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Climate change reporting: a systematic literature review

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Abstract: Climate change is one of the most crucial issues with implications for the natural environment, communities, economies, and companies worldwide. In particular, companies are subject to growing pressures to communicate their climate risks, carbon mitigation initiatives, achievements, and opportunities. This paper thus explores the status of the research on climate change reporting and future research perspectives through a systematic literature review of 80 articles published in influential accounting and management journals from 2015 to 2021. Our overview demonstrates that since climate change reporting is mainly voluntary, the lack of universally recognised standards and guidelines makes it difficult to compare research. Several drivers affect climate change reporting, while companies have to identify, manage, and report their climate-related risks to establish mitigation actions. This review therefore highlights specific opportunities to integrate and expand the existing climate change reporting knowledge, offering new insights for future research.

Keywords: climate change reporting; GHG emissions; carbon reporting; voluntary disclosure; climate risk; systematic literature review.

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1 Introduction

In recent decades, climate change has become a dominant issue. A wide range of entities (e.g., national governments, nongovernmental organisations, companies, investors, and citizens) worldwide have gained an awareness of the need to take joint action to control carbon greenhouse gas (GHG) emissions to create an economy with low carbon emissions and high resilience to climate change (EC, 2019a; European Parliament and European Commission, 2021; UNEP, 2021).

This surge of attention towards climate change issues has been accompanied by a call for more corporate disclosures of global warming impacts and their associated risks and a push to develop guidelines and regulations on carbon information disclosures (Kolk et al., 2008; Solomon et al., 2011; Harsky, 2012; Borghei et al., 2016; Talbot and Boiral, 2018).

Several terms have been used to determine the accounting and reporting tools for emissions, for example, carbon accounting and reporting, climate change accounting and reporting or GHG accounting and reporting. The literature has sought to define these concepts; however, there is still no shared definition (Ascui and Lovell, 2011; Hahn et al., 2015). Unless otherwise stated, we use climate change reporting as an umbrella term to refer to all forms of outward-facing reporting on climate-related information. Generally, climate change disclosure is part of a nonfinancial report (e.g., sustainability report, environmental report), but it can also be a standalone report (e.g., climate change report, carbon report). It is mainly voluntary, although there is a growing development of regulations that require the mandatory reporting of certain climate-related information. Indeed, this is, for example, the case for the non-financial reporting directive (NFRD), adopted in European countries, which requires large public-interest companies to disclose social and employee-related matters and environmental issues, including climate change information (EC, 2014, 2019b, 2021). In the UK, listed companies must provide a report disclosing their annual GHG emissions and other nonfinancial and sustainability information under the Companies Act 2006 (Tang and Demeritt, 2018; Companies Act 2006 – Section 414CB).

An available channel for disclosures about GHG emissions is the CDP (formerly, the carbon disclosure project), which collects carbon data from the world's largest listed firms that voluntarily participate in a yearly questionnaire.

Several standards (Global Reporting Initiative-GRI-Standards, 2021; Sustainability Accounting Standards Board-SASB-Standards, 2018, 2020), frameworks (World Business Council for Sustainable Development-WBCSD and World Resources Institute-WRI, 2004; Climate Disclosure Standards Board-CDSB, 2019) and guidelines (EC, 2019b) can be adopted to disclose information about carbon performance and other carbon-related issues. Many existing standards focus on the disclosure of climate-related information; however, they do not consider information concerning the financial implications of climate-related aspects. The recommendations developed by the Task Force on Climate-Related Financial Disclosures-TCFD (2017, 2021a) aim to close this gap by encouraging organisations to evaluate and disclose their climate-related risks and opportunities as part of the annual financial reporting processes related to their business activities. The European Commission (EU) has also issued a communication aimed at helping companies provide nonfinancial information relating to the climate in a relevant, useful, consistent, and comparable way. This communication specifies that companies are encouraged to integrate climate-related information with other financial and nonfinancial information, as appropriate, in their reports (EU, 2019). Recently, the CDP, CDSB, GRI,

International Integrated Reporting Council (IIRC), and SASB have issued a joint statement of intent, outlining a vision for a comprehensive corporate reporting system and their commitment to work together to achieve it (CDP et al., 2020a). In their view, the components of the current frameworks and standards, along with the recommendations set out by the TCFD, can be used together to provide a starting point for the development of a new prototype standard for climate-related financial disclosures (CDP et al., 2020b). Moreover, several accounting boards (e.g., Australian Accounting Standards Board and Auditing and Assurance Standards Board-AASB/AUASB, 2019; International Financial Reporting Standard-IFRS, 2020; The International Auditing and Assurance Standards Board-IAASB, 2020) have activated reporting requests on GHG emissions in addition to traditional financial information. All these initiatives will also play an important role in the IFRS Foundation's project to develop, via the recently created International Sustainability Standards Board (ISSB) (3 November 2021), a new set of sustainability reporting standards (IFRS Foundation, 2021).

The research community has shown an increased interest in this topic, and a growing number of publications have emphasised the current climate emergency and the need to regulate (e.g., McNicholas and Windsor, 2011; Whiteman et al., 2013), measure (e.g., Milne and Grubnic, 2011; Cooper and Pearce, 2011) and disclose GHG emissions (e.g., Gibassier and Schaltegger, 2015; Pitrakkos and Maroun, 2020).

Therefore, given that climate change is attracting growing political and public attention, there is an ongoing push towards the necessity to report on corporate climate change performance in financial and nonfinancial reports. Although much research on climate change issues has been published in recent years, this research remains fragmented. Accordingly, we suggest that a systematic literature review can help identify the trends, coherences, and caveats regarding this emerging issue.

Recently, other reviews have been published on carbon accounting and reporting in the accounting literature (Velte et al., 2020; He et al., 2021; Borghei, 2021). However, in contrast to our literature review, those of Velte et al. (2020) and He et al. (2021) primarily focus on the governance-related determinants and financial consequences of carbon performance and disclosure and carbon accounting, respectively. These studies are also limited to papers published in 2018 (He et al., 2021) and 2019 (Velte et al., 2020). Borghei (2021) performs a systematic literature review of the carbon disclosure literature by considering papers published in the business economics area until February 2020. Thus, the extant research lacks the most recent developments in climate reporting research. In contrast, our review includes articles published up to the end of 2021 in the business, management and accounting areas. Moreover, unlike the other reviews, we perform content analysis using NVivo software and collect specific bibliometric data using VOSviewer software. Therefore, the aim of our systematic literature is to answer the following research questions:

RQ1 How is the research on climate change reporting and carbon reporting progressing?

RQ2 What are the main themes of the future research in this field?

Our thematic analysis reveals three main groups of findings: voluntary versus mandatory climate change reporting; the drivers of climate change disclosure; and the relevance of climate change risk and climate-related risk disclosure. These findings thus contribute to

a comprehensive and holistic overview of the published research and shed light on future research streams in this area. Overall, then, our literature review extends and complements the current body of knowledge on climate change reporting research (Velte et al., 2020; Borghei, 2021; He et al., 2021).

The remainder of the paper is structured as follows: the next section presents the research method we used to analyse the literature. The article then provides the results of our descriptive and thematic analysis. The final section provides our concluding remarks and describes some avenues for future research.

2 Research method

We adopt the systematic literature review approach to investigate climate change reporting from 2015 to 2021. According to Tranfield et al. (2003), Massaro et al. (2016), and Fink (2010), such a literature review is a systematic, explicit, and replicable method for identifying, evaluating, and synthesising an existing body of completed works by researchers, scholars, and practitioners with the aim of developing research questions, insights, critical reflections, and future research directions. According to Tranfield et al. (2003), a systematic review is the most efficient and high-quality method for identifying and evaluating an extensive literature. Conducting a systematic literature review involves the following main stages (Tranfield et al., 2003; Fink, 2010), which are applied in this study:

- Planning the review: identify the research questions and develop the review protocol.
- Conducting the review: select the article sources, choose search terms and keywords, define screening criteria, extract data, apply inclusion and exclusion criteria, and analyse data.
- Reporting and dissemination: perform descriptive and thematic analyses and synthesise the results.
- Identifying future research areas.

The last two stages, namely, reporting and dissemination and identifying future research areas, are described below in separate paragraphs.

2.1 Planning the review

Once the research questions are defined, an important step in conducting a systematic literature review is drafting the review protocol, a document describing the process that will be followed, the review questions, and the methodology that will be used to increase the reliability and objectivity of a study (Tranfield et al., 2003; Massaro et al., 2016). The information specified in the following review protocol is employed in the subsequent article coding process with NVivo software. The review protocol is divided into two main sections: the first offers bibliographic information on the papers; the second provides some content information from each article.

Table 1 The review protocol

Bibliographic information	
Authors	Who is (are) the author(s) of the publication?
Title	What is the title of the publication?
Year	In which year was the article published?
Journal name	What is the name of the journal?
Geographical area	What is the location of the article's author?
Content information	
Keywords	What are the keywords of the article?
Research method	What is the research method used in the article?

2.2 Conducting the review

After drawing up the research questions and developing the review protocol, the review process continues with the bibliography search, the extraction of suitable articles, and the coding of these with NVivo software. The first step taken by the authors was the database choice. For this study, as climate change is analysed from an accounting view and not a nature-based perspective, two databases were selected: Scopus and the Web of Science. Therefore, two parallel searches were carried out in both databases: the first on the issue of climate change reporting and the second on carbon reporting. Each search began with a definition of search terms based on the concepts framing our research questions (Fink, 2010). A keyword search was launched within 'article title, abstract, keywords' in the Scopus database; in the Web of Science database, we conducted a search in 'topic', i.e., 'Title, abstract, author keywords, and keywords plus'.

The table below summarises the articles' extraction process, including all the keywords and screening criteria we applied, which we deemed the most appropriate for the study (Massaro et al., 2016).

The authors set 2015 as the starting year for the review to investigate what occurred in the literature following the Paris Agreement (December 2015), which brought all nations together to combat global warming and adapt to climate change, and following this launch, by the United Nations' Agenda 2030. Indeed, the inclusion of sustainable development goal (SDG) 13 on climate action, which specifically focuses on climate change, highlights the global significance of this issue.

The application of the screening criteria restricted the number of articles, generating 190 articles on climate change and 198 on carbon emissions.

Further skimming of these articles entailed removing duplicates, totalling 152. At this stage, an essential activity is deciding the criteria for including and excluding articles (Tranfield et al., 2003; Fink, 2010). Therefore, to ascertain whether the remaining articles were relevant, the following exclusion criterion was applied: articles not dealing with the topic of climate change and carbon reporting were excluded. The Figure 1 summarises our article selection process.

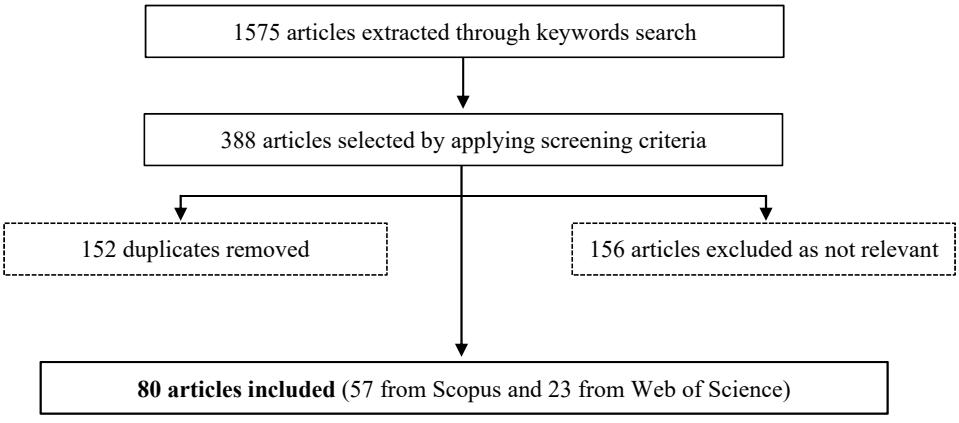
Table 2 Overview of the articles' extraction process

Climate change			
Scopus		*Web of Science*	
Keywords: (corporate AND climate AND change AND reporting) OR (corporate AND climate AND change AND accounting)			
Timespan	2015–2021	Timespan	2015–2021
Subject area	Business, Management and Accounting	Research area	Business economics
Document type	article	Document type	article
Source type	Journal	Web of Science categories	business; management
Language	Only English	Language	Only English
		Citation indexes	SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, ESCI (exclusion of A&HCI, BKCI-S, BKCI-SSH, CCR-EXPANDED, IC)
Carbon/emissions			
Scopus		*Web of Science*	
Keywords: (corporate AND carbon AND reporting) OR (corporate AND carbon AND accounting) OR (corporate AND GHG AND reporting) OR (corporate AND GHG AND accounting) OR (corporate AND greenhouse AND gases AND emissions AND reporting) OR (corporate AND greenhouse AND gases AND emissions AND accounting)			
Timespan	2015–2021	Timespan	2015–2021
Subject area	Business, Management and Accounting	Research area	Business economics
Document type	article	Document type	Article
Source type	Journal	Web of Science categories	business; management
Language	Only English	Language	Only English
		Citation indexes: SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, ESCI (exclusion of A&HCI, BKCI-S, BKCI-SSH, CCR-EXPANDED, IC)	

The next step in conducting a literature review is the analysis of the articles that are included in the sample. The authors employed qualitative data analysis software (QDAS) to code the articles, as these programs provide tools for data analysis (O'Neill et al., 2018). NVivo software was used in this review to help the authors code the articles and develop graphs of the results (Massaro et al., 2016). To code the information and analyse the articles, it was first necessary to import all the references in NVivo. Afterwards, the NVivo nodes for coding were created according to the review protocol established in the first stage.

All data and information of articles listed in the references were coded by one of the authors and then shared and discussed with the other.

Figure 1 Overview of the articles' selection process



The next paragraphs describe the descriptive and thematic analyses we performed. The former provided some insights into the contributions to the field (Tranfield et al., 2003), determining the categories of analysis. In contrast, our thematic analysis focused on the articles' content to identify research trends and relevant themes to answer our research questions (Braun and Clarke, 2012). The authors carefully read and examined the content of each article to familiarise themselves with the articles and identify common areas. Then, the collected data were coded and grouped into homogenous categories to generate several themes. According to Braun and Clarke (2012), a theme captures an important quality of data in relation to a research question; therefore, this stage facilitates exploring the relationships between themes. Afterwards, the authors named and reviewed the selected themes according to the coding data (Braun and Clarke, 2012) to test the quality of the entire analysis.

3 Results of the descriptive analysis

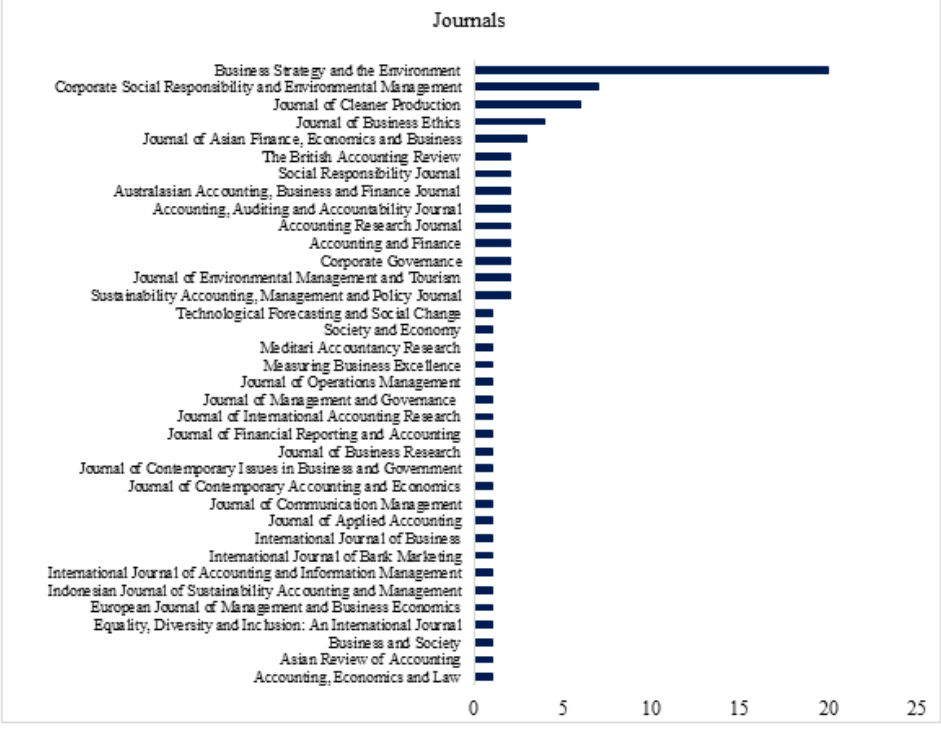
Descriptive analysis is part of the third stage of conducting a literature review, namely, reporting and dissemination. This analysis was performed with NVivo software and VOSviewer software. After coding all the articles according to the node classification, NVivo tools were used to create summary graphs and present the results related to the distribution of articles over time, the most frequent journals, and the geographical areas. The most frequently occurring keywords and research methodologies were also included in this descriptive analysis.

With regard to publication year, the descriptive analysis highlighted that the year with the largest number of published articles is 2021 (26.25%), followed by 2020 (17.5%), 2019 (15%), and 2018 (11.25%). In contrast, in 2015, 2016, and 2017, the number of articles published was fixed at 8 (10%). As a result, as shown in Figure 2, the trend of publications on climate change and carbon emissions reporting has increased over time due to the growing interest in this topic.

Figure 2 Overview of articles published from 2015 to 2021 (see online version for colours)

The articles we analysed were published in 36 journals. Business strategy and the environment had the highest number of publications, with 20 articles. Figure 3 shows the publication frequencies for each journal. The multitude of journals that have published articles on climate change and emissions reporting suggests the relevance and cross-sectional nature of the topic and implies the interest of several journals in addressing this issue.

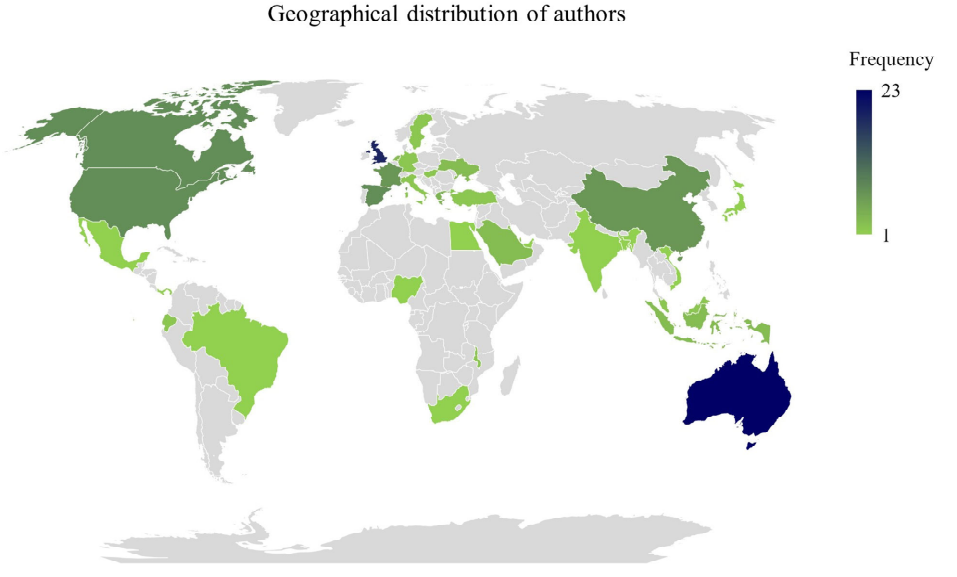
Figure 3 Journals (see online version for colours)



Regarding the geographical areas of the publications, our descriptive analysis showed that the most productive region is Europe, as 39.34% of authors came from this area. Asia is the second most productive area (20.49%), followed by Australia (18.85%) and North America (13.93%). Among the least productive areas are Africa (with 4.10% of the

authors), South America and New Zealand (with 2.46% and 0.82%, respectively). Figure 4 shows the geographical distribution of these authors, highlighting in blue the countries with the highest number of authors and in green those with the lowest number. These results suggest that it is primarily the researchers in the most industrialised countries (e.g., Australia, UK, Canada, Spain, USA, France) who have investigated topics related to climate change and carbon emissions. Hence, authors from certain developing countries (e.g., Indonesia, Ukraine) have paid less attention to these issues.

Figure 4 Geographical distribution of authors (see online version for colours)



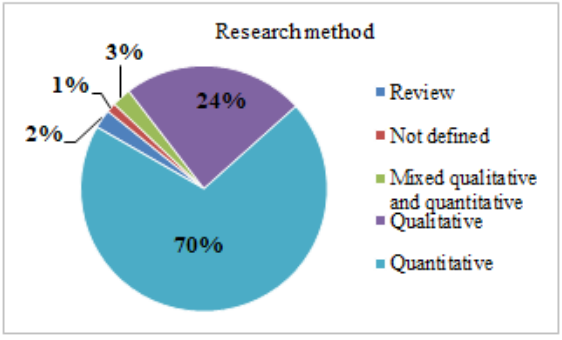
Another significant analysis was screening for the most frequently occurring authors, i.e., those who had published the most contributions in our sample of articles. Table 3 demonstrates that the authors with the largest contributions come from Australia and the UK; this is consistent with the results we obtained by analysing the most productive nations, namely, the UK and Australia.

Table 3 Most frequent authors

Authors	*Location*	*Frequency*
Luo L.	Australia	6
Tang Q.	Australia	6
Elnahass M.	UK	3
Salama A.	UK	3
Chithambo L.	UK and Malawi	3

The most frequent research methodology discerned by the authors is quantitative (70%), represented mainly by the regression analyses in 61.25% of the articles. On the other hand, 23.75% of the articles adopt a qualitative research methodology, while mixed approaches are the least common.

Figure 5 Research methods applied in publications (see online version for colours)



Concluding our descriptive analysis, Table 4 highlights the most used keywords in the keyword section of each article. We excluded keywords with frequencies of 1 and 2 to achieve meaningful results. As expected, considering the topic of this review, climate change is the most used keyword, occurring in 23 articles. Similarly, the second most used keyword is GHG emissions, as shown in Table 4. Nevertheless, the words carbon, reporting, environmental, and disclosure are also recurrent within the other keyword combinations listed in the table.

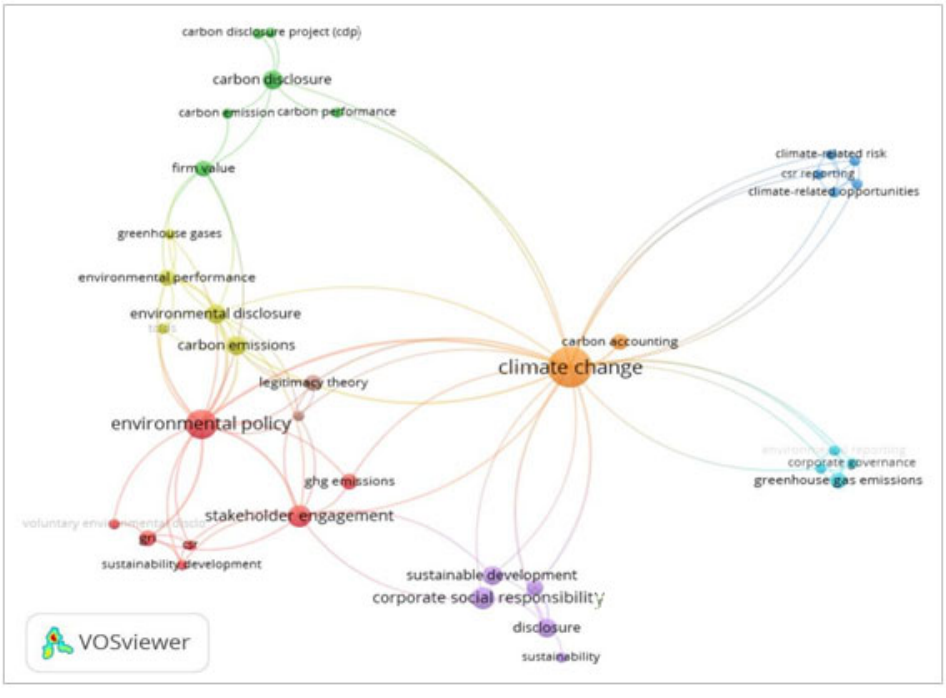
Table 4 Most frequent keywords

Keywords	*Frequency*
Climate change	23
GHG emissions OR greenhouse gas emissions	16
Carbon disclosure, Carbon accounting, environmental disclosure OR environmental reporting	11
Corporate social responsibility OR CSR	9
Carbon emissions, carbon disclosure project OR CDP, sustainability reporting OR sustainability disclosure, environmental policy	8
Stakeholder engagement	7
Global reporting initiative OR GRI, sustainable development OR Sustainability development, voluntary disclosure, carbon performance	6
Corporate governance, environmental performance	5
Carbon management, disclosure, TCFD, firm value	4
Legitimacy theory, financial performance, sustainability, institutional theory, climate risk and opportunities	3

Figure 6 summarises the most frequently appearing keywords by highlighting their relationships. For this, the authors used VOSviewer software, a helpful tool for creating maps based on network data (Van Eck and Waltman, 2020). In this review, the software was employed to construct a network of keywords by visualising the co-occurrence of words, grouped by the software into clusters. Here, the weight of each item determines the size of each label and circle; therefore, the larger circles are those with a higher weight that are, thus, the most significant. Moreover, the lines among the labels and circles represent the links between items, where the increased closeness of items

represents their higher correlation (Van Eck and Waltman, 2020). Furthermore, colours are used to identify each cluster, as shown in the figure.

Figure 6 Network visualisation of the most frequent keywords (see online version for colours)



Our VOSviewer map of the keyword network suggests that the issue of climate change is at the core and central in the review performed within this study. It is directly linked to the other keywords and topics discussed in the reviewed articles, such as corporate social responsibility, stakeholder engagement, disclosure, environmental policy, and carbon and GHG emissions. The map also indicates the voluntary nature of climate change reporting. In this regard, different guidelines are linked with climate change keywords, such as GRI, CDP, and TCFD recommendations (TCFDs). Additionally, the network suggests the association between climate change and emissions, as underlined by several references to 'Carbon', 'GHG' or 'emission' terms. Furthermore, the issue of climate change is clearly and closely linked to a company's environmental policy, corporate social responsibility, and environmental performance. At the same time, the issue of climate risk and opportunities is addressed on the map and directly connected with climate change and CSR reporting.

4 Results of the thematic analysis

The thematic analysis of the selected articles on climate change reporting revealed three current research trends: communication tools and guidelines, drivers affecting corporate

climate change reporting, and risks associated with climate change and GHG emissions. The following sections address these three aspects in detail.

4.1 Communications tools and guidelines

First, climate change reporting is mainly a voluntary activity, and till now, no global baseline climate reporting standard exists. This aspect is underlined in the majority of the reviewed articles, in particular Ben-Amar and McIlkenny (2015), Liesen et al. (2015), Giannarakis et al. (2018), Liu and Yang (2018), Luo et al. (2018), Talbot and Boiral (2018), Datt et al. (2019), Rahman et al. (2019), Alsaifi et al. (2020a), Chithambo et al. (2020), Mateo-Márquez et al. (2021), and Wedari et al. (2021). These authors emphasise that reporting is a nonstandardised activity, based essentially on the voluntary approach of companies and their management's discretion. Jiang et al. (2021) define voluntary carbon disclosure as the attitude of a company towards voluntarily providing carbon information and the quality thereof in regards to informing stakeholders about carbon management, strategies, and accountability. Our review shows that the framework most used to report on climate change and emissions is the GHG protocol (Gibassier and Schaltegger, 2015; Csutora and Harangozo, 2017; Harangozo and Szigeti, 2017), developed by world business council for sustainable development (WBCSD) and World resources institute (WRI) to support companies in measuring and reporting their direct and indirect GHG emissions (WBCDS and WRI, 2004; Dhanda et al., 2021). Our review highlights that companies also use the CDSB framework for reporting environmental and climate change information (CDSB, 2022) and that the CDP scheme provides both a universal system to measure, disclose, manage, and share environmental and climate information (Caritte et al., 2015; Talbot and Boiral, 2018) and a comprehensive database on GHG emissions (Depoers et al., 2016). Other authors (Comyns, 2016; Talbot and Boiral, 2018; Scholten et al., 2020) cite the GRI guidelines and standards, which provide a framework and indicators for reporting economic, environmental, and social performance. In this scenario, the standard ISO 14064 is also used in detailing accounting and reporting of GHG emissions (Tauringana and Chithambo, 2015). Finally, the Department for Environment, Food and Rural Affairs' (DEFRA's) guidance is also mentioned, although it is specifically employed in the UK context. Its aim is to support UK organisations in reducing their impact by defining the measurement and reporting criteria for their GHG emissions (Tauringana and Chithambo, 2015; Caritte et al., 2015). However, the evidence of Doda et al. (2016) suggests that a useful organisational practice would be to explain how adopting carbon strategies leads to reducing GHG emissions.

Our review underlines that companies may use different communication tools and channels, such as websites, financial reports, and nonfinancial reports, which are preferred, when disseminating climate change information (Thaker, 2020). He et al. (2021) support this evidence, suggesting that companies can report their GHG emissions to government agencies through CDP and sustainability or CSR reports. In this regard, Talbot and Boiral (2018) affirm that companies use sustainability reports as a public relations tool to communicate their commitment to climate issues. Furthermore, due to the voluntary nature of reporting, companies can adopt impression management strategies to communicate information on climate change and thus strengthen their image among stakeholders (Ahmad and Hossain, 2019). Several authors (Comyns, 2016; Hoştut and van het Hof, 2020; Tsalis et al., 2020; Talbot and Boiral, 2018; Murillo-Avalos et al., 2021) describe the critical role of sustainability reports in communicating nonfinancial

performance and CSR strategies to different stakeholders. Moreover, the publication of CSR or sustainability reports may increase the carbon reporting of a company (Cordova et al., 2021a). The multitude of different guidelines that can be used for voluntary reporting and the lack of a standardised and universally recognised framework makes it difficult to compare the reports drawn up by companies. Our literature review underlines this point, acknowledging the lack of consistency and comparability of climate change reporting across firms (Ben-Amar and McIlkenny, 2015). The challenge in interpreting or comparing environmental, social, and governance (ESG) information and carbon data stems from such inconsistencies and the absence of common reporting practices, accepted disclosure standards or global agreements on corporate carbon reporting (Doda et al., 2016; Giannarakis et al., 2018; de Silva Lokuwaduge and de Silva, 2020). Wegener et al. (2019) analyse the suitability of GHG emissions data to communicate carbon performance information, pointing out that the lack of shared international accounting standards has led to different methodologies for quantifying and estimating emissions. Furthermore, given the lack of mandatory regulations, the comprehensiveness of carbon disclosure rests mainly in the hands of managers (Luo et al., 2018) who can decide what and how much to report (He et al., 2021). Hassan (2018) underlines that managers can thus take advantage of corporate environmental disclosure to adopt mitigation actions and reduce emissions. Therefore, according to Doda et al. (2016) and based on these findings, companies must enhance the quality of their reporting.

4.2 Drivers of corporate climate change reporting

The second group of findings relates to companies' drivers for reporting climate change information. In this regard, stakeholders' pressure on companies' climate change reporting is increasing due to the global relevance of the urgent need to mitigate climate change and reduce GHG emissions. Therefore, companies are expected to respond to these pressures by improving their environmental performance (Wedari et al., 2021), adopting carbon management practices (Evangelinos et al., 2015; Doda et al., 2016), and disclosing such information transparently. The following authors confirm this finding: Fontana et al. (2015), Kumarasiri (2015), Liesen et al. (2015), Depoers et al. (2016), Guenther et al. (2016), Giannarakis et al. (2017), Liu and Yang (2018), Maaloul (2018), Talbot and Boiral (2018), Tang and Demeritt (2018), Albarrak et al. (2019), Bravo and Reguera-Alvarado (2019), Cadez et al. (2019), Datt et al. (2019), Kouloukoui et al. (2019), Alsaifi et al. (2020b), Chithambo et al. (2020), de Silva Lokuwaduge and de Silva (2020), Radu et al. (2020), Nguyen et al. (2020), Villena and Dhanorkar (2020), Cordova et al. (2021), Córdova Román et al. (2021), Hardiyansah et al. (2021), Naranjo Tuesta et al. (2021), and Rodríguez et al. (2021). Accordingly, several authors have investigated the following main drivers affecting climate change reporting: stakeholder pressure, legitimacy, image improvement, size, regulation, national culture, board composition, industry sector, financial performance, and investors.

As mentioned above, stakeholders play a crucial role in promoting both the quality and quantity of the information that is reported (Arvidsson and Dumay, 2021) and the adoption of different mitigation strategies for climate change (Dhanda et al., 2021) and GHG reduction policies (Doda et al., 2016). At the same time, their pressure helps researchers understand how companies deal with climate change and may support the establishment of the frameworks and transparency requirements for carbon reporting (He et al., 2021). Additionally, the information reported is significant in stakeholders'

decision-making (Mysaka et al., 2021) and how they perceive carbon footprint and management and emissions reduction (Gibassier and Schaltegger, 2015; Jiang et al., 2021). Therefore, voluntary reporting also aims to satisfy stakeholders' information needs (Mysaka et al., 2021). In this sense, Gibassier and Schaltegger (2015) emphasise that the information required depends on the type of stakeholder. This, in turn, has resulted in the establishment of various carbon accounting approaches, which have led to different measures of carbon performance and emissions management practices, as well as varying levels of support for the disclosure of such information (Evangelinos et al., 2015; Gibassier and Schaltegger, 2015). Stakeholder theory thus better explains the relationship between company, stakeholders and sustainability reporting practices (Kouloukoui et al., 2019).

That is, various stakeholders, e.g., investors, policy-makers, regulators, standard-setters, governments, consumers, and communities, are interested in companies' responses to climate change and reporting, as they are conscious of the strategic significance of climate change and carbon emissions (Elsayih et al., 2021) and the value of carbon information (Albarrak et al., 2019). Moreover, this statement is not limited to the context of climate change, as it can be extended to total social responsibility. In this sense, Guo and Yang (2017) argue that stakeholders demand environmental and social responsibility disclosure from corporations. Climate change and GHG emissions reporting are becoming of global interest, allowing stakeholders to assess firms' environmental impacts and related risks (Liesen et al., 2015; Ben-Amar et al., 2017; Hollindale et al., 2019). Therefore, stakeholders' demand for greater transparency in terms of corporate performance related to climate change may compel companies to report such information (Fontana et al., 2015; Datt et al., 2019; Córdova Román et al., 2021). As a result, firms voluntarily communicate their approach to climate change mitigation to respond to stakeholders' pressure and become more transparent (Kumarasiri, 2015; Rodríguez et al., 2021), while stakeholders learn about companies' carbon performance via such voluntary disclosure (Datt et al., 2019). Consequently, Villena and Dhanorkar (2020) define carbon transparency as providing high-quality carbon emission information to stakeholders. In this regard, He et al. (2021) identify the need for a correlation between carbon information and the actual carbon performance of a company.

The second driver influencing the decision to start the climate change and emissions reporting process is legitimacy, as suggested by legitimacy theory, which refers to the relationship between companies and society. According to this theory, companies voluntarily disclose their GHG emissions, climate change mitigation efforts, and environmental sustainability information to gain legitimacy (Helfaya and Moussa, 2017; Liu and Yang, 2018) or maintain their existing legitimacy (Comyns, 2016) among their relevant stakeholders. For these reasons, a sustainability report can be considered a legitimising tool for mitigating political and social pressure (Giannarakis et al., 2017; Talbot and Boiral, 2018), as disclosure and environmental reporting are defined as a way to increase legitimacy (Braam et al., 2016; Wedari et al., 2021).

A direct effect of an increase in voluntary environmental reporting is improving corporate image and reputation (Helfaya and Moussa, 2017; Albarrak et al., 2019; Hoştut and van het Hof, 2020; Kurnia et al., 2020). However, Wedari et al. (2021) highlight the potential for greenwashing when disclosing environmental information. According to the authors, the practice of greenwashing occurs when a company publishes misleading information to portray a positive image of its performance or improve its reputation

(Wedari et al., 2021). In the common scenario of voluntary reporting, the lack of common disclosure standards has thus led to an increase in greenwashing practices (Wedari et al., 2021). On the other hand, a firm reputation could be negatively affected by poor or a lack of reporting (Tang and Luo, 2016).

The size of a company is another factor impacting voluntary reporting. Darus et al. (2020) and Chithambo et al. (2021) identify a positive relationship between company size and disclosure; as larger companies have a greater impact on the environment and more stakeholders than small firms, they are more visible and exposed to pressures. Hence, large companies publish standalone reports to disclose environmental information (Hassan and Guo, 2017). Similarly, Wang et al. (2021) underline that larger firms tend to be more aware of climate change scenarios. Murillo-Avalos et al. (2021) also observe that large companies disclose environmental information more often.

Although climate change reporting is mainly voluntary, regulations or compliance requirements can play a central role. Chithambo et al. (2021) acknowledge the positive relationship between regulatory pressure and GHG disclosure. Existing regulations, such as the emission trading scheme (ETS) or taxes, have tried to guide corporate responses to climate change and the reduction of carbon emissions (Qian et al., 2018), increasing companies' carbon disclosure (Datt et al., 2019). Meanwhile, stakeholders have demanded more regulations on carbon information disclosure (Ben-Amar and McIlkenny, 2015). The existence of a regulation can also be a stimulus for companies to invest in new technologies and green energy activities (Tauringana and Chithambo, 2015). Furthermore, such regulation is a key issue that is closely related to the quality of the information disclosed, as discussed above. According to Mateo-Márquez et al. (2021), a regulation that sets compliance requirements may increase the quality of climate information. Therefore, companies located in countries with strict regulations and higher regulatory pressures are more likely to report climate and carbon information than in those with low compliance requirements (He et al., 2021; Mateo-Márquez et al., 2021). As a result, climate change reporting is aligned with regulatory conditions (Thaker, 2020). In this sense, He et al. (2021) underline the relevance of the Kyoto Protocol and its relationship with disclosure. According to them, companies in countries subscribing to the Protocol tend to disclose more detailed information on their activities and achievements related to climate change. A study conducted by Yang and Farley (2016) on the Chinese context reveals a greater influence of country-level reporting guidelines than of international guidelines on the content of climate reporting; thus, this finding highlights the impact of a specific government or national context on company reporting. That is, environmental reporting differs between companies, depending on their home country (Murillo-Avalos et al., 2021).

Climate change reporting is also shaped by national cultures. The role of cultural factors cannot be ignored in voluntarily reporting, as they affect corporate carbon strategy, policy (Luo and Tang, 2016; Luo et al., 2018), and decision-making (Wang et al., 2021). More specifically, Luo and Tang (2016) highlight how companies embedded in societies based on masculine values are less prone to disclose environmental information voluntarily. This finding is aligned with the remarks in Wang et al.'s (2021) study. These authors emphasise the role of national culture in responding to climate change. Notably, companies with female-dominated values are more proactive in carbon disclosure, mitigation, and adaptation, resulting in them being more conscious of the negative impact of their activities on the climate. More generally, Kasbun et al. (2019)

point out the role of organisational culture in encouraging the adoption of environmental practices, which in turn translates to better environmental performance.

This evidence can also be verified in companies' board membership. Several authors, such as Ben-Amar et al. (2017), Helfaya and Moussa (2017), Charumathi and Rahman (2019), Hollindale et al. (2019), and Bravo and Reguera-Alvarado (2019), positively connect the management of climate change issues with female representation on a board of directors. Indeed, women are more likely to communicate climate actions to stakeholders and report on climate change (Jizi et al., 2021). These actions are mainly due to their sensitivity and orientation towards environmental issues (Ben-Amar et al., 2017). He et al. (2021) affirm this evidence by emphasising the positive association between carbon disclosure and female representation in corporate governance. Moreover, Jizi et al. (2021) highlight the correlation between the presence of women on boards and their implementation of various policies, including those related to climate change mitigation and disclosure. However, such analysis of corporate boards is not limited only to female representation, as it also refers to the heterogeneity of board members. A study performed by Mardini and Lahyani (2021) on French-listed firms explores the association between carbon reporting and the inclusion of foreign directors on a corporate board. Specifically, they show that foreign directors are prone to increase transparency in reporting and to undertake decarbonisation strategies. In addition to gender diversity, the evidence of Cordova et al.'s (2021) study implies the inclusion of other corporate governance drivers, such as a CSR committee, ESG executive compensation policy, or CEO duality. According to these authors, such factors increase the likelihood of carbon reporting.

Industry sector also directly impacts environmental disclosure (Rahman et al., 2019). It is expected that environmentally sensitive and high-profile industries, e.g., chemical and energy producers, disclose their carbon emissions and improve their environmental performance, as they produce greater environmental impacts and more GHG emissions (Cadez et al., 2019; Nguyen et al., 2020; Hardiyansah et al., 2021; Chithambo et al., 2021). Thus, companies in such industries are exposed to greater pressure than those in less sensitive industries (Liu and Yang, 2018).

Another driver impacting voluntary disclosure is financial performance. Darus et al. (2020) and He et al. (2021) identify a positive relationship between profitability and carbon disclosure, arguing that profitable companies tend to be more transparent when investing in voluntary initiatives and environmental reporting to differentiate themselves from less profitable firms. The latter have fewer resources to address carbon reporting and are more focused on financial issues. Kılıç and Kuzey (2019) point out that financial development can encourage environmental improvement and policies to control carbon emissions and mitigate environmental damages. In this regard, financial incentives could help firms disclose their emissions (Tang and Demeritt, 2018). The relationship between carbon disclosure and financial performance can also take on a different meaning, as explained in a study by Alsaifi et al. (2020). According to these authors, voluntary carbon reporting and proactive carbon policies may improve a company's financial performance; thus, a positive association is identified in this case. However, a further remark is needed; regarding a company, its environmental performance also exerts an influence. Braam et al. (2016) thus argue that companies with poorer environmental performance tend to disclose more environmental information to obtain corporate legitimacy and increase the accuracy of their reports. Similarly, the external assurance of reports increases the reliability and trustworthiness of information (Braam et al., 2016). In contrast to these

findings, Broadstock et al. (2018) reveal a nonlinear relationship between UK firms' performance and their GHG emissions reporting, which they evaluate through various performance measures.

Referring to financial pressure, He et al. (2021) identify a final driver affecting the reporting activity that concerns investors. When evaluating investment opportunities, investors examine companies' exposure to climate risks and opportunities and their proficiency in managing climate change (He et al., 2021; Jiang et al., 2021). A study conducted by Radu and Maram (2021) on Canadian companies' carbon disclosure highlights a negative relationship between the GHG emissions that are produced and a firm's market value. Therefore, according to Arvidsson and Dumay (2021), investors are likely to choose companies that take action to mitigate climate change. Hence, managers are encouraged to disclose more information on GHG emissions and climate change, as the requests for such information are increasing (Arvidsson and Dumay, 2021). In contrast, misleading carbon information could make it difficult for investors to assess their investment risk (Alsaifi et al., 2020).

4.3 Risks related to climate change and GHG emissions

The last group of findings addresses reporting climate change and GHG emissions risks, which need to be emphasised as business risks for all industries (Kılıç and Kuzey, 2019; Thaker, 2020). The reporting of such risks is considered challenging by Alsaifi et al. (2020), and it is one of the main emerging issues (Charumathi and Rahman, 2019; de Silva Lokuwaduge and de Silva, 2020). Indeed, companies have to identify, manage, and report these risks and establish mitigation actions (Kouloukoui et al., 2019; Dhanda et al., 2021). Demaria and Rigot (2021) underline the need to promote climate reporting to determine the consequences of climate risks. The TFCD has provided some recommendations to support voluntary environmental reporting, focusing on climate risks to satisfy investors' demand for transparency (Demaria and Rigot, 2021) by describing the process of identifying, assessing, and managing climate-related risks (O'Dwyer and Unerman, 2020). In this context, companies are trying to make their climate risk disclosures more transparent to inform their various groups of financial and nonfinancial stakeholders (Ben-Amar and McIlkenny, 2015; Guenther et al., 2016; Albarrak et al., 2019; Hollindale et al., 2019; Kouloukoui et al., 2019; O'Dwyer and Unerman, 2020; Rodríguez et al., 2021; Mateo-Márquez et al., 2021). Furthermore, in their study on corporate carbon proactivity, Wang et al. (2021) observe that companies undertaking climate change mitigation actions need to be more aware of their carbon risks and provide more transparent disclosures. Accordingly, Egbunike and Emudainohwo (2017) and O'Dwyer and Unerman (2020) underline the need to enclose climate-related risks within an overall corporate risk management process. Abhayawansa and Adams (2021), conducting a study on pandemic and climate risk reporting, underline the consequences of such risks for society and the economy and the related interests of different stakeholders in their disclosures and mitigation strategies. Notably, it is helpful to analyse the impact of climate change on a company and its effects on the climate (Abhayawansa and Adams, 2021). Such risk analysis also includes studying the opportunities related to climate change. To this end, according to Dhanda et al. (2021), the recognition of such opportunities encourages companies to carry out mitigation and emissions reduction actions.

The following table provides a summary of the three research trends arising from this review:

Table 5 Findings of the thematic analysis

Findings of the thematic analysis	*Papers*
Voluntary/mandatory climate change reporting, and communication tools and guidelines	Ben-Amar and McIlkenny (2015), Caritte et al. (2015), Gibassier and Schaltegger (2015), Liesen et al. (2015), Tauringana and Chithambo (2015), Comyns (2016), Depoers et al. (2016), Doda et al. (2016), Csutora and Harangozo (2017), Harangozo and Szigeti (2017), Giannarakis et al. (2018), Hassan (2018), Liu and Yang (2018), Luo et al. (2018), Talbot and Boiral (2018), Ahmad and Hossain (2019), Datt et al. (2019), Rahman et al. (2019), Wegener et al. (2019), Alsaifi et al. (2020), Chithambo et al. (2020), de Silva Lokuwaduge and de Silva (2020), Hoştut and van het Hof (2020), Scholten et al. (2020), Thaker (2020), Tsalis et al. (2020), Cordova et al. (2021), Dhanda et al. (2021), He et al. (2021), Jiang et al. (2021, Mateo-Márquez et al. (2021), Murillo-Avalos et al. (2021), Wedari et al. (2021)
Drivers of corporate climate change reporting	Ben-Amar and McIlkenny (2015), Evangelinos et al. (2015), Fontana et al. (2015), Gibassier and Schaltegger (2015), Kumarasiri (2015), Liesen et al. (2015), Tauringana and Chithambo (2015), Braam et al. (2016), Comyns (2016), Depoers et al. (2016), Doda et al. (2016), Guenther et al. (2016), Tang and Luo (2016), Yang and Farley (2016), Ben-Amar et al. (2017), Giannarakis et al. (2017), Guo and Yang (2017), Hassan and Guo (2017), Helfaya and Moussa (2017), Broadstock et al. (2018), Liu and Yang (2018), Luo et al. (2018), Maaloul (2018), Qian et al. (2018), Talbot and Boiral (2018), Tang and Demeritt (2018), Albarrak et al. (2019), Bravo and Reguera-Alvarado (2019), Cadez et al. (2019), Charumathi and Rahman (2019), Datt et al. (2019), Hollindale et al. (2019), Kasbun et al. (2019), Kılıç and Kuzey (2019), Kouloukoui et al. (2019), Alsaifi et al. (2020), Chithambo et al. (2020), Darus et al. (2020), de Silva Lokuwaduge and de Silva (2020), Hoştut and van het Hof (2020), Kurnia et al. (2020), Nguyen et al. (2020), Radu et al. (2020), Rahman et al. (2019), Thaker (2020), Villena and Dhanorkar (2020), Arvidsson and Dumay (2021), Chithambo et al. (2021), Cordova et al. (2021), Córdova Román et al. (2021), Dhanda et al. (2021), Elsayih et al. (2021), Hardiyansah et al. (2021), He et al. (2021), Jiang et al. (2021), Jizi et al. (2021), Mardini and Lahyani (2021), Mateo-Márquez et al. (2021), Murillo-Avalos et al. (2021), Mysaka et al. (2021), Naranjo Tuesta et al. (2021), Radu and Maram (2021), Rodríguez et al. (2021), Wang et al. (2021), Wedari et al. (2021)
Climate-related risk reporting	Ben-Amar and McIlkenny (2015), Guenther et al. (2016), Egbunike and Emudainohwo (2017), Albarrak et al. (2019), Charumathi and Rahman (2019), Hollindale et al. (2019), Kılıç and Kuzey (2019), Kouloukoui et al. (2019), Alsaifi et al. (2020), de Silva Lokuwaduge and de Silva (2020), O'Dwyer and Unerman (2020), Thaker (2020), Abhayawansa and Adams (2021), Demaria and Rigot (2021), Dhanda et al. (2021), Mateo-Márquez et al. (2021), Rodríguez et al. (2021), Wang et al. (2021)

5 Conclusions

5.1 Recommendations for future research

Our literature review has highlighted the increasing attention of the scientific community on climate change reporting, mainly in certain developed countries. Figure 7 provides an overview of our key results.

This literature review can help future researchers identify untapped areas of research. Specifically, each finding leaves room for much future research on climate change reporting Figure 7. Moreover, our results can help outline further research directions in addition to those more directly related to our findings.

Future research developments, based on previous research, could be related to the introduction of mandatory reporting requirements. The results could be drafting more responsible, transparent, high-quality, reliable, and comparable reports. Therefore, verifying whether mandatory reporting will lead to greater standardisation in corporate reports and improvements in corporate communication on climate change could be explored in future studies. Indeed, several organisations support the mandatory climate-related financial and nonfinancial disclosures that are considered useful decision-making information among stakeholders (for a summary, TCFD, 2021b). Mandatory reporting could become more relevant, especially in environmentally sensitive sectors (e.g., chemical, energy, mining, oil and gas, construction), which, as stated above, are one of the primary sources of GHG emissions.

More research is needed on climate-related risks and opportunities, as they represent an emerging issue that remains underexplored. The literature seems more focused on the existence of climate risks than on the description of the strategies for managing these risks under different scenarios. It could be useful to evaluate the interplay between the management of climate change issues and an overall business strategy and how companies include decarbonisation investments and activities in their day-to-day business practices. The disclosure of costs and opportunities deriving from the management of climate risks could undoubtedly be an interesting research area.

As emphasised in this review, the number of studies on climate change reporting has increased yearly, and new issues are constantly arising for further research. In this regard, it may be helpful to study the connections between SDG 13 (climate action) and other SDGs. As highlighted in our descriptive analysis, despite the increasing attention in the last seven years, as shown in Figure 4, the climate change reporting literature has been underexposed in some developed and developing countries. Therefore, research opportunities can be found in terms of extending such analyses to other economic and sociocultural contexts through multilevel and comparative studies that highlight the approach and quality of disclosure in different industries and countries.

Our thematic analysis has revealed what motivates companies to report on climate change by discussing the drivers that emerged from our review. Thus, future research could investigate the other drivers and determinants affecting companies' decisions to report on climate change and carry out mitigation actions to reduce carbon emissions (e.g., sustainable behaviours, predictive variables relating carbon disclosure to future scenarios, environmental and carbon strategies, external assurances, sociopolitical instabilities and war).

Moreover, future studies could adopt other methodologies to investigate the issue of climate change beyond a literature review. Data could be collected via corporate

websites, annual or sustainability reports, case studies, surveys, or interviews to evaluate a company's approach to climate change and measure its carbon strategy.

As underlined above, accountants play an active role in determining how climate change information is reported. Many contributions are emerging from accounting research, helping develop high-quality disclosure on climate change and sustainability. First, the European Commission has proposed revising the nonfinancial reporting directive in the European Green Deal (EC, 2019a, 2021) to address the need to increase company disclosures on climate and environmental data.

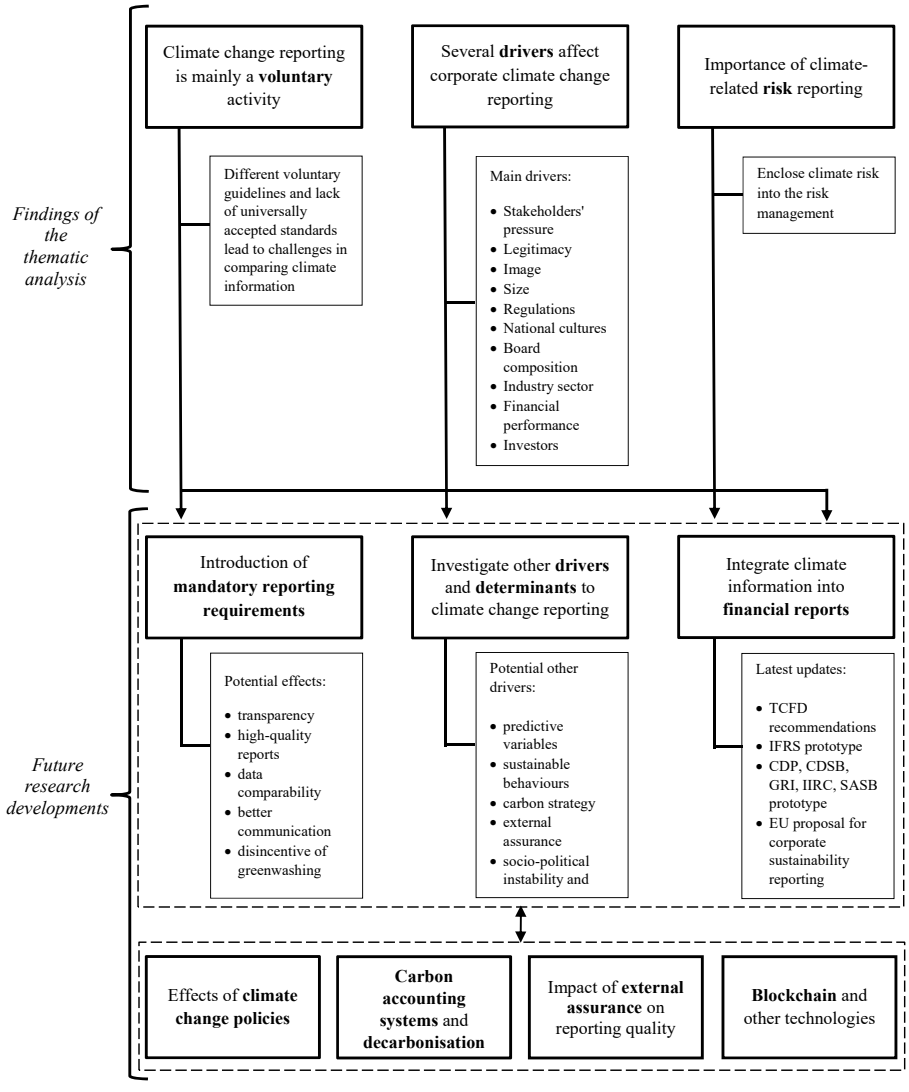
Further contributions have originated in the standard setters' efforts to include climate-related information in financial disclosures. Hence, the IFRS suggests incorporating climate-related matters into financial reporting (IFRS, November 2020) to support the consistent application of its standards. Notably, companies applying the existing IFRS standards should consider climate-related issues when their effects are material for their financial statements (IFRS, November 2020). Moreover, a climate-related standard is being drafted, and sustainability and integrated reporting organisations have issued two main prototypes. The first one is a prototype, climate-related financial disclosure standard developed by the CDP, CDSB, GRI, IIRC, and SASB in December 2020 to build a comprehensive reporting system. The proposal adopts the recommendations of the TCFD to develop global standards for sustainability-related financial disclosure. The main aim is to support management when disclosing the climate-related financial information related to governance, strategies, risks and opportunities, targets and metrics, and their impact on financial performance to evaluate their ability to create enterprise value (CDP, CDSB, GRI, IIRC, SASB, 2020a). More recently, the IFRS Foundation has also engaged in developing high-quality disclosure standards on climate matters to meet stakeholders' information needs by establishing the ISSB. This update led to the publication of a draft of the climate-related disclosure prototype in November 2021 by the technical readiness working group (TRWG). Its purpose is consistent with the objective of the other prototype discussed above, guiding companies when reporting their exposure to the climate-related risks and opportunities related to governance, strategy, risk management, metrics, and targets. Therefore, interesting research perspectives on the standards and assessment methods that companies use and how information on climate change will be disclosed in companies' financial statements are being applied.

In addition to the future trends we have outlined thus far, further avenues for research can be explored. These studies should focus on unexplored topics, such as the application of blockchains or other new technologies in the reporting and assurance of climate-related information. Indeed, the dissemination of this information must be accompanied by an improvement in the transparency, reliability, and credibility of data to discourage greenwashing practices. The use of blockchain technologies ensures that such data cannot be modified or manipulated without the consent of an entire network (Calderón and Stratopoulos, 2020).

Such analyses could be extended to different national carbon accounting systems and their effects on improving environmental performance, thus supporting companies' decarbonisation when measuring emissions reductions. Concurrently, such analyses could concern the reporting models developed by public, private, and nonprofit companies. For example, they could verify what aspects climate change reports focus on and investigate the similarities and differences among the reports drawn up by relevant companies. Future studies could also investigate the role of governments in shaping and promoting

climate policies and their effects on encouraging better environmental performance and transparency.

Figure 7 Overview of the thematic findings and areas for future research



5.2 Contributions and limitations of the study

This literature review has contributed to the research on climate change reporting by integrating and expanding existing studies and outlining a research agenda for future investigations. Future reviews on climate change reporting may build on this review and re-examine and update our results concerning the state of climate change reporting.

Our analysis is relevant not only for research but also for standard setters and governments. We have highlighted that there are no guidelines or standards that are widely shared and adopted by companies for climate change reporting. This situation influences the comparability of climate change information. Several standard setters and international organisations are taking action in this regard, and our analysis has confirmed the relevance and usefulness of such commitments. Indeed, drawing up specific and shared standards can support the clarity of information disclosed to investors and broader society. Nonetheless, improving the disclosure of emissions data is a valuable management tool for companies to manage GHG issues.

We have also found that such reporting is mainly voluntary. However, the increasing need of society to reduce and control emissions requires a broad commitment by companies to reporting on the actions that they have undertaken to mitigate their environmental risks and reduce emissions. Hence, there is the possibility of moving towards the mandatory reporting of climate change information.

Despite the strengths of using a systematic literature review as a research method, our research protocol has revealed some potential limitations of this method. We excluded the grey literature, and our search was limited to articles; thus, we excluded some insights from other documents (e.g., books, reports, proceedings, conference papers, editorials, reviews, letters). Moreover, our search was limited to only two databases, to English articles, and to specific keywords; hence, there is the possibility that some studies have not been considered.

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