized in the figure above, it can be observed that terms like performance, disclosure and impact holds the greatest significance. These terms are widely used along with its connection with corporate social responsibility, climate-change and legitimacy whereas topics like consumption

doesn't have any relevance with respect to research on this field in this decade. Now that we have found out the trend topics we need to move to the next section, i.e., clustering which answers **Research Question (RQ) 6.** Clustering is shown on a coupling map in this analysis which involves four parts which have been divided according to centrality and impact. Centrality, as denoted on the x-axis indicates how central an author or organization is to a network whereas impact as denoted on the y-axis indicates the effectiveness of that study in the concerned field. The coupling map along with the network are shown in the following figures:
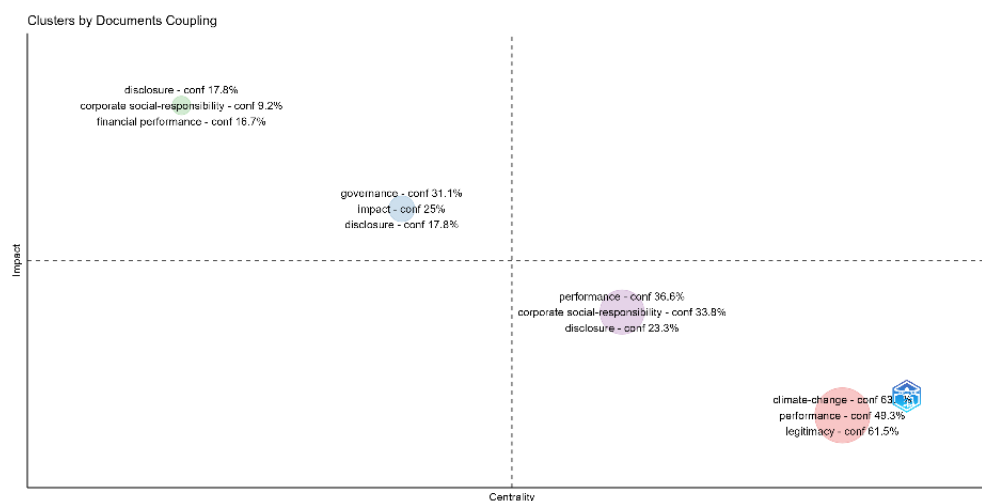

Figure 18: Documents Coupling
Source: *Author's Computation using R*

The following observations have been made after looking at the map:

High Impact, Low Centrality: The involved themes in this cluster are disclosure with confidence value of 17.8%, corporate social responsibility with 9.2% and financial performance with 16.7%. It is clearly observed from this cluster that these themes are highly impactful in this research interest area but are low on centrality, i.e., less centralized and are only found in specialized studies.

High Impact, High Centrality: The involved themes in this cluster are governance with confidence value of 31.1%, impact with 25% and disclosure with 17.8%. It can be said about this cluster that the themes in it are both impactful and central. This means that there have been several studies that address the link between disclosure and its impact on several facets of an organization.

Medium Impact, High Centrality: The involved themes are performance with confidence value of 36.6%, corporate social responsibility with 33.8% and disclosure with 23.3 %. The themes have a medium impact but are highly central to the network. It means that these topics are niche and specialized but pursued by many researchers across the world.

Low Impact, High Centrality: This cluster involve themes that have surfaced recently, thus having low impact on the overall field but has centrality which indicates that everyone has shifted their focus on these themes. The themes found are climate change with 63.2% of confidence value, performance with 49.3% and legitimacy 61.5%. So, this was the end of the discussion on cluster analysis or the coupling map.
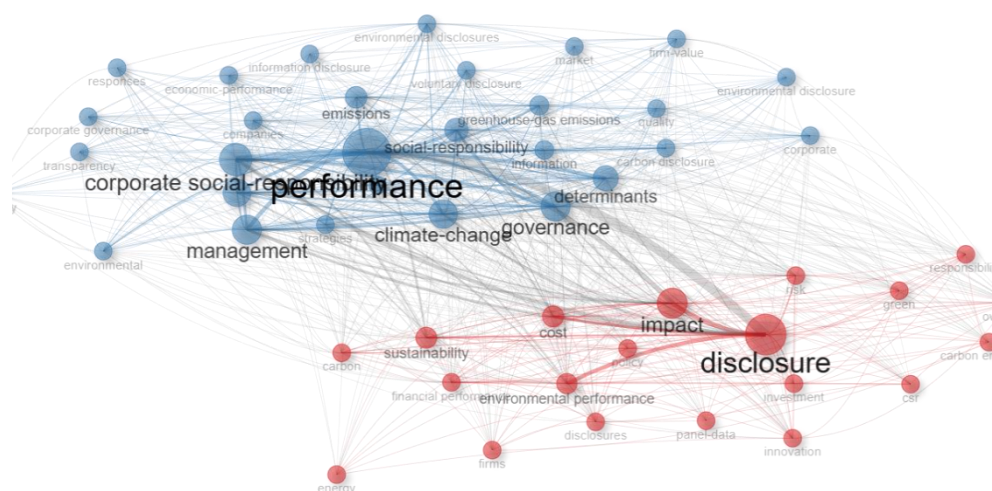
Figure 19: Co-occurrence Network
Source: *Author's Computation using R*

As mentioned before that the Section 3 also seems to cover the structures of the study. Out of which, the first structure that needs to be studied is the conceptual structure which briefly answers **Research Question (RQ) 7.** The conceptual structure consists of two approaches, viz. the network approach and the factorial approach. The network approach will involve interpretation of two types of formation: co-occurrence network and the thematic map which are shown in the Figure 19 and Figure 20.

Co-occurrence network is usually a representation of key terms involved in a study based on their appearances across documents like official reports, research papers, government publications and others. During interpretation of a co-occurrence network, three factors are taken into consideration: sizes and colors of the nodes formed and the connections developed between them. More number of occurrences indicate close relationship between the words. In the figure 19., it can be clearly observed that terms like disclosure and performance holds significant position and is interlinked with terms like sustainability, greenhouse gas emissions and its determinant. Another link can be observed which points toward corporate social responsibility and its connection with associated theories like the legitimacy theory. It was also found connected with terms like environmental performance, voluntary disclosure, corporate governance, etc. which explains the impact this domain has on regulatory framework. The term climate change acts as a bridge between these two categories of words. In the end it can be asserted that a researcher can enhance their research by focusing on these interconnected themes to generate maximum impact.
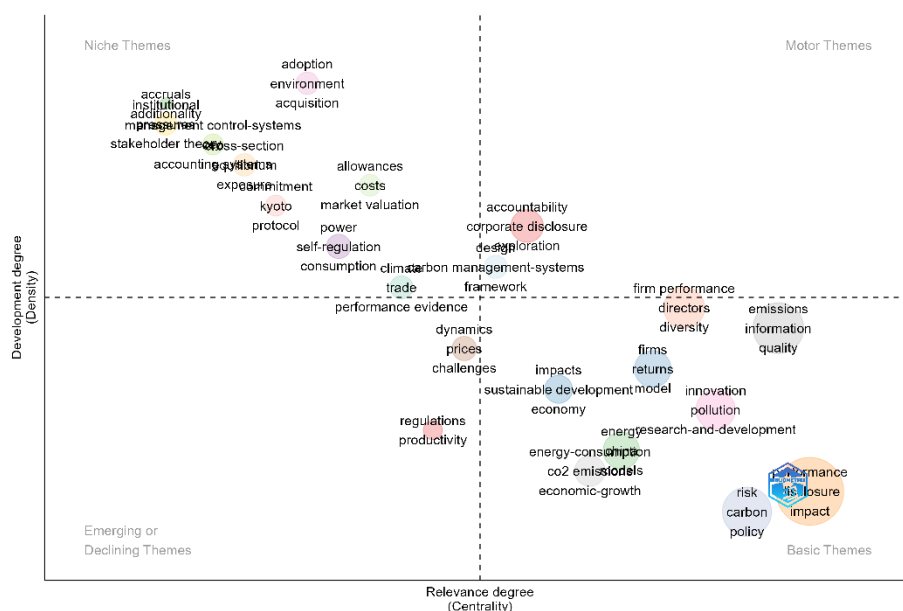
Figure 10: Thematic Map
Source: Author's Computation using R

In the Figure 20, the thematic map has been presented which is divided into four types of themes on the basis of two degrees: density and centrality. The four types as mentioned earlier are niche themes, motor themes, emerging or declining themes and basic themes. These quadrants have been briefly explained below:

Niche Themes: The upper left quadrant of the thematic map indicates those themes which are highly developed in nature but are less relevant in today's world. They are specialized but not so influential topics and include themes like stakeholder theory, Kyoto Protocol, carbon trade, market valuation, consumption level, self-regulation, etc.

Motor Themes: The upper right quadrant of the map indicates those themes that are well developed and also highly relevant in their research interest area. It includes key topics like accountability, corporate disclosure, carbon management, etc. These themes often act as a mediator between two major research domains.

Emerging or Declining Themes: These are those themes that have less relevance and also had less development in comparison to the other themes. It includes topics that have failed to garner attention overtime from researchers. It includes topics like regulations, productivity, dynamics, challenges, etc.

Basic Themes: Found at the Lower right of the quadrant, these are those themes that are highly relevant in nature and also seek more and more development on the part of researches being conducted overtime. It includes topics like energy consumption, CO_2 emissions, economic growth, sustainable development, disclosure, performance, etc.

After studying the conceptual structure from the network approach, we get to move towards the factorial approach. The factorial approach will involve factorial analysis which in this case will be studied using a factorial map as shown in the figure below:
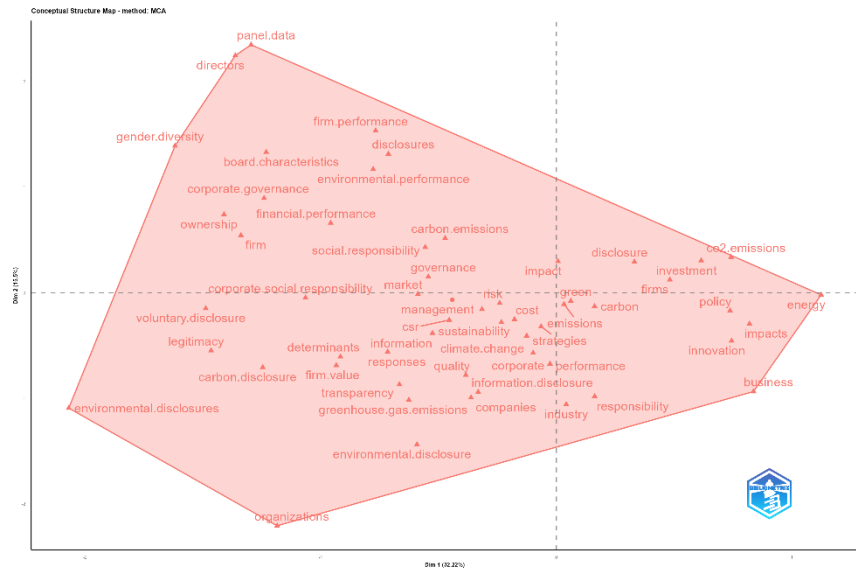
Figure 11: Factorial Map
Source: *Author's Computation using R*

A factorial map forms a conceptual structure using a method called Multiple Correspondence Analysis and has a plane having a horizontal and a vertical axis. If we observe carefully, we will be able to trace two dimensions. Each dimension represents the intersection between the variables that are found in them. For instance, into the dimension 1, the horizontal axis we can find the intersection between left and right set of variables pointing out a spectrum of business or market related topics like companies, corporate performance, CSR, sustainability, etc. whereas into the dimension 2, the vertical axis we can find the intersection between top and bottom set of variables pointing towards an intersection of corporate related and environmental issues. This map helps the researcher to identify three kinds of factors which are enterprise-related, market-related and environment-related factors. Now that we have understood the conceptual structure, we need to identify the intellectual structure of this study which answers **Research Question (RQ) 8**. The intellectual structure is a type of structure that is built upon the foundation of relationships that has existed due to the interaction between the authors involved, topics discussed and the publications made afterwards. This intellectual structure can be understood using the co-citation network and the historiograph. Let's discuss these in the following paragraphs: The co-citation network represents the cluster of documents that are cited together frequently.
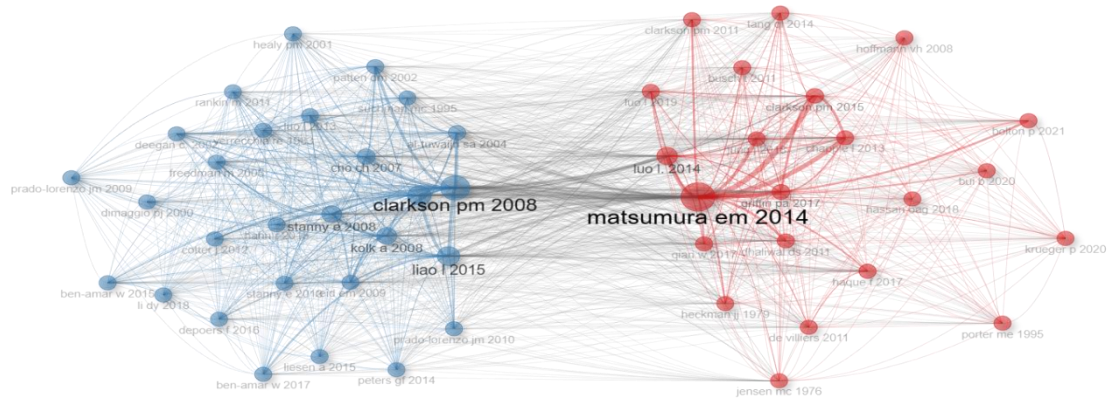

Figure 12: Co-citation Network
Source: *Author's Computation using R*

In the Figure 22, two types of color-coded clusters have been indicated. The red cluster indicates works associated with corporate or financial performance. It can also be related to corporate carbon disclosure. The most influential work in this cluster is Clarkson PM (2008). Other works can be Ben-Amar W (2017) and Liao L (2015) whereas the blue cluster indicates those works that are related to theories like sustainability, Porter's competitive advantage or other strategies. The most influential papers found in this cluster are Matsumura EM (2014) and Luo L (2014). These two clusters have been linked by the paper Matsumura EM (2014) which indicates the high quality of the paper. This was all about the co-citation network. Now let's shift our focus towards the historiography which is shown in the following figure:
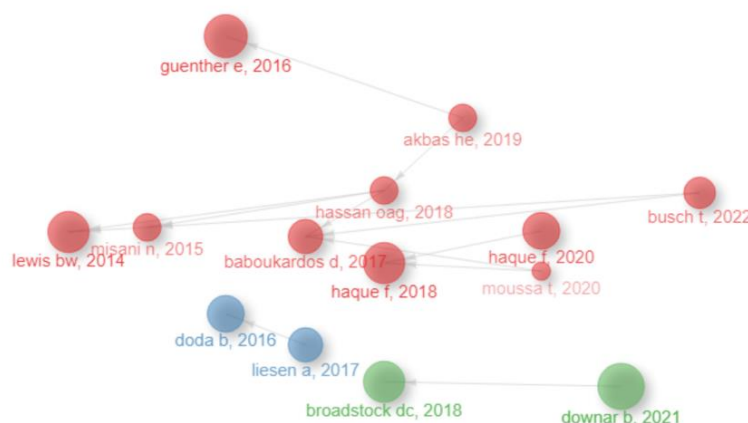

Figure 13: Historiograph
Source: Author's Computation using R

The historiograph represents a network between significant papers published in a certain field and overall, its citation. The color codes indicated in the map represents different types of themes involved in the network and the size of the nodes indicates the amount of literary presence, a paper has in its field. These papers are connected through lines pointing towards their interaction. The left side of the map represents older manuscripts whereas the newer ones are found on the right side. Lewis BW (2014) is the oldest paper in the chosen period whereas Busch T (2022) is the newest paper. This was the interpretation of the intellectual structure. Now let's analyze the social structure of the study.

The Social Structure in a bibliometric analysis refers to the network of relationships formed among the contributors of a study due to sharing of ideas and opinions. It can be assessed or analyzed using a collaboration network and countries' collaboration world map. These two aspects have been briefly discussed below:
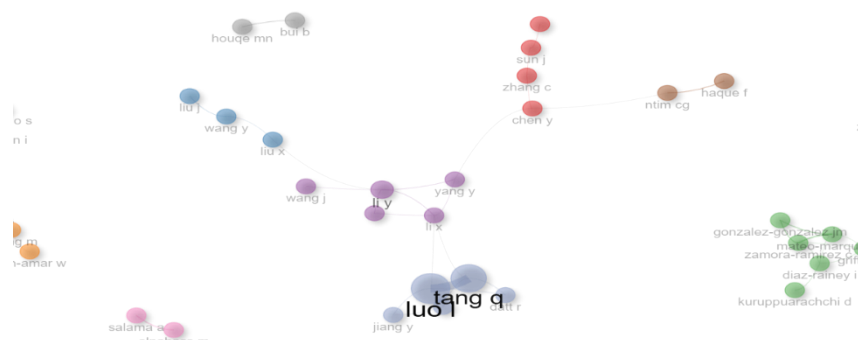

Figure 14: Collaboration Network
Source: Author's Computation using R

Collaboration Network signifies the collaboration between the authors on a certain topic. If we look in the Fig.24, we'll make the following observation: The nodes refer to the authors. Larger the node, higher the impact. Color represents the different types of themes involved in a research domain. There are some nodes in a group representing increased collaboration whereas isolated nodes represent lack of community building and collaboration between the researchers. Yang YL, Liu Z, Zhou MD and He R have occupied a central position in the network. The rationale followed behind this position is that their work has impacted other authors to make contributions towards the study. Followed by the analysis and interpretation of a collaboration network, we get to study the countries' collaboration world map as depicted in the following figure:
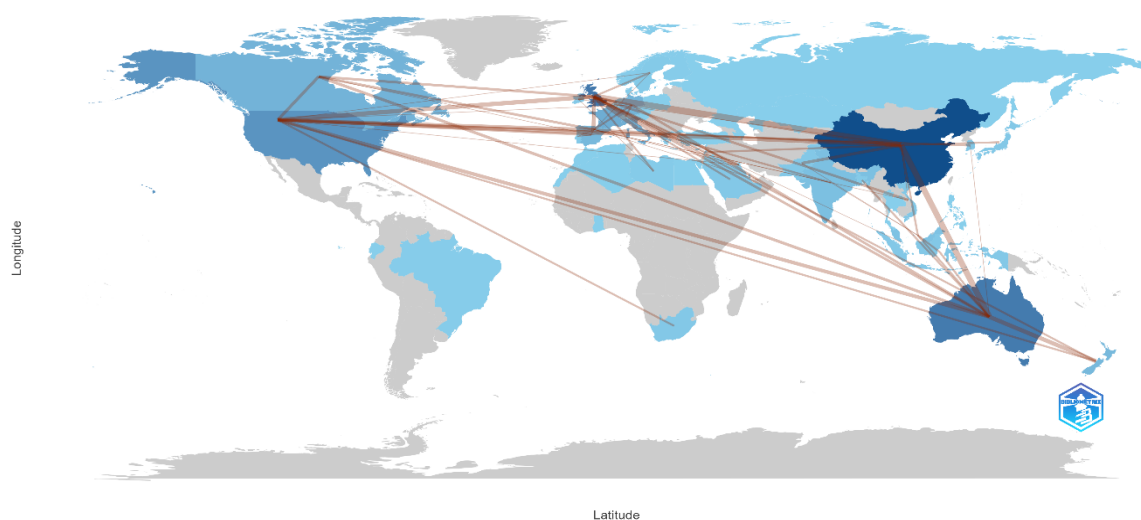

Figure 15: Country Collaboration Map
Source: *Author's Computation using R*

Fig. 25 depicts country collaboration map which represents international collaborations involving countries from different continents. A major partnership has been developed across China, the United States and Australia enhancing cross-continental research. When it comes to different color codes, grey color indicates little or no participation on the part of the researchers whereas light blue indicates involvement on moderate level and dark blue indicates higher research caliber from their researchers. The width of the lines indicates intensity of the collaborations made.
This was the overall interpretation of the bibliometric analysis.

Conclusion
The present study has provided a detailed overview of research related to carbon disclosure over the past 10 years. The analysis and interpretation of bibliometric data obtained from the Web of Science revealed that research related to this particular area has grown over time. It has also been observed that academicians and scholars from all across the world have shown keen interest in carbon disclosure. The annual scientific production revealed a consistent increase in the articles produced whereas the country scientific production revealed the impactful presence that China has had on this domain. The study also revealed that topics like disclosure and performance and their interaction has been given top priority in scholarly articles. The thematic map revealed that CO_2 emissions, renewable energy and power consumption are the most developed and relevant topics highlighting the focus on sustainability and means and mechanisms to achieve that. Despite so much progress made in this direction, researchers have failed to produce studies on analysis and impact of this disclosure and its tracking. Future research should focus on developing standards and frameworks to monitor carbon

emissions in corporations and institutions. It should also focus on understanding interdisciplinary connections and provide more comprehensive and detailed analysis of the carbon disclosure research.

References
1. Albertini, E. (2013). Does environmental management improve financial performance? A meta-analytical review. *Organization & Environment, 26*(4), 431–457. https://doi.org/10.1177/1086026613510301
2. Asensio, O. L. (2015). Mitigating the effectiveness of carbon disclosure: The influence of organizational reputation and industry context. *Journal of Business Ethics, 130*(2), 373–389.
3. Busch, T. (2022). Carbon disclosure and corporate governance: Insights from the energy sector. *Journal of Business Ethics, 155*(1), 23–42.
4. Clarkson, P. M. (2008). Revisiting the relation between environmental performance and disclosure. *Accounting, Organizations and Society, 33*(4), 303–327.
5. Dilling, P. F. A., Sobhan, N., Hassan, A., & Fletcher, M. (2018). The corporate carbon disclosure puzzle: Analyzing influencing factors. *Sustainability, 10*(11), 3917. https://doi.org/10.3390/su10113917
6. Griffin, P. A., Lont, D. H., & Sun, E. Y. (2017). The relevance of carbon emissions for firm valuation. *Journal of Business Finance & Accounting, 44*(1-2), 182–210.
7. Hahn, R., Reimsbach, D., & Schiemann, F. (2015). Organizations, climate change, and transparency: Reviewing the literature on carbon disclosure. *Organization & Environment, 28*(1), 80–102.
8. Haque, F. (2018). The effect of mandatory ESG disclosure on firm performance. *Business Strategy and the Environment, 27*(8), 1292–1304.
9. Huang, X., Kerstein, J., & Wang, C. (2017). The impact of climate risk on corporate financial reporting. *Journal of Accounting and Economics, 63*(2-3), 294–312.
10. Lewis, B. W. (2014). The role of voluntary environmental disclosures in influencing investor decisions. *Sustainability Accounting, Management and Policy Journal, 5*(4), 449–474.
11. Liao, L. (2015). Corporate social responsibility and financial performance: An empirical analysis. *Journal of Business Ethics, 127*(1), 1–16.
12. Luo, L. (2012). Corporate carbon performance and carbon disclosure: A review of current research. *Business Strategy and the Environment, 21*(6), 393–409.
13. Matsumura, E. M., Prakash, R., & Vera-Munoz, S. C. (2014). Firm-value effects of carbon emissions and carbon disclosures. *The Accounting Review, 89*(2), 695–724.
14. Ntim, C. G. (2015). Corporate governance and carbon disclosure practices: An international perspective. *Business Strategy and the Environment, 24*(5), 339–355.
15. Ooi, S. K., & Amran, A. (2018). Climate change reporting in Malaysia: A longitudinal analysis. *Sustainability, 10*(3), 883.
16. Sullivan, R., & Gouldson, A. (2012). Does voluntary carbon disclosure mean business? *Accounting, Auditing & Accountability Journal, 25*(1), 145–173.
17. Tang, Q. L. (2020). The role of carbon accounting in corporate sustainability. *Journal of Cleaner Production, 275*, 123236.