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A BIBLIOMETRIC ANALYSIS OF SUSTAINABILITY DISCLOSURE IN HIGH POLLUTING INDUSTRIES

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ABSTRACT

This bibliometric analysis aims to comprehensively examine the sustainability disclosure for heavy polluting industries. To achieve this goal, we meticulously reviewed a collection of 76 scholarly documents, encompassing journal articles focused on sustainability disclosure in high-polluting sectors. The timeframe for this study spanned from 1981 to 2021. To facilitate our analysis, we leveraged the biblioshiny web interface, which operates on the bibliometrix 3.0 R-package. our investigation revealed that the preeminent journal in this domain is "Corporate Social Responsibility and Environmental Management." Among the pivotal works, a standout article is titled "Global Warming, Commitment to the Kyoto Protocol, and Accounting Disclosures by the Largest Global Public Firms from Polluting Industries." Moreover, scrutinizing the citation impact, two prominent nations emerged as the focal points of scholarly attention: China and the USA. across titles, abstracts, author keywords, and keyword plus fields, the term "environmental disclosure" surfaced as the most recurrent. upon delving into the co-occurrence network, we identified four distinct research streams. These streams encompass the relationship between environmental disclosure and corporate performance, particularly concerning a company's environmental impact. additionally, the focus extends to electric utilities and their disclosure patterns in alignment with the Global Reporting Initiative (GRI) framework. Another stream investigates the interplay between environmental disclosure and ownership structures. Lastly, the connection between environmental financial reporting and the GRI standards constitutes the fourth research avenue. we utilized a thematic mapping approach to classify themes into categories such as basic, emergent, declining, and highly developed. This segmentation facilitated a comprehensive understanding of the research landscape, enabling insights into current trends and guiding future research trajectories.

KEYWORDS: Sustainability disclosure, high polluting industries, conceptual structure, bibliometric analysis, biblioshiny

1. INTRODUCTION

The world's ecology is impacted by the high polluting industries. many companies disclose their sustainability-related information and work for the environment and do corporate social responsibility (H. M. Arslan, Chengang, Komal, & Chen, 2023). Environmental disclosure involves the comprehensive revelation of a firm's operational activities and their corresponding environmental impacts. by openly disclosing these activities and their associated effects, the aim is to mitigate potential impacts on stakeholders, thus fostering a reduced environmental footprint (Gray, Owen et al. 1996), de Klerk and de Villiers (2012), (De Klerk, De Villiers et al. 2015). The concept of Environmental Information Disclosure (EID) first gained prominence in March 1989 during international conferences (H. M. Arslan, Khan, Latif, Komal, & Chen, 2022). Standardized reporting practices were discussed in the seventh meeting of the export working group, aiming to bolster industrial performance and ensure sustainable development (Bi, Peng et al. 2012). Notably, the Kyoto Protocol stands out as a significant milestone, wherein various nations united to curtail pollution emissions (Mahmood et al., 2023). The international panel on climate change has said that GHG emissions are the reason for the greenhouse effect and climate change (Change, Pachauri et al. 2007). The issue of greenhouse gas (GHG) emissions originating from various industries represents a fundamental matter in accounting practices, constituting a significant global societal concern (Lawrence, Botes et al. 2013, Massa, Farneti et al. 2015). The absence of a robust regulatory

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framework at the government level provides companies with the discretion to determine the extent and content of their emissions disclosure (Li, 2018)**.** Industries rely upon the Global Reporting Initiative (GRI) guidelines to construct sustainability reports and divulge information pertaining to environmental carbon emissions (Comyns 2016, Haque and Ntim 2018). While predominantly recognized for their adverse ecological impact, heavily polluting industries are progressively embracing innovative developmental strategies that facilitate emission reduction and bolster environmental disclosure efforts (Moser and Martin 2012, de Sousa Jabbour, Jabbour et al. 2018). The cultivation of stakeholder interest emerges as a pivotal driver for incentivizing industries to transparently communicate their environmental practices, particularly those that might inflict harm upon the environment(Lu and Abeysekera 2017).

Effectively managing climate change issues necessitates the stringent control of carbon dioxide (CO2) emissions emanating from industrial activities (CHANGE 2007). The significance of maintaining commendable environmental performance has been steadily on the rise over the last four and a half decades, exerting substantial influence on decision-making processes (H. M. Arslan, Chengang, Komal, & Chen, 2023). However, quantifying the costs and benefits associated with this performance in monetary terms remains a complex endeavor for organizations (Chauhan, 2005). For enterprises, the pursuit of sustainable growth is intrinsically linked to their commitment to disclosure practices, which in turn contributes to enhancing their social standing and expanding investment prospects (Endrikat, Guenther et al. 2014, Benlemlih, Shaukat et al. 2018, Lu, Li et al. 2020). Liu and Anbumozhi (2009) establish a direct correlation between environmental sensitivity, enterprise scale, and the imperative of environmental disclosure, which collectively shape Environmental Information Disclosure (EID) practices (Bilal et. al., 2023). Conversely, inadequate disclosure efforts, as evidenced by (Meng, Zeng et al. 2019) coupled with the absence of robust disclosure regulations, have been associated with suboptimal firm performance (H. M. Arslan, Chengang, Bilal, Siddique, & Yahya, 2022). The reduction of information asymmetries significantly impacts the extent of environmental disclosure, resulting in equitable access to information by a spectrum of stakeholders, including customers, governmental entities, and other influential factors (M. A. Souza, Rásia, & Jacques, 2010; Rosa, Ensslin, Ensslin, & Lunkes, 2011; Husted & Sousa-Filho, 2018)**.**

The Chinese government has employed diverse strategies to enforce environmental disclosure practices. a significant milestone occurred in 2015 with the revision of the environmental law, which now serves as a framework for addressing pertinent issues and safeguarding against environmental threats across various sectors (Ramos-Meza et al., 2021). A notable example is the established positive correlation between environmental performance and the dissemination of environmental information, as illuminated by (Clarkson, Li et al. 2008). In the realm of legitimacy theory, Alrazi, De Villiers et al. (2016) leverage the concept of ideology legitimacy, incorporating societal norms and values to elucidate its role in shaping perceptions and inducing carbon disclosure. furthermore, the regulatory landscape concerning environmental information disclosure, as explored by (Bi, Peng et al. 2012) plays a pivotal role in guiding industries to regulate their environmental disclosure practices effectively (Mahmood et al., 2023).

Environmental information disclosure is disclosed by different theoretical approaches (Gray, Kouhy et al. 1995). These diverse perspectives offer distinct frameworks for firms to unveil their environmental practices. two prominent theories, stakeholder theory and legitimacy theory (H. M. Arslan, Chengang, Komal, & Chen, 2023), serve as foundational pillars for shaping the landscape of pollution disclosure, as evidenced in the work of (Gray, Kouhy et al. 1995). The legitimacy theory posits that companies can achieve enhanced growth by operating within a broader societal context, integrating norms and values that bolster their public image and consequently fostering a willingness to voluntarily disclose more information (Patten 1991, Patten 1992, Gray, Kouhy et al. 1995, Deegan and Rankin 1996, O'Donovan 1999, Haniffa and Cooke 2002, Patten 2002, Cho and Patten 2007, Clarkson, Li et al. 2008, Nurhayati, Taylor et al. 2015, Ortas, Gallego-Alvarez et al. 2015). On the other hand, leads not give only to value to investors also benefits to the stakeholders include business employees, suppliers, creditors, and others who are interested in the business (Ullmann 1985, Roberts 1992, Clarkson 2016). These multifaceted theories collectively contribute to shaping the strategic disclosure of environmental information (Li et al., 2023).

Environmental reporting represents a significant facet within the broader realm of environmental information disclosure (Hackston and Milne 1996, Sahay 2004). Research has demonstrated the variance in information disclosure intensity across diverse industries (Wiseman 1982, Cormier and Gordon 2001, Aerts, Cormier et al. 2008, da Silva Monteiro and Aibar-Guzmán 2010). This variation is echoed in studies by (Buhr and Freedman 2001, Cormier and Gordon 2001, Cowan and Gadenne 2005, Aerts, Cormier et al. 2008) largely attributable to divergent regulatory frameworks existing within each country. Zeng, Xu et al. (2010) discern that companies operating within sensitive industries, those of larger scale, and those under governmental oversight tend to disclose more comprehensive information compared to their counterparts (H. M. Arslan, Khan, Latif, Komal, & Chen, 2022). Lu and Abeysekera (2014) ascertain that larger and well-regarded companies exhibit heightened environmental disclosure intensity (H. Arslan & Bashir, 2021), driven by their commitment to fulfilling public expectations regarding environmental transparency (H. M. Arslan, Chengang, Bilal, Siddique, & Yahya, 2022). The Kyoto Protocol serves as a paramount

instrument for enhancing environmental protection, primarily aimed at mitigating the release of greenhouse gas emissions originating from diverse industries (Ramos-Meza et al., 2021). Participating countries collectively commit to regulating their respective gas emissions in accordance with predetermined levels, as established by the **(**UNFCCC, 2018). Within the corporate landscape, there is a heightened emphasis on addressing external factors, and the extent of information disclosure concerning these factors is held in high regard, as noted by (Ye, Wang et al. 2015). Additionally, LI and FENG (2015) observe that listed companies exhibit superior internal control over factors, resulting in increased levels of information disclosure. this, in turn, establishes a positive correlation between disclosure of environmental information and heightened information disclosure awareness. The nexus between corporate social responsibility and the divulgence of environmental information is underscored in previous research (Chen and Lindkvist, 2013; Wu et al., 2015; Wang and Ni, 2016). moreover, Meng, Zeng et al. (2014) find that companies displaying exceptional performance, whether good or poor, tend to divulge more environmental information compared to their counterparts with average performance.

According to Alrazi, De Villiers et al. (2016) the study's objectivity and prior research collectively indicate that nations with a stronger commitment to environmental protection tend to yield superior outcomes. In these countries, both the companies operating within them and their corresponding national indices demonstrate heightened levels of environmental commitment, resulting in enhanced environmental performance across industries (H. Arslan & Bashir, 2021). This improvement is attributed to the practice of environmental disclosure (Li et al., 2023). The insights derived from these studies carry significant global implications, particularly in identifying sectors where a reduction in greenhouse gas (GHG) emissions is imperative. moreover, they offer valuable guidance to highly polluting industries seeking to uphold sustainability through enhanced disclosure practices. Our contribution involves conducting a comprehensive bibliometric analysis that amalgamates all the pertinent prior research pertaining to our focal subject (Bilal et. al., 2023).

2. THE PROCEDURE OF BIBLIOMETRIC ANALYSIS

The sequence of actions, referred to as a bibliometric workflow, is outlined in the article proposed by (Zupic and Čater 2015). Illustrated in figure 1 is the comprehensive five-step procedure for conducting bibliometric analysis on environmental disclosure within heavily polluting industries.

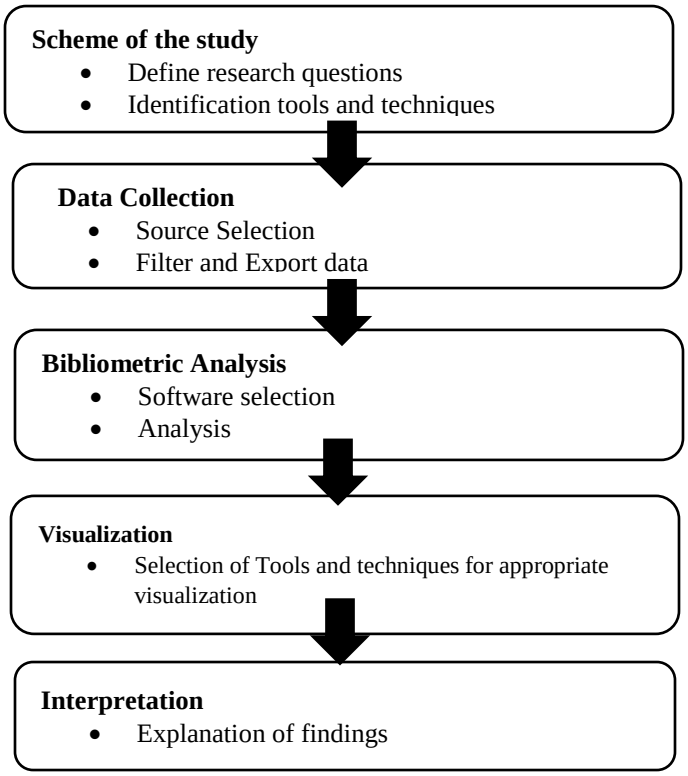

Figure 1. Workflow Chart

3. SCHEME OF STUDY

This research aims to address the following inquiries, seeking to unveil the intricate patterns of environmental disclosure within industries known for their high levels of pollution. these findings are expected to provide valuable insights that can pave the way for future explorations in this field of study. the following questions are addressed by this research.

i. What are the influential aspects of environmental disclosure in high-polluting industries?
ii. Exploring environmental disclosure in high polluting industries, what are the main trends and key themes?
iii. Prepare for the future, what inclusive lessons take from the past literature and what future directions can be set?

To address the initial inquiry, we employ a descriptive analysis approach. our objective is to ascertain the principal origins, nations, authors, publications, and affiliations within the realm of environmental disclosure studies concerning industries renowned for their significant pollution output. in the pursuit of this, we leverage source impact, total citations (TC), and net publications (NP) on a yearly basis, specifically focusing on core sources and authors. employing Bradford's law, a methodology attributed to its eponymous researcher, we categorize sources into three distinct zones, each serving as a determinant for identifying core sources. zone 1, colloquially referred to as the "nuclear zone," signifies a realm of utmost productivity. zone 2 embodies a state of moderate productivity, while Zone 3 encapsulates sources exhibiting comparatively lower levels of productivity. In light of our analysis, we recommend prioritizing countries and establishing connections based on the frequency of publication and the cumulative citations received.

The fundamental aspects necessary for establishing connections between distinct research streams encompass the core areas of study and pivotal themes. This process serves as a catalyst for shaping the trajectory of future research endeavors. Employing various technical tools, including co-occurrence maps, thematic maps, and thematic evolution analysis, the study endeavors to delineate the knowledge structure. this, in turn, facilitates the identification and linkage of disparate research domains. to achieve this, the approach employs the incorporation of keywords alongside an analytical methodology outlined by (Li, An et al. 2016). Author-assigned keywords serve as markers for the primary focal points of the study. expanding this approach, the database supplies additional contextual insights through the utilization of "keyword plus," a feature that elucidates the content of articles in more comprehensive terms, as highlighted by (Tripathi, Kumar et al. 2018). In the specific context of identifying research streams and themes related to carbon emissions within heavily polluting industries, the study employs biblioshiny – a bibliometric analysis tool provided by the R-program – to effectively map out these dimensions.

4. OBJECTIVES, TOOLS, AND TECHNIQUES

The primary aim of this study is to present a bibliometric perspective on environmental disclosure within industries characterized by high pollution levels. To enhance comprehension and underscore the purpose of contributing to our sustainable environment, the objective is further broken down into distinct facets. the initial facet pertains to identifying core publications, authors, countries, and institutions. this foundational step serves as a cornerstone, enabling us to embark on a descriptive analysis of documents. To achieve this, we harness the biblioshiny tool, a specialized R package designed for web-based bibliometric analysis. We use tools like Bradford's law, global citation metrics, h-index, g-index, and m-index inside this toolbox since they all work together to provide us a thorough analytical interface. The goal of the second component is to identify important research streams and thematic trends. This project makes use of scientific mapping approaches, concentrating on the conceptual framework. for this purpose, we employ "keyword plus" as input data, a method that offers a dynamic insight into this intricate landscape. ultimately, upon achieving the culmination of the first and second facets, the study seeks to offer a comprehensive interpretation of the findings. This comprehensive interpretation lays the groundwork for defining future research agendas, positioning this study as a springboard for further exploration and scholarly advancement

4.1. COMPOSING OF BIBLIOMETRIC DATA

Our bibliometric data compilation comprises two distinct components. in the initial component, we meticulously curate and analyze articles, discerning sources that align with our research objectives. to facilitate this, we have chosen databases of high repute, including Scopus, sci-hub, and Google Scholar. The second component of our data assembly process involves formulating a comprehensive research query to ensure the robust collection of data. employing this query, we apply a range of filters meticulously tailored to harmonize with our research goals, thereby enhancing the precision and quality of our findings. (TITLE-ABS-KEY ("corporate social responsibility" OR csr OR sustainability OR carbon OR "Carbon emission*" OR "climate change" OR ghg OR "greenhouse gas*" OR environment*) AND TITLE ("high pollu*" OR "pollu*" OR enger* OR chemi* OR electric* OR steel* OR iron*) AND TITLE-ABS-KEY (disclosure*)) AND (LIMIT-TO (LANGUAGE, “English”)). The process of generating themes involves the utilization of keywords within a conceptual framework. the research query is

specifically constrained to encompass solely english language articles and journal publications, a selection designed to optimize the depth of our analyses. While an initial pool of over 250 articles emerged, our final sample size stands at 76 documents. this refined selection is both efficient and directly pertinent to the focal subject matter.

4.2. BIBLIOMETRIC ANALYSIS AND VISUALIZATION

We employ bibliometric analysis, that applies mathematical and statistical tools to books and media communication (Andrés 2009). This approach furnishes a comprehensive resource for scientometric exploration. one such tool within this framework is "biblioshiny," a component of the package designed to cater to non-coders. It offers a multitude of options categorized into sources, documents, authors, conceptual structure, and intellectual framework. This utility facilitates the generation of a diverse array of results, presented in the forms of tables and graphs, which remain unparalleled in other software alternatives (Moral-Muñoz, Herrera-Viedma et al. 2020). In the realm of sustainability analysis, it becomes imperative to grasp the descriptive characteristics elucidated in table 1, pertaining to disclosure within highly polluting industries. This comprehension serves as a crucial preliminary step. from a selection of journal articles, we meticulously curated a final set of 76 documents. these selected journals collectively employ 427 keyword plus descriptors and 220 author keywords. the temporal scope chosen for investigating sustainability disclosure within heavily polluting industries spans from 1981 to 2021. A total of 173 authors contributed to these documents, with 10 articles attributed to single authors. this equates to a document per author ratio of 0.439, signifying an average collaboration of two authors per document.

Table 1: Descriptive Information

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1981-2021
Sources (Journals, Books, etc.)	65
Documents	76
Average years from publication	8.74
Average citations per documents	13.26
Average citations per year per doc	1.317
References	2821
DOCUMENT TYPES	
Article	61
conference paper	11
Review	4
DOCUMENT CONTENTS	
Keywords Plus (ID)	427
Author's Keywords (DE)	220
AUTHORS	
Authors	173
Author Appearances	194
Authors of single-authored documents	10
Authors of multi-authored documents	163
AUTHORS COLLABORATION	
Single-authored documents	12
Documents per Author	0.439
Authors per Document	2.28
Co-Authors per Documents	2.55
Collaboration Index	2.55

4.3. TOP AUHOR IMPACT BASED ON CITATION

Table 2 represents the top authors which have a significant impact on Sustainability Disclosure related literature. the hierarchy of core authors is structured according to three key indices: h, g, and m. Leading this lineup is Freedman M, who extensively addresses the intricate correlation between pollution disclosure and economic performance through meticulous analysis. Following closely in the second position, Jaggi B takes on a dual role, both as a first author and a co-author alongside Freedman M, delving into the realm of environmental disclosure within the domain of polluting industries and its far-reaching implications for global warming. In a distinctive contribution, Chang K takes the stage to reveal compelling financial data extracted from China's heavily polluting industries, shedding light on their significant impact on environmental performance. Similarly, Li X undertakes a comprehensive study, centering on the analysis of environmental disclosure among listed steel companies and their performance within the given context. In an exploration of considerable import, STAGLIANO AJ examines the historical reverberations of the 1990 Clean Air Act in relation to pollution disclosure among electric companies. Shifting the focus to the realm of Chinese polluting industries, WANG J probes the intricate interplay between their environmental information disclosure and the attendant costs of debt financing. addressing the imperative of transparency, GREILING D delves into the realm of environmental reporting by electric companies, elucidating its significance for public awareness. In a broader global perspective, ALRAZI B engages in a thorough discourse on sustainability disclosure within the electric industry's purview. Finally, Li B brings forth a nuanced discussion, highlighting the influential role of China's chemical industry across various financial phases through the prism of environmental information disclosure.

Table 2: Auther Impect based on citation

Author	h_index	g_index	m_index	TC	NP	PY_start
FREEDMAN M	6	6	0.146	402	6	1981
JAGGI B	5	5	0.122	376	5	1981
CHANG K	3	3	0.333	29	3	2013
LI X	2	2	0.182	13	2	2011
STAGLIANO AJ	2	2	0.105	37	2	2003
WANG J	2	2	0.667	32	2	2019
GREILING D	1	3	0.333	9	3	2019
ALRAZI B	1	2	0.167	38	2	2016
LI B	1	1	0.077	3	2	2009
SLACIK J	1	1	0.333	1	2	2019

4.4. COUNTRY SCIENTIFIC PRODUCTION

Figure 2 illustrates the yearly scientific output concerning sustainability disclosure within publications focused on high-polluting industries. initially, there is a modest production, and from 1989 to 1993, no discernible publication trend emerges. However, starting from 1995, a resurgence in literature production becomes apparent, accompanied by a progressive upward trajectory in publication trends. Notably, a substantial surge is witnessed from 2018 to 2021, underlining a marked increase in output during this period.

4.5. CORE JOURNALS ARTICLES

The first paper in rank discusses the public companies has a nature of high polluting in industries and disclosure the environmental information by (Freedman and Jaggi 2005). Second paper in rank about the pollution information disclosure by polluting firms and their pollution and economic performance(Freedman and Jaggi 1982). Discuss the third rank paper about environmental disclosure by the chemical industry through the legitimacy or its changes(Laine 2009). fourth paper in rank discusses CSR reporting and disclosures by investors of the chemical and banking or insurance sector(Lock and Seele 2015). Fifth paper disclosure by the chemical industry and its regulations(Maule, Makey et al. 2013). The sixth paper discusses the electric industry its environmental disclosure from the perspective globally(Alrazi, De Villiers et al. 2016). Discuss the seventh paper in rank about disclosure made by the electric companies about the environmental performance in the phase of clean air act(Freedman and Stagliano 2008). Paper eight in which study conducted and gathered data from having polluting listed companies of china about environmental disclosure or debt financing cost(Luo, Guo et al. 2019). Ninth paper in which discuss the specifics of consumer-preferred labeling policies based on environmental disclosure of electric companies(Roe, Teisl et al. 2001). Tenth

paper in which discus the CSR disclosure of the chemical industry based on analyzing some cases of south Africa and Mexican(Acutt, Medina-Ross et al. 2004).

Figure 2. Annual scientific production

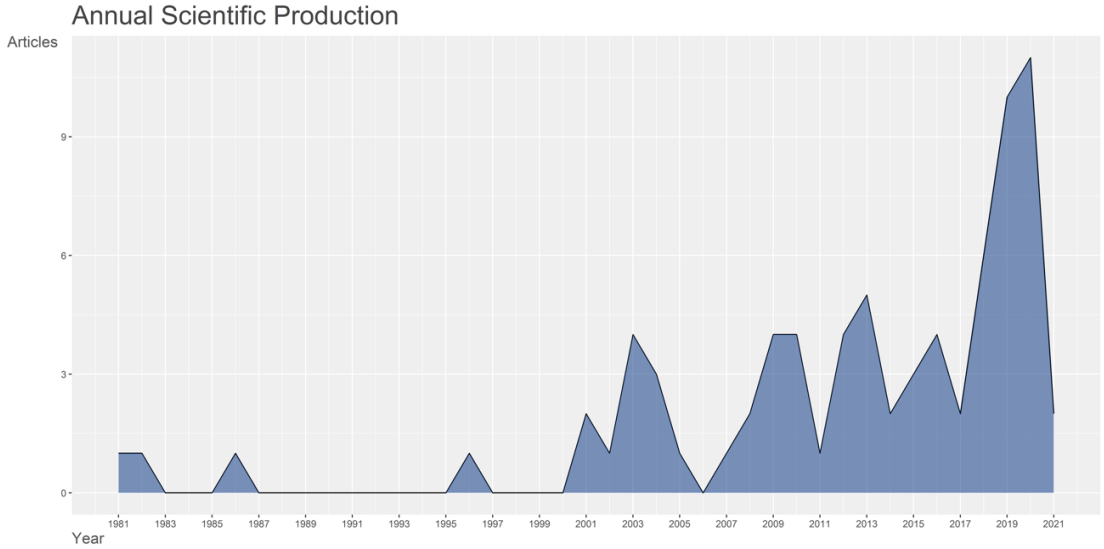

Table 3: Most globally cited articles

Paper	Total Citations	TC per Year	Normalized TC
Global warming, commitment to the Kyoto protocol, and accounting disclosures by the largest global public firms from polluting industries	186	10.9412	1
Pollution Disclosures, Pollution Performance, and Economic Performance	152	3.8	1
Ensuring legitimacy through rhetorical changes?: A longitudinal interpretation of the environmental disclosures of a leading Finnish chemical company	91	7	3.5686
Analyzing Sector-Specific CSR Reporting: Social and Environmental Disclosure to Investors in the Chemicals and Banking and Insurance Industry	48	6.8571	2.25
Disclosure Of Hydraulic Fracturing Fluid Chemical Additives: Analysis Of Regulations	46	5.1111	3.4848
The environmental disclosures of the electricity generation industry: a global perspective	37	6.1667	2.96
Environmental disclosures: electric utilities and Phase 2 of the Clean Air Act	26	1.8571	1.1064
Environmental information disclosure quality, media attention, and debt financing costs: Evidence from Chinese heavy polluting listed companies	25	8.3333	3.9683
Characteristics of Consumer-Preferred Labeling Policies: Experimental Evidence from Price and Environmental Disclosure for Deregulated Electricity Services	25	1.1905	1.9231
Perspectives on corporate social responsibility in the chemical sector: A comparative analysis of the Mexican and South African cases	23	1.2778	1.3269

4.6. CORRESPONDING AUTHOR'S COUNTRY

Table 4 provides a comprehensive overview of corresponding author countries, top 10 authors' corresponding countries are included. china takes the lead, securing the 1st position with 24 articles attributed to corresponding authors. among these, 19 articles pertain to SCP (Sustainability and Corporate Performance), while 5 delve into MCP (Market and Corporate Performance). Claiming the 2nd spot is the USA, with 13 articles designated under corresponding authorship. of these, 11 articles revolve around SCP, and the remaining 2 delve into MCP. Occupying the 3rd position is Finland, contributing 3 articles, each intricately tied to SCP. Austria and Switzerland secure the 4th and 5th positions, both with 2 publications apiece. among these, 1 publication from each country centers on SCP, while the other explores MCP.

Table 4: Corresponding author's country

Country	Articles	Freq	SCP	MCP	MC_Ratio
CHINA	24	0.4364	19	5	0.208
USA	13	0.2364	11	2	0.154
FINLAND	3	0.0545	3	0	0
AUSTRIA	2	0.0364	1	1	0.5
SWITZERLAND	2	0.0364	1	1	0.5
AUSTRALIA	1	0.0182	1	0	0
BRAZIL	1	0.0182	0	1	1
CANADA	1	0.0182	0	1	1
CZECH REPUBLIC	1	0.0182	1	0	0
INDIA	1	0.0182	1	0	0

4.7. MOST CITED COUNTRIES

Table 5 illustrates the countries associated with citations and also represent the regions' frequency of production over time. notably, China takes the lead in terms of publications, securing the top rank. the USA and Brazil claiming the 2nd and 3rd positions in the publication rankings. In the realm of citations, the USA commands the 1st rank, with China securing the 2nd position. Upon comparison, it becomes evident that the citation performance of the USA surpasses that of China. remarkably, China occupies the 2nd rank in citations while maintaining its preeminent status in publications.

Table 5: Top countries in terms of publications and citations

Country	Total Citations	Average Article Citations	Regions	Freq
USA	372	28.62	CHINA	51
CHINA	95	3.96	USA	36
FINLAND	91	30.33	BRAZIL	6
SWITZERLAND	69	34.50	ROMANIA	6
NEW ZEALAND	37	37.00	AUSTRIA	4
AUSTRIA	21	10.50	PORTUGAL	4
CANADA	21	21.00	UK	4
AUSTRALIA	15	15.00	AUSTRALIA	3
NORWAY	12	12.00	FINLAND	3
CZECH REPUBLIC	8	8.00	INDIA	3

4.8. MOST CITED SOURCES

To identify the journals whose publication related to sustainability disclosure in high polluting industries use the source impact and brad fords law. Table 2 represents the g. h. m-index, net production (NP), and total citation (TC) and publication starting per year (PY).

Corporate social responsibility (CSR) and environmental management play a pivotal role in driving sustainability disclosures within industries known for high levels of pollution. Recent scholarly works have shed light on this connection, delving into the empirical intricacies of environmental management vis-à-vis the corporate social responsibilities undertaken by businesses (Dubravská, Marchevská et al. 2020). Furthermore, another study focuses on the assessment of sustainability feasibility among Vietnamese firms and their corresponding societal obligations (Vuong, La et al. 2021). This investigation underscores the prevalent lack of comprehensive sustainability reporting and the suboptimal upkeep of environmentally sustainable practices, both of which contribute to a diminished performance role.

Table 6: Top ten journals according to source impact

Source	h_index	g_index	m_index	TC	NP	PY_start
Corporate Social Responsibility And Environmental Management	3	3	0.3	78	3	2012
Journal Of Cleaner Production	2	3	0.666666667	29	3	2019
Critical Perspectives On Accounting	2	2	0.142857143	47	2	2008
Energy Policy	2	2	0.105263158	33	2	2003
New Solutions	2	2	0.133333333	59	2	2007
Advances In Public Interest Accounting	1	2	0.047619048	16	2	2001
Chemical Engineering Transactions	1	2	0.2	7	2	2017
Sustainability (Switzerland)	1	1	0.5	1	2	2020
2009 Ieee International Symposium On Sustainable Systems And Technology, Issst '09 In Cooperation With 2009 Ieee International Symposium On Technology And Society, Istas	1	1	0.076923077	7	1	2009
Accounting And Business Research	1	1	0.166666667	37	1	2016

5. KEYWORD ANALYSIS

The term that appears most frequently in table 7 pertains to sustainability disclosure within industries characterized by high levels of pollution. These instances are categorized into four sections, encompassing a keyword, author-provided keyword, abstract, and title. among all the tables, "environmental disclosure" emerges as the most recurrent term. these keywords collectively revolve around the corporate social responsibilities undertaken by firms, which contribute to the underlying causes of environmental degradation. these specific keywords serve to illuminate the correlation between a company's divulgence concerning its environmental actions. Notably, the term "China" predominates in the section focusing on article keywords, while the remaining entries predominantly feature the widely employed term "environmental disclosure."

Figure 3 depicts a word cloud generated from the amalgamation of keywords. the prominence of a term within the cloud image corresponds to its frequency of use in the literature. notably, within this depiction, the terms "environmental performance," "electric utilities," and "global reporting initiatives" assume the largest dimensions, signifying their prevalence across the spectrum of words presented. This visual representation underscores their recurrent presence in the literature. Additionally, the term "disclosure" emerges as another frequently encountered keyword. The interconnectedness of these keywords converges to create a cohesive narrative, articulating the subject matter pertaining to environmental disclosure.

Figure 4 illustrates the evolution of words over various time series, portraying their growth patterns. within the depicted visual, the term "China" becomes noticeable, commencing its trajectory in 2005. However, it experiences a significant decline in 2007, followed by a notable resurgence in 2011, reaching its zenith. Similarly, the term "pollution" and the concept of "environmental information disclosure" both exhibit growth trends that commence after 2006. This figure serves as an instrument for the application of a progressive analytical technique that scrutinizes the progression of words over time. notably, terms such as "industry," "United States," and "chemical industry" all demonstrate a decline in growth subsequent to 2013.

Table 7: Most frequent words

Keyword Plus		Author Keywords	
Words	Occurrences	Words	Occurrences
environmental disclosure	10	environmental	43
environmental information disclosure	8	disclosure	40
electric utilities	5	evidence	19
environmental performance	5	industry	17
global reporting initiative	5	chemical	15
Disclosure	4	companies	15
Gri	4	pollution	14
content analysis	3	disclosures	11
corporate social responsibility	3	electric	11
environmental accounting	3	industries	11

Abstract		Article	
Words	Occurrences	Words	Occurrences
environmental	251	china	14
disclosure	198	industry	12
companies	116	pollution	12
pollution	78	united states	10
corporate	69	environmental information disclosure	9
disclosures	58	chemical industry	8
study	55	environmental information	8
performance	53	environmental protection	8
emissions	51	information disclosure	8
Firms	50	environmental impact	7

Figure 3: Word cloud

Figure 5 serves as a visual representation of affiliations in reporting. this diagram highlights China as the foremost contributor, ranking first in document publications pertaining to research. This encompassing category includes both single-author publications and those produced collaboratively by multiple authors. The United States follows as the second-highest contributor, succeeding China in affiliations. Finland secures the third position, specifically in the context of single-country publications. moving to the fourth position is Austria, significant for its article publications, which encompass both Single-Country Publications (SCP) and multi-Country Publications (MCP). Switzerland claims the fifth spot, with Australia in sixth place concerning country affiliations in publications. this roster of the top ten countries significantly shapes the relevant landscape of affiliations in sustainability disclosure within industries

marked by high pollution levels. For clarification, the term SCP pertains to publications originating from a single country, authored by individuals from the same nation. On the other hand, MCP refers to multi-author publications that feature participation from co-authors hailing from different countries.

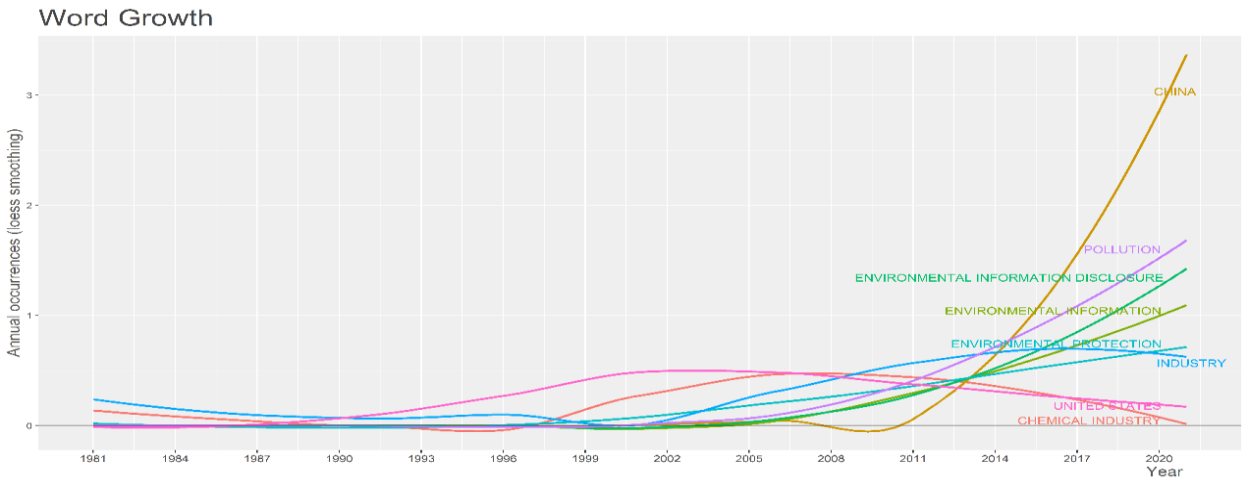

Figure 4: Word growth overtime

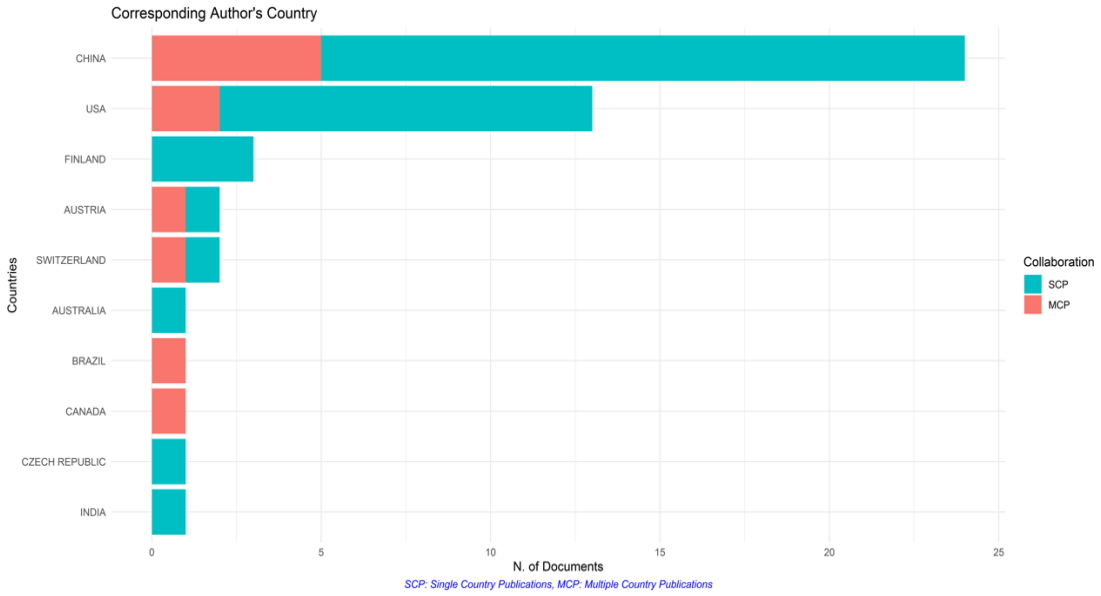

Figure 5: Most relevant affiliation

6. THREE-FOLD ANALYSIS

Examining the principal themes, geographical distribution, and institutional affiliations underpinning sustainability disclosure within publications focused on high-polluting industries becomes imperative. As depicted in Figure 6, an intricate visualization of affiliations within these publications is presented. this figure encapsulates a threefold analysis, delineating keywords on the left, affiliations on the right, and countries of interest in the middle. the visual representation highlights China's prominent role in spearheading affiliations related to these vital themes. Moreover, substantial contributions from the United States in affiliations pertaining to pertinent topics are evident. Conversely, nations like Canada, Australia, and New Zealand exhibit comparatively modest affiliations in the discourse surrounding these thematic publications.

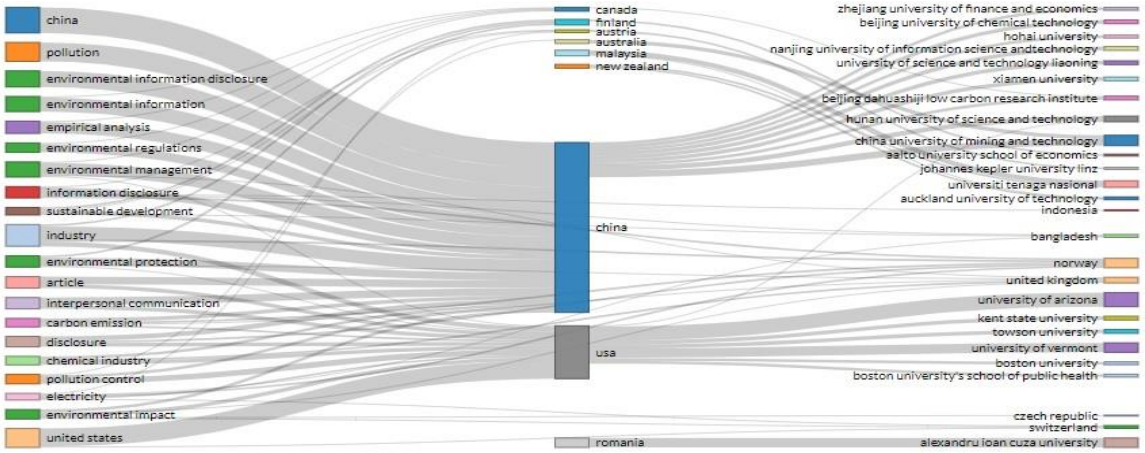

Figure 6: Three-fold analysis of sustainability disclosure in high polluting industrie

7. CONCEPTUAL FRAMEWORK

This part holds paramount importance in comprehending the intricate interconnections existing among the keywords, accomplished through the utilization of thematic analysis. Within this framework, a co-occurrence network is harnessed to unveil the evolving themes intricately linked with sustainability disclosure within industries characterized by heightened pollution levels.

7.1. CO-OCCURRENCE NETWORK

Figure 7 vividly illustrates the interrelation of keywords through a co-occurrence network, crafted utilizing the R-package biblioshiny. within this visual representation, four distinct clusters emerge. Notably, the central cluster, depicted in red, holds a pivotal significance. this cluster is chiefly aligned with the core subject of environmental disclosure and its pronounced impact on a company's environmental performance.

Figure 7: Co-occurrence network

This thematic focus underpins the prominence of the red cluster. The blue cluster, on the other hand, spotlights the interconnectedness between industries that contribute to pollution, with particular emphasis on electric utilities. It sheds light on how these industries intertwine with environmental performance reporting, as well as their endeavors to meet the stringent requirements and standards set forth by global reporting initiatives, all in pursuit of mitigating climate change. The pink cluster accentuates the correlation between companies' environmental information disclosure and their implications on ownership structures, specifically delving into ownership concentration. This thematic nexus is elegantly represented within this cluster. lastly, the purple cluster encapsulates the realm of environmental financial reporting, enshrined in adherence to the standards stipulated by the Global Reporting Initiative (GRI). This thematic domain finds its articulation within the purple cluster, delineating a comprehensive view of financial reporting with environmental sustainability as its cornerstone.

8. CONCLUSION

The study endeavors to introduce an innovative approach in delineating pivotal dimensions within the realm of sustainability disclosure for high-polluting industries. Through meticulous analysis, a compilation of seventy-six scholarly articles spanning various journals was assembled, revealing consequential and influential facets within the literature on sustainability disclosure. These pivotal facets not only offer a foundation for forthcoming research directions in the context of sustainability disclosure but also within the purview of corporate capital structure considerations. The study underscores that the preeminent journal for delving into the domain of sustainability disclosure is "Corporate Social Responsibility and Environmental Management." Appraising the publication landscape through the lens of Bradford's Law, it becomes evident that ten journals have been instrumental in disseminating literature concerning sustainability disclosure. Among these, "Corporate Social Responsibility and Environmental Management" stands as a paramount repository for insights into sustainability disclosure within high-polluting industries. In the pursuit of pertinent literature, the central keyword has been identified as "sustainability." this keyword serves as the nucleus around which four distinct categories of core terms orbit: keyword plus, author keywords, abstract, and title. notably, the phrase "environmental disclosure" emerges as the most recurrent among these core terms. At the vanguard of authorship, Freedman M garners the top rank, illuminating the correlation between disclosure of pollution and economic performance. In the panorama of affiliations, China takes the lead, both in terms of publication and citation impact, solidifying its prominence in the discourse on sustainability disclosure. simultaneously, the United States attains the first position among nations in terms of citation impact. This research unearths a prominent collaborative partnership between China and the United Kingdom in the pursuit of advancing this field of study. Within the conceptual framework, the study employs the 'biblioshiny' R-package to unveil core streams and thematic trajectories. this provides a structured outlook by identifying essential foundations for future explorations within this scholarly domain.

8.1. FUTURE RECOMMENDATIONS

The research offers a thorough overview of the literature on sustainability disclosure, it also opens up potential avenues for future action among societal leaders, financial institutions, and governments.

i. Further research can delve into how corporate environmental information disclosure and the quality of disclosed environmental data affect corporate debt financing costs. this can be achieved by broadening the sample size and acknowledging differences across industries.
ii. Future studies could compare environmental disclosure practices among companies from different countries, including those subject to environmental regulations and those exempt from them. these comparisons could involve additional proxies and theoretical approaches. additionally, the disclosure practices of potentially polluting companies could be juxtaposed with those that are not potentially polluting.
iii. Subsequent research endeavors could amalgamate data on corporate environmental investments to foster a more comprehensive comprehension of the consequences of air pollution on corporate entities.
iv. This research primarily focuses on heavily polluting listed companies. further research can continue by examining how corporate environmental information disclosure and the quality of disclosed environmental data impact corporate debt financing costs. this can be achieved by enlarging the sample size and accounting for industry-specific differences.

8.2. LIMITATIONS OF THE STUDY

This study has its limitations, primarily stemming from the fact that the data exclusively originates from the set of high-pollution industries specified in the list. Another notable constraint pertains to the relatively fewer instances of author-provided keywords, especially when contrasted with the utilization of combined keywords and supplementary terms. Onsequently, the integration of these extended keyword combinations plays a pivotal role in the cultivation of diverse thematic dimensions.

REFERENCES

Acutt, N. J., (2004). Perspectives on corporate social responsibility in the chemical sector: A comparative analysis of the Mexican and South African cases. Natural Resources Forum, Wiley Online Library.

Aerts, W., (2008). Corporate environmental disclosure, financial markets and the media: An international perspective. *Ecological economics* 64(3), 643-659.

Alrazi, B., (2016). The environmental disclosures of the electricity generation industry: a global perspective. *Accounting and Business Research* 46(6), 665-701.

Andrés, A. (2009). Measuring academic research: How to undertake a bibliometric study, Elsevier.

Arslan, H. M., Chengang, Y., Komal, B., & Chen, S. (2023). Nexus between environmental disclosures and top management team characteristics: a systematic review. *Environmental Science and Pollution Research, 30*(4), 9763-9781.

Arslan, H. M., Chengang, Y., Bilal, Siddique, M., & Yahya, Y. (2022). Influence of senior executives characteristics on corporate environmental disclosures: a bibliometric analysis. *Journal of Risk and Financial Management, 15*(3), 136.

Arslan, H., & Bashir, M. (2021). Contemporary research on spillover effects of COVID-19 in stock markets. A systematic and bibliometric review.

Benlemlih, M., et al. (2018). "Environmental and social disclosures and firm risk. *Journal of business ethics*, 152(3), 613-626.

Bi, Q., (2012). Environmental information disclosure system, corporate governance and environmental information disclosure. *Accounting Research Study* 7, 39-47.

Bilal, Gerged, A. M., Arslan, H., Abbas, A., Chen, S., & Manzoor, S. (2023). A bibliometric review of corporate environmental disclosure Literature. *Journal of Accounting Literature*. 2022-0006

Buhr, N. and M. Freedman (2001). Culture, institutional factors and differences in environmental disclosure between Canada and the United States. *Critical Perspectives on Accounting*, 12(3), 293-322.

Change, I. P. O. C., et al. (2007). Climate Change 2007: Synthesis Report Summary for Policymakers. Valencia: IPCC.

CHANGE, O. C. (2007). Intergovernmental panel on climate change. World Meteorological Organization.

Cho, C. H. and D. M. Patten (2007). The role of environmental disclosures as tools of legitimacy: A research note. *Accounting, organizations and society*, 32(7-8), 639-647.

Clarkson, M. B. (2016). A stakeholder framework for analysing and evaluating corporate social performance, University of Toronto Press.

Clarkson, P. M., et al. (2008). Revisiting the relation between environmental performance and environmental disclosure: An empirical analysis. *Accounting, organizations and society*, 33(4-5), 303-327.

Cobo, M. J., et al. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for information Science and Technology*, 62(7), 1382-1402.

Comyns, B. (2016). Determinants of GHG reporting: An analysis of global oil and gas companies. *Journal of business ethics*, 136(2), 349-369.

Cormier, D. and I. M. Gordon (2001). An examination of social and environmental reporting strategies. *Accounting, Auditing & Accountability Journal*.

Cowan, S. and D. Gadenne (2005). Australian corporate environmental reporting: a comparative analysis of disclosure practices across voluntary and mandatory disclosure systems. *Journal of Accounting & Organizational Change*.

da Silva Monteiro, S. M. and B. Aibar-Guzmán (2010). Determinants of environmental disclosure in the annual reports of large companies operating in Portugal. *Corporate Social Responsibility and Environmental Management* 17(4), 185-204.

de Klerk, M. and C. de Villiers (2012). The value relevance of corporate responsibility reporting: South African evidence. Meditari Accountancy Research.

De Klerk, M., et al. (2015). The influence of corporate social responsibility disclosure on share prices. *Pacific Accounting Review*.

de Sousa Jabbour, A. B. L., et al. (2018). Industry 4.0 and the circular economy: a proposed research agenda and original roadmap for sustainable operations. *Annals of Operations Research* 270(1), 273-286.

Deegan, C. and M. Rankin (1996). Do Australian companies report environmental news objectively? An analysis of environmental disclosures by firms prosecuted successfully by the Environmental Protection Authority. *Accounting, Auditing & Accountability Journal*.

Dubravská, M., et al. (2020). Corporate Social Responsibility and Environmental Management Linkage: An Empirical Analysis of the Slovak Republic. *Sustainability* 12(13), 5431.

Endrikat, J., et al. (2014). Making sense of conflicting empirical findings: A meta-analytic review of the relationship between corporate environmental and financial performance. European Management Journal 32(5), 735-751.

Freedman, M. and B. Jaggi (1982). Pollution disclosures, pollution performance and economic performance. *Omega* 10(2), 167-176.

Freedman, M. and B. Jaggi (2005). "Global warming, commitment to the Kyoto protocol, and accounting disclosures by the largest global public firms from polluting industries." The International Journal of Accounting 40(3), 215-232.

Freedman, M. and A. Stagliano (2008). Environmental disclosures: electric utilities and Phase 2 of the Clean Air Act. *Critical Perspectives on Accounting*, 19(4), 466-486.

Gray, R., et al. (1995). Corporate social and environmental reporting. *Accounting, Auditing & Accountability Journal*.

Gray, R., et al. (1996). Accounting & accountability: changes and challenges in corporate social and environmental reporting, Prentice Hall.

Hackston, D. and M. J. Milne (1996). Some determinants of social and environmental disclosures in New Zealand companies. *Accounting, Auditing & Accountability Journal*.

Haniffa, R. M. and T. E. Cooke (2002). Culture, corporate governance and disclosure in Malaysian corporations. *Abacus* 38(3), 317-349.

Haque, F. and C. G. Ntim (2018). Environmental policy, sustainable development, governance mechanisms and environmental performance. *Business Strategy and the environment* 27(3), 415-435.

Laine, M. (2009). Ensuring legitimacy through rhetorical changes? A longitudinal interpretation of the environmental disclosures of a leading Finnish chemical company. Accounting, Auditing & Accountability Journal.

Lawrence, S. R., et al. (2013). Does accounting construct the identity of firms as purely self-interested or as socially responsible? *Meditari Accountancy Research*.

Li, H., et al. (2016). "Evolutionary features of academic articles co-keyword network and keywords co-occurrence network: Based on two-mode affiliation network. *Physica A: Statistical Mechanics and its Applications*, 450, 657-669.

Li, H., Arslan, H. M., Mousa, G. A., Bilal, Abbas, A., & Dwyer, R. J. (2023). Exploring sustainability disclosures in family firms: a bibliometric analysis. *Economic Research-Ekonomska Istraživanja, 36*(3), 2188238.

LI, Q. and B. FENG (2015). Do companies quietly disclose environmental information? A study of the relationship between environmental investment and environmental information disclosure quality under the pressure of competition. *Journal of Zhongnan University of Economics and Law*, 04.

Liu, X. and V. Anbumozhi (2009). Determinant factors of corporate environmental information disclosure: an empirical study of Chinese listed companies. *Journal of Cleaner Production* 17(6), 593-600.

Lock, I. and P. Seele (2015). Analyzing sector-specific CSR reporting: Social and environmental disclosure to investors in the chemicals and banking and insurance industry. *Corporate Social Responsibility and Environmental Management* 22(2), 113-128.

Lu, J., et al. (2020). Sustainability of enterprise export expansion from the perspective of environmental information disclosure. *Journal of Cleaner Production* 252, 119839.

Lu, Y. and I. Abeysekera (2014). Stakeholders' power, corporate characteristics, and social and environmental disclosure: evidence from China. *Journal of Cleaner Production*, 64, 426-436.

Lu, Y. and I. Abeysekera (2017). What do stakeholders care about? Investigating corporate social and environmental disclosure in China. *Journal of business ethics*, 144(1), 169-184.

Luo, W., et al. (2019). Environmental information disclosure quality, media attention and debt financing costs: Evidence from Chinese heavy polluting listed companies. *Journal of Cleaner Production* 231, 268-277.

Massa, L., et al. (2015). Developing a sustainability report in a small to medium enterprise: process and consequences. Meditari Accountancy Research.

Maule, A. L., et al. (2013). Disclosure of hydraulic fracturing fluid chemical additives: analysis of regulations. *New Solutions: A Journal of Environmental and Occupational Health Policy*, 23(1), 167-187.

Mahmood, A. N., Arslan, H. M., Younas, Z. I., Komal, B., Ali, K., & Mubeen, M. (2023). Understanding the dynamics of capital structure, corporate governance, and corporate social responsibility in high-and low-leveraged US and Chinese firms. *Environmental Science and Pollution Research*, *30*(16), 46204-46221.

Meng, X., et al. (2014). The relationship between corporate environmental performance and environmental disclosure: An empirical study in China. *Journal of environmental management*, 145, 357-367.

Meng, X., et al. (2019). Beyond symbolic and substantive: Strategic disclosure of corporate environmental information in China. *Business Strategy and the environment* 28(2), 403-417.

Moral-Muñoz, J. A., et al. (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review.

Moser, D. V. and P. R. Martin (2012). A broader perspective on corporate social responsibility research in accounting. The accounting review 87(3), 797-806.

Nurhayati, R., et al. (2015). Investigating social and environmental disclosure practices by listed Indian textile firms. *The Journal of Developing Areas* 49(6), 361-372.

O'Donovan, G. (1999). Managing legitimacy through increased corporate environmental reporting: an exploratory study. *Interdisciplinary Environmental Review*, 1(1), 63-99.

Ortas, E., et al. (2015). Financial factors influencing the quality of corporate social responsibility and environmental management disclosure: A quantile regression approach. *Corporate Social Responsibility and Environmental Management* 22(6), 362-380.

Patten, D. M. (1991). Exposure, legitimacy, and social disclosure. *Journal of Accounting and public policy*, 10(4), 297-308.

Patten, D. M. (1992). Intra-industry environmental disclosures in response to the Alaskan oil spill: a note on legitimacy theory. *Accounting, organizations and society*, 17(5), 471-475.

Patten, D. M. (2002). "The relation between environmental performance and environmental disclosure: a research note. *Accounting, organizations and society* 27(8), 763-773.

Pucheta-Martínez, M. C. and I. Gallego-Álvarez (2020). Corporate environmental disclosure practices in different national contexts: The influence of cultural dimensions. *Organization & Environment* 33(4), 597-623.

Revkin, A. (2001). Global warming impasse is broken. New York Times A 1: 8.

Roberts, R. W. (1992). Determinants of corporate social responsibility disclosure: An application of stakeholder theory. *Accounting, organizations and society* 17(6), 595-612.

Roe, B., et al. (2001). Characteristics of consumer-preferred labeling policies: experimental evidence from price and environmental disclosure for deregulated electricity services. *Journal of Consumer Affairs*, 35(1), 1-26.

Ramos-Meza, C. S., Zhanbayev, R., Bilal, H., Sultan, M., Pekergin, Z. B., & Arslan, H. M. (2021). Does digitalization matter in green preferences in nexus of output volatility and environmental quality? *Environmental Science and Pollution Research*, *28*, 66957-66967.

Sahay, A. (2004). Environmental reporting by Indian corporations. *Corporate Social Responsibility and Environmental Management* 11(1), 12-22.

Tripathi, M., et al. (2018). Occurrence of author keywords and keywords plus in social sciences and humanities research: A preliminary study. *COLLNET Journal of Scientometrics and Information Management*, 12(2), 215-232.

Ullmann, A. A. (1985). Data in search of a theory: A critical examination of the relationships among social performance, social disclosure, and economic performance of US firms. *Academy of management review*, 10(3), 540-557.

Vormedal, I. and A. Ruud (2009). Sustainability reporting in Norway–an assessment of performance in the context of legal demands and socio-political drivers. *Business Strategy and the environment*, 18(4), 207-222.

Vuong, Q. H., et al. (2021). Identifying the moral–practical gaps in corporate social responsibility missions of Vietnamese firms: An event-based analysis of sustainability feasibility. *Corporate Social Responsibility and Environmental Management*, 28(1), 30-41.

Wang, P., et al. (2018). The Effect of Ultimate Ownership on the Disclosure of Environmental Information. *Australian Accounting Review* 28(2), 186-198.

Wiseman, J. (1982). An evaluation of environmental disclosures made in corporate annual reports. *Accounting, organizations and society* 7(1), 53-63.

Ye, C., et al. (2015). External governance, environmental information disclosure and the cost of equity financing. *Nankai Business Review* 18(5): 85-96.

Zeng, S., et al. (2010). Towards corporate environmental information disclosure: an empirical study in China. *Journal of Cleaner Production* 18(12), 1142-1148.

Zupic, I. and T. Čater (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, 18(3): 429-472.