

## Mapping the Development of Sustainability Reporting Standards: A Scientometric Analysis of Paradigm Shift Towards IFRS S2



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### ABSTRACT

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*sustainability reporting, IFRS S2, circular economy, climate risk disclosure, standard*

This research portrays the development of sustainability reporting standards towards mandatory IFRS S2 standards. The Web of Science database was accessed to obtain the papers from 2015 to April 2025. The CiteSpace software was used to identify publication trends, popular subjects, keywords, and cross-national collaboration patterns. The results demonstrate a significant surge in sustainability reporting since 2017, with the main cluster issues being compliance, mandatory disclosure, and climate risk disclosure. The main findings of this study underscore the role of international regulations in driving the transition towards standardized mandatory reporting, with IFRS S2 as the main catalyst in the integration of financial and non-financial disclosures. New fields such as climate risk disclosure and the circular economy have been recognized as revolutionary potential that offers innovative solutions to regional and global environmental issues. These subjects were studied to comply with the global rules of countries by advocating cooperation and partnership. They may increase the effect of environmental reports, establish sustainable development, and encourage their circumstances toward the global business community, which values visibility and accountability reports.

## 1. INTRODUCTION

The environment grapples with activities resulting in emissions to the air. These studies pilot organizations and stakeholders to assess their negative contribution to the environment during their activities process [1-3]. It is calculated in form EPD dished up to incorporate potential environment risk applied by organization for their business plans. It denotes an earnestness of organization to conduct sustainable management of environmental, social, and governance (ESG) hazards and climate risk [4]. However, stability and thoroughness in reporting remain challenging. Especially to close reporting gaps in underdeveloped countries and specific industries [2, 5, 6].

The sustainability report represents an accountability and transparency where aims to standardize report system, to improve discloser, and to assist corporations recognizing their ESG effect. Initially, many companies reported their EPD applied by the Global Reporting Initiative (GRI). The European Union's Directive 2014/95/EU mandating non-financial report [7, 8]. According to studies, it was entrusted non-financial reporting that may lead to more uniform reporting at the price of complexity and richness [9, 10]. On the other hand, it seeks to encourage businesses for implementing green business practice by incorporating sustainability into all aspects of their operations complied with specification of the organizations and the industry in which it

runs [11, 12]. In the global trend, most developed countries are leading obligatory sustainability reporting. However, the impact of them remains debatable. Corporate governance and overall commitment to green development influence the implementation of ESG practices [13, 14]. Shifting from voluntarily imposed to mandatory sustainability reporting frameworks is vital for gaining corporate accountability and transparency, though the extent to which the reporting improves quality and impact is contingent on the frameworks' flexibility to various corporate environments and the genuine willingness of the firms to incorporate sustainability into their business models.

Integrating global warming disclosures and sustainable accounting into TCFD and IFRS frameworks improves financials transparency and corporate governance, but reduces cross-border comparability [15, 16]. The shift from the TCFD framework to IFRS S2 standardizes sustainable reporting, improving stakeholder decision-making by ensuring comparability and coherence of reported information [17, 18]. To effectively manage risk, organizations must report on environmental effect and include sustainability into their strategy and decision-making process [18, 19]. While the benefits of the standardization are abundant, challenges such as the need for context specific framework, capacity building, and balancing disclosure innovation with prescriptive reporting also arise [15, 20, 21].

This study seeks to help with understanding the evolution

of sustainability reporting standards as well as provide a systematic mapping of the literature in the field. There are three key objectives in this research work, which are: first, to outline the intellectual framework of literature on sustainability reporting; second, to determine areas of research interest throughout the evolution of reporting standards; and third, to evaluate the impact of the shifts in the frameworks on the sustainability reporting practices. It is hoped that this research will make noteworthy, interesting sustainable development reporting contributions for the concerned parties concerning the shift from the TCFD recommendation framework to IFRS S2 standard and its subsequent recommendation framework to IFRS S2 standardized interdisciplinary sustainable development reporting and provide a basis for future directions of the research in the area of sustainability reporting [19].

It is helpful to comprehend the evolution of sustainability reporting standards to adapt reporting practices to regulatory changes, improve disclosure of information, and fulfill the expectations of relevant stakeholders for accurate and trusted ESG (environmental, social, and governance) information. This research aims to examine the history of sustainability reporting, including study concerns, major contributions, and scientific partnerships. The goal is to advise academics, support rational decision-making, and advocative laws. This systematic mapping will exhibit trends and patterns in the evolution of regulation based on the standard, helping organizations in protecting the fundamental paradigm towards an incorporated standard model of environmental effect and sustainability reporting. It will provide a deep understanding for academics, professionals, and policymakers. In pursuit of the goals of this study, these questions arise, and they are formulated as four research questions (RQs) which are all individually and comprehensively addressed through specific scientometric techniques as detailed in Table 1.

**Table 1.** Research matrix

Research Objectives	Research Questions (RQ)	Analysis Method
Mapping the intellectual structure of research	<b>RQ1:</b> What are the publication trends?	Visualization of publication trends
	<b>RQ2:</b> What is the dominant theme of co-citation analysis?	Analysis of co-citation and cluster
Identify research focus shifts	<b>RQ3:</b> What are the dominant keywords and their emerging trends?	Analysis of keyword co-occurrence
Analyzing the implications of standard changes	<b>RQ4:</b> Which countries are dominant and how is the collaboration between countries?	Analysis of collaboration networks between countries

## 2. LITERATURE REVIEW

### 2.1 The evolution of non-financial reporting standards

The significance of sustainability and corporate social responsibility (CSR) in business operations can be seen in the major developments and challenges that have shaped the global growth of non-financial reporting standards [22, 23]. Non-financial reporting includes CSR reporting, integrated reporting (IR), and GRI reporting, and the absence of harmonized standards in myriad practices across the globe

continues to fuel the divergence [22]. In this context, the enactment of Directive 2014/95/EU in Europe is a significant milestone since it made non-financial reporting a legal obligation for a certain category of large businesses, although the limited transparency and comparability of the reports continue to fuel debate on the directive's effectiveness [24, 25]. The growing call for the establishment of sector-specific standards to cater for reporting oddities in the non-financial disclosures of the different industries, particularly the energy and banking industries, is a welcome initiative [26, 27].

The goal of integrated reporting is to merge financial and non-financial disclosures to give a complete picture of a company's performance and strategy. This trend is being documented around the globe due to the work of the International Integrated Reporting Council (IIRC) [28]. While some steps have been taken toward achieving this goal, the lack of report quality and comparability, and the varied stakeholder needs, remain significant barriers. Standardized reporting, due to the lack of flexible approaches in the EU, is expected to alleviate these pressures [29]. The development of non-financial reporting standards has taken a great deal of work especially in Europe, but the lack of flexible standards still needs to address the adaptation of non-financial reporting toward corporate global sustainability [30, 31].

### 2.2 International financial reporting standards S2 (IFRS S2)

Numerous studies analyze the formation of the ISSB and its aim of achieving global cross-jurisdictional sustainability reporting standards. Bohn et al. [32] discussed the various stakeholder views surrounding the ISSB's legitimacy, and Millar and Slack [33] assessed global investors' reactions to the ISSB standards in draft form. There are other studies like Wang et al. [34] and De Villiers et al. [35] that center on the integration of and the critical discourse on the development of the ISSB's financially and non-financially geared annual reports. Conversely, Kulik and Dobler [36] note the inclusion of stakeholders in the ISSB standard-setting process, and Benhayoun et al. [37] identified barriers to adopting ISSB standards in developing nations. These ISSB sustainability reporting standards studies highlight the challenges associated with ISSB harmonization as well as the integration of stakeholder input, transparency, and accountability initiatives.

## 3. MATERIALS AND METHODS

### 3.1 Research method: Scientometric analysis

Scientometrics is a scientific theory that focuses on comprehending, evaluating, and predicting research activities and outcomes by applying mathematics and statistics to systematically and quantitatively evaluate information [38-40]. This approach goes beyond the literature data and assesses the context and the quality of the relationships within scientific works, thus facilitating the comprehensive mapping of the evolution of knowledge and the identification of gaps in research, especially in sustainability reporting [41, 42]. Within Scientometrics, bibliometric analysis, citation analysis, co-citation, co-word, and clustering techniques serve to uncover research hotspots and trends in the literature [43, 44]. Unlike bibliometrics, Scientometrics places greater emphasis on the science of research and the dynamic systems of science,

including the impact of science in various disciplines, the flow and the interrelation of scientific works, the generation and the dissemination of knowledge [42]. By providing reliable, transparent, and relevant results, this approach enables objective visual representation and quantitative measurement that strengthens knowledge domain analysis, while facilitating the identification of themes, trends, and influential publications in the social sciences and other fields, including sustainability reporting [38, 40]. The use of scientometrics can ensure the validity and reliability of research results [45].

### 3.2 Sources and data collection

Web of Science was chosen because it provides a wide range of high-quality publications in all academic fields and is one of the largest repositories of research articles since the early 20th century [46]. This database is managed by Clarivate Analytics, which is regarded as the most comprehensive and reliable source in the scientific world [42], including relevant and pertinent leading journals, while offering broad coverage of published research, particularly in sustainability and other fields [47, 48]. Furthermore, this provides metadata required for efficient scientometric analysis. The study’s literature was conducted on April 30, 2025, so that the search result covered all papers that had been indexed as of that date. The years 2015 to 2025 were selected because they represent a significant turning point in the evolution of sustainability reporting guidelines, particularly those pertaining to climate-related concerns. The year 2015 marked the beginning of increased global attention to sustainability issues and more systematic ESG reporting, along with the growth of literature and policies in this field. During this decade, there were many regulatory developments and international initiatives that encouraged the integration of sustainability reporting into the official financial reporting framework. The year 2025 was chosen as the

endpoint because it is projected to be the beginning of the global implementation and adoption of IFRS S2, allowing for a comprehensive analysis of trends from the initial exploration stage to the adoption and consolidation of the latest standards. Thus, the 2015–2025 timeframe provides a relevant and up-to-date picture of the academic and practical dynamics in the evolution of sustainability reporting standards towards IFRS S2.

### 3.3 Article selection

Article selection was conducted through a search on the Web of Science Core Collection using the following strategy: (“sustainability reporting” OR “ESG reporting” OR “CSR reporting” OR “non-financial reporting” OR “triple bottom line reporting” OR “environmental reporting”) (All Fields) AND Standards (All Fields) and 2015 or 2016 or 2017 or 2018 or 2019 or 2020 or 2021 or 2022 or 2023 or 2024 or 2025 (Publication Years) and Article (Document Types) and English (Languages) and Business Economics (Research Areas) and All Open Access (Open Access).

Figure 1 shows the article selection process flow in this study. The initial search yielded 972 articles. After applying a filter for publications between 2015 and 2025, the number of articles was reduced to 845. Next, by limiting the document type to “article” to ensure that only scientific publications were included, the number was reduced to 705. The selected articles also had to be in English, given the international standards for scientific publications, reducing the number of articles to 687. Then, by limiting the research area to “Business Economics” to ensure relevance to the research focus, the number of articles was reduced to 442. To support transparency and accessibility in data analysis, this selection only included articles that were openly accessible. Consequently, there were 187 articles that met all criteria.

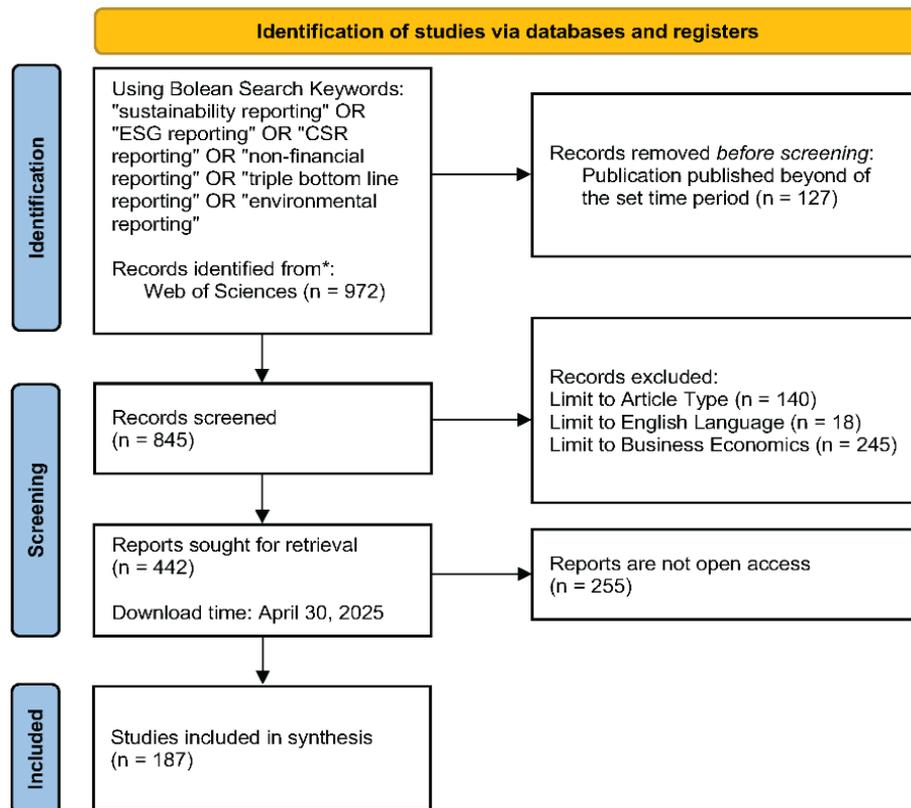


Figure 1. PRISMA flow diagram

### 3.4 Techniques analysis and CiteSpace visualization parameters

These studies employ comprehensive scientometric analytic tools to describe a cognitive framework in the sustainability reporting area, following Li's approach [45] that highlights the utility of keywords and references as indicators of literature evolution. CiteSpace version 6.3.R1 was applied to depict the scientometric analysis in this study, which covered all articles information (title, abstract, keywords, and references) throughout a one-year period from 2015-2025. The analyzed nodes include keywords, authors, and countries. Record selection applied a scale factor  $k = 20$ , beginning point (Top)  $N = 50$  and Top  $N\% = 10.0$ , with limit 100 items per slice, allowing the number of nodes to be changed to strike a compromise between networking completion and visual clarity.

Science mapping matrix applied consist of peak identification, which identifies surge in terms or mentions with an interval of time to be an indicator of topic increased [49]; citing analysis, which serves as substitute for scientific effects [50]; and connectivity prominence, which measures the impact of beginning point as key connections the scientific structure [49]. Furthermore, nations were evaluated as indications of their strategic advantage development and response to global reporting standards [51]. Pathfinder pruning, sliced network pruning, and comminated network pruning approaches used to increase the network structure's transparency and reduce noise. Regions were evaluated with the log-likelihood Ratio (LLR) technique, and inter-node closeness was computed using the coefficient of cosine. These factors guarantee the reliability, accessibility, and correctness of the analysis wrapping the growth of environmental reporting.

## 4. RESULTS

### 4.1 RQ1: Publication trend analysis

This subsection answers RQ1 regarding publication trends in sustainability reporting literature. This analysis visualizes changes in research volume and identifies periods of notable increase over the past decade. The number of publications on sustainability reporting has significantly grown since 2017, peaking in 2023, as Figure 2 illustrates. This increase indicates the escalation of academic effort on sustainability reporting concerns and a worldwide reorientation of research. This early adoption stage and contentious discussions regarding IFRS S2, the international standard designed to improve the integration of sustainability financial, and non-financial reporting [12, 52]. Earlier research on sustainability reporting focused primarily on the issues of CSR and environmental reporting whereby companies, as a legitimacy strategy, emphasized their social responsibility and environmental disclosures to stakeholders [53, 54]. Today, however, pressure to disclose integrated reports due to global dynamics change and expectations of transparency, accountability, and reporting standards.

As a result, sustainability reporting is now seen as an integral aspect of financial reporting and strategic decision-making rather than as a stand-alone element [55, 56]. This shift is also supported by the emergence of international regulations and initiatives that demand consistency and comparability of sustainability reports at the global level, such as IFRS S2 and

the framework from the IFRS Foundation. As a result, many researchers and practitioners have begun to shift their attention from traditional issues to topics such as integration, standardization, and the implications of implementing IFRS S2 in various industrial and jurisdictional contexts [12, 57]. This reflects not only a response to regulatory changes, but also the emergence of an academic need to explore various theoretical and practical aspects in the process of adopting more comprehensive and strategic sustainability reporting standards.

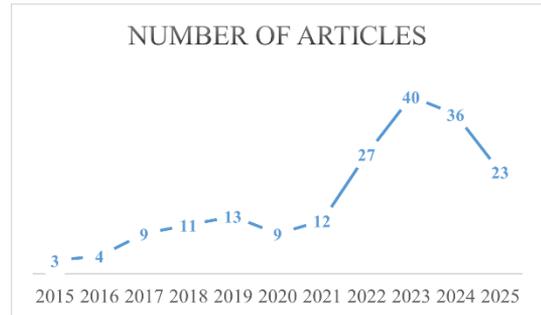


Figure 2. Publication trends

### 4.2 RQ2: Co-citation analysis (Identifying key research clusters)

This section answers RQ2 regarding the intellectual structure of the research field, which is analyzed through co-citation networks and the grouping of major research clusters. Figure 3 shows a map of co-citation relationships between scientific articles (document co-citation network) that represents the knowledge structure in the field of sustainability reporting. This network has high quality with an average silhouette value of 0.8875 (close to 1.0), which indicates excellent clustering quality. In addition, high modularity ( $Q = 0.8543$ ) indicates that elements within clusters have stronger connections with elements in the same cluster than with elements in other clusters, further reinforcing the quality of the clustering.

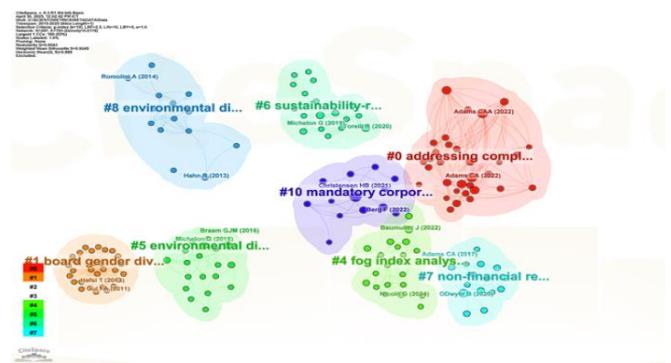


Figure 3. Co-citation analysis

The results of the main research cluster analysis show that the development of sustainability reporting research is increasingly focusing on multidimensional and complex issues. Clusters focusing on compliance (cluster #0) and mandatory disclosure (cluster #10) become more pronounced due to the role of international regulations, especially regarding the expansion of the global standards framework with IFRS S2. This singular focus on regulations influences the enhancement

of corporate transparency and accountability and compels firms to achieve international consistency and comparability of reports [12, 56]. Furthermore, the environmental disclosure cluster (#8) has grown with the literature and public discourse, primarily due to stakeholders demanding firms to disclose more accessible and quantifiable data on the environmental consequences of their operations [54, 55]. This corresponds to the global sustainability agenda and the responsive management of environmental risks and opportunities.

Integrated reporting has emerged to tackle the need to report on the valuation of an entity's long-term value creation and the integration of financial and non-financial reporting. The value of integrated reporting is said to enhance information relevance and quality to stakeholders and motivate organizations towards more strategic and proactive reporting [56, 57]. Additionally, having more women on boards, gender diversity (cluster #1), is starting to be recognized as an important variable for good corporate governance as scholarship in the cluster has established that women on boards can enhance the quality of more strategic decisions, including those related to sustainability governance and CSR reporting [53, 58]. These findings support the argument that implementing more inclusive corporate governance broadens the scope of the narrative and consolidates public legitimacy. More generally, the dynamics of the primary clusters in the literature highlight the importance of compliance and transparency, and the interaction of global regulation, governance, practice innovation, and corporate reporting.

### 4.3 RQ3: Keyword analysis: Mapping the evolution of keywords and concepts

This analysis answers RQ3 by mapping the emergence of dominant keywords, the evolution of research topics, and the

identification of emerging themes in literature. A visualization of keyword interconnections mapping the development of significant issues in this field of study from 2015 to 2025 is presented in Figure 4. There are nine clusters built by 273 nodes and 1169 connections. This network has a density of 0.0315, which means that only around 3.15% of all possible links are present. The modularity (Q) 0.4672 suggests that items in this network are fairly excellent, and the Silhouette (S) score of 0.8028 implies excellent consistency in each cluster. Every hue represents a group of connected concepts, with the most significant and most prominent cluster being #0, which focuses on the theory of agency and includes terms like agency theory, funding, theory of shareholders, business regulation, and assurance. This subject emphasizes the significance of corporate regulation and the theory of agency in the circumstances of environmental reporting, which continued a major emphasis throughout the time. Group #1 then concentrates on sustainable reporting and CSR, utilizing language such as sustainable disclosure, CSR and environment to reflect a substantial focus on the sustainable disclosure concerns and social obligations in business reports. Groups #2 and #3 include concepts like responsibility, non-financial disclosure, and board attributes, which all contribute to non-financial disclosure and merged reporting. Pointing to a shift in study for including budgeting and non-budgeting issues into environmental reporting. Furthermore, group #4 attend to the financial relevance and financial transparency, although groups#5 and #6 highlight the significance of environmental report and assurance. Group #7 discusses the independence of assurance providers in reporting, while group #8 addresses the ISSB's first exposure, depicting the latest developments in sustainability reporting and standardization publication in 2022. It indicates global efforts to harmonize and builds up sustainability reporting.

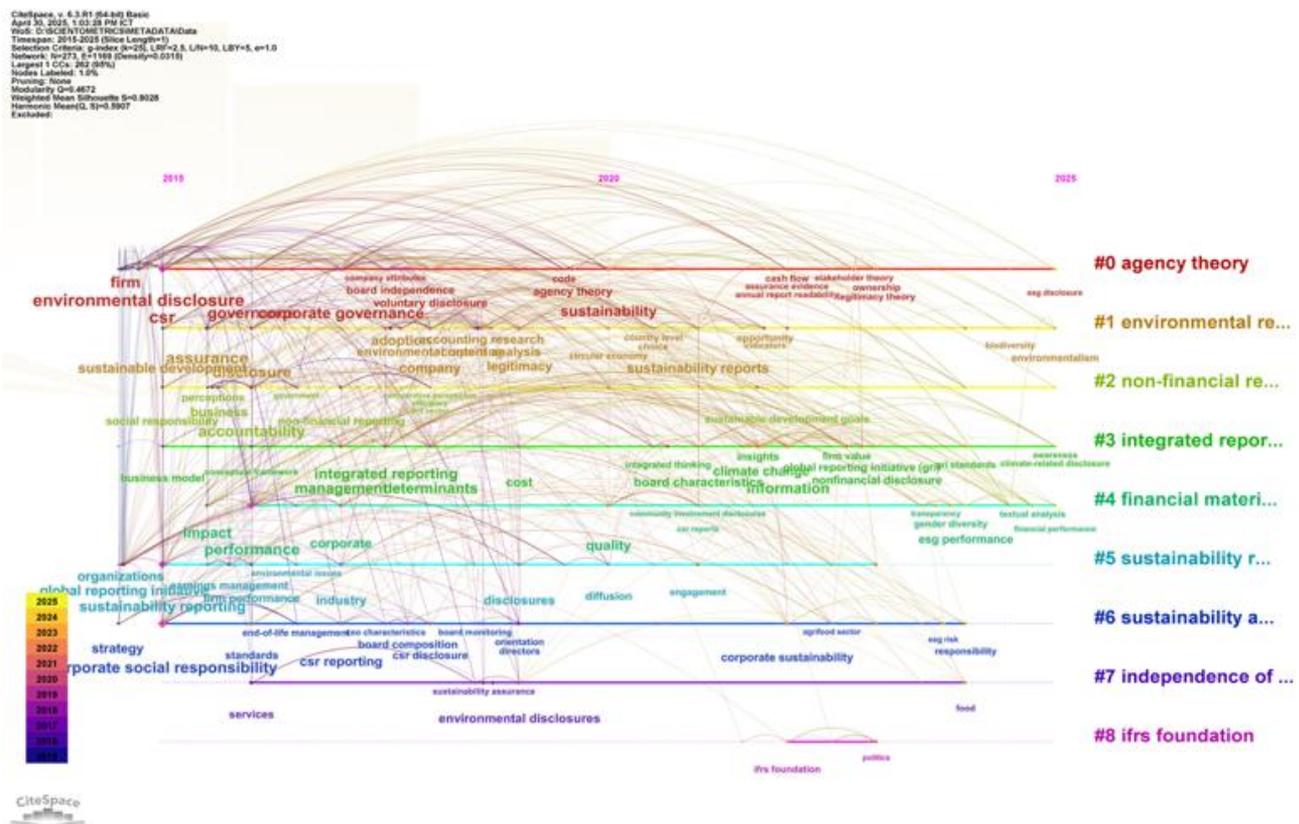


Figure 4. Keyword evolution

**Table 2.** Top 20 keywords with the strongest citation bursts

Keywords	Year	Strength	Begin	End	2015 - 2025
Integrated reporting	2018	2.07	<b>2020</b>	2022	████████████████████
Disclosures	2019	1.99	<b>2019</b>	2021	████████████████████
Environmental reporting	2018	1.91	<b>2018</b>	2019	████████████████████
Insights	2022	1.70	<b>2022</b>	2023	████████████████████
Standards	2016	1.65	<b>2023</b>	2025	████████████████████
Strategy	2015	1.60	<b>2015</b>	2017	████████████████████
Determinants	2018	1.55	<b>2018</b>	2019	████████████████████
Sustainability reports	2021	1.49	<b>2021</b>	2022	████████████████████
IFRS foundation	2022	1.36	<b>2022</b>	2023	████████████████████
Sustainable development	2015	1.35	<b>2017</b>	2018	████████████████████
Climate change	2022	1.35	<b>2022</b>	2023	████████████████████
Nonfinancial disclosure	2023	1.34	<b>2023</b>	2025	████████████████████
Diffusion	2020	1.13	<b>2020</b>	2021	████████████████████
Accountability	2016	1.10	<b>2016</b>	2018	████████████████████
Board composition	2018	1.07	<b>2018</b>	2019	████████████████████
Adoption	2018	1.06	<b>2018</b>	2022	████████████████████
Business	2016	1.02	<b>2016</b>	2017	████████████████████
Corporate social responsibility (CRS)	2019	0.96	<b>2019</b>	2021	████████████████████
Management	2017	0.95	<b>2017</b>	2018	████████████████████
Non-financial reporting	2017	0.87	<b>2017</b>	2018	████████████████████

Burst keywords are keywords that suddenly experience a very high spike in citations. A keyword that has been around for a long time but is rarely cited, then experiences a significant increase in citations and becomes a ‘star keyword’ for a certain period. After generating a network of co-occurring keywords using CiteSpace, a burstness function is performed to identify these burst keywords.

From 2015 to 2025, there were 20 keywords with the highest burst strength in the field of sustainability reporting (Table 2). Several important keywords have recently received attention in the literature: integrated reporting, disclosures, environmental reporting, IFRS Foundation, non-financial disclosure, and climate change. This shows the change in focus of the literature from basic information disclosure and fundamental topics to more sophisticated and strategic integrative issues [12, 57]. Attention from scholars has most certainly moved beyond simply the integration of financial and non-financial reporting to more advanced issues, including the circular economy, climate risk disclosure, and accountability.

For instance, interest in the circular economy develops in the context of global reduction of waste and resource efficiency through sustainable business models [59]. Climate risk is one of the most important issues related to transparency demands from investors and regulators concerning the disclosure of risk related to climate change [56, 60]. Furthermore, the accountability element emphasizes the need of environmental reporting in not just intercommunication but also reporting supervision, regulation, and responsibility [53, 61]. This exhibits how the introduction of IFRS S2 enhances reporting specifications from technical standpoint by connecting incorporation of environmental report with oversight, global sustainable frameworks, and global economic guidance [52]. Accordingly, the most recent reference on environmental reporting demonstrates through and continuous modifications to advance the subject of research. They show how specification reports like IFRS S2

are economically vital for fostering growth, strengthening governance, and increasing the pertinency and effects of green data in corporate and governance. This item of trend detection, especially on “Emission Disclosure” and “Economic Circularity” directly promotes the shift to IFRS S2. It highlights how this requirement simplifies it to determine GHG emissions and carry out global warming to concept analysis, which were in advance scattered in before 2022 literature.

#### 4.4 RQ4: Country analysis: Pattern of collaboration between countries

This subsection answers RQ4 regarding the most dominant countries and patterns of international collaboration in sustainability reporting research. The pattern of collaboration between countries (Figure 5) in sustainability reporting research highlights the dominance of Western European countries, particularly the United Kingdom, Germany, and Italy, as major hubs in international research collaboration networks. These countries not only play a role as major producers of academic literature, but also as strategic connectors that facilitate knowledge exchange and the development of cross-jurisdictional reporting standards [62, 63]. The collaboration network in the European nations plays an instrumental role in the harmonization and global dissemination of sustainability reporting standards such as IFRS S2. The level of cross-institutional and cross-border collaboration as demonstrated by extensive co-authorship and research circulation, facilitates the flow of novel ideas and enhances the ability of countries to adjust to changes in regulations, documenting the case of Christensen et al. [12] and Giner and Luque-Vílchez [56]. Nonetheless, the same bodies of work point to a lack of research, especially in developing countries, on cross-border and cross-institutional collaboration in the field of sustainability reporting.

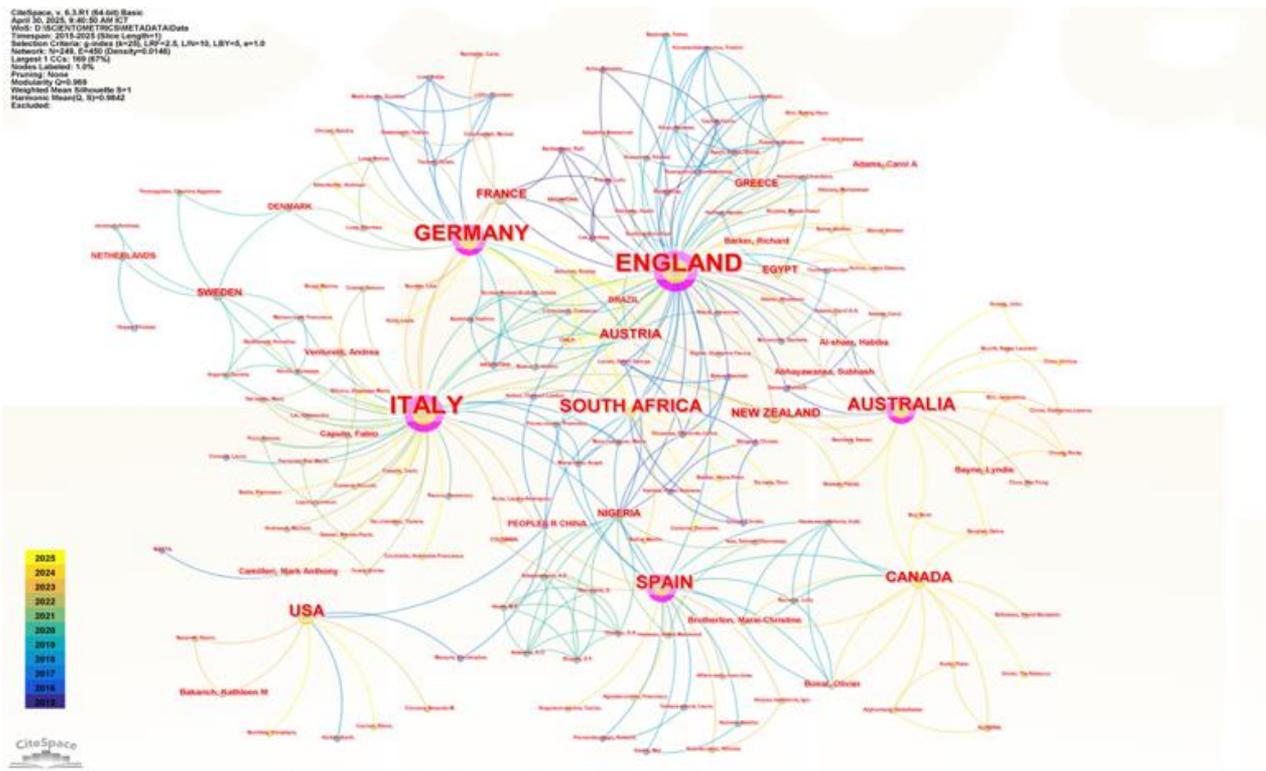


Figure 5. Collaboration between countries

## 5. DISCUSSIONS

### 5.1 Transformation of the academic landscape of sustainability reporting

The growing body of literature on sustainability reporting shows a more integrated view of joint financial and sustainability reporting from the corporate and academic perspective. With the implementation of more international regulations like the IFRS S2 standard, more of the literature emphasizes the need for sustainability-related information disclosure and the value of accountability. This results in the prominence of more analysis on theories aimed at the management of climate change-related risks and transitioning to a low-carbon economy [12, 56] in the climate change literature.

Academic research has moved out of conceptual structure to solicit worldwide specification reporting and focusing on the accuracy of structure criteria of sustainability reporting. This study perceived the research metrics as hint to a significant shift in the environmental reporting sector warranting further investigation. The co-occurrence analysis (CPA) shows that the area is shifted from the conventional concentration to CSR (Group#1) into attend to conformity (Groups #1) and obligatory reporting (Group#10), matched to the transition of IFRS S2. It is significant transformation; it is a profound and elemental alteration.

### 5.2 IFRS S2 implementation: Challenges and opportunities

IFRS S2, published global Sustainability Requirements Committee June of 2023 and practical in January 2024. It is an important step toward including life cycle effect information into business reporting process. At this point, there are four

major characteristics stand out: oversight, plan, frisk control and measurement and objectives, each of which have counterparts in current TCFD, CDP, SASB, CDSB, and GRI structures [64, 65]. Based on the result of this research of items of anomaly detection, study into “Emission Reporting” has surged since 2020, coinciding with the establishment of the phase of IFRS S2. It has the possibility to repeat the achievement of IFRS requirements, which are now in the inventories of tens of thousands of enterprises in over one hundred countries. The beginning stages of implementing comfort a range of challenging hurdles, including a pressing demand for technical expertise, technological enhancements, and massive funding [65].

The main difficulty in implementation lies in data collection, particularly for Scope 3 emissions involving supply chains that are difficult to monitor and verify, requiring companies to have sophisticated and integrated information systems [65, 66]. Given that auditors need to engage external experts to confirm the information provided by companies, high audit fees are another obstacle [33]. Global regulatory fragmentation also creates challenges for multinational companies that must comply with conflicting regulations, such as the disparities in materiality approaches between IFRS S2 and EU CSRD [66]. IFRS S2 is less stringent than SBTi in providing guidance on setting net-zero targets, which may pose a risk of greenwashing because formal disclosures are not always followed by actual emissions reductions [67].

### 5.3 Global gap in adoption readiness

The implementation of issues are getting increasingly problematic as a result of the clear preparation gaps between developed and developing countries, as seen by examination of inter-country collaboration (Figure 5), which reveal the Western European countries as the dominating force.

Southeast Asia nations consisting of Thailand, Indonesia, Singapore, and Malaysia, in addition to African nations like Ghana and Malawi, possess just 46.6% preparation owing structural deficiencies, and institutional strength [68-70]. Advanced nations with minimal compliance of regulation experience higher difficulty in adhering to these norms [37], owing to a shortage of legal obligations and planned awareness. Malawi exemplifies this special difficulty, considering public enterprises possess little expertise in independent reporting, necessitating intense collaboration between stakeholders to reconcile IFRS S2 regional rules [69]. Meanwhile, developed countries such as those in Europe and Australia already have mature emissions trading schemes [64, 66]. This difference is reflected in the practice of stronger accounting conservatism in developed countries with good governance, while in developing countries, information imbalances weaken its influence [71, 72]. Although large companies in countries with active emissions trading systems are beginning to adapt, political resistance and uncoordinated government policies still affect their ability to adapt to global sustainability reporting standards [64, 66].

#### 5.4 Fundamental criticism and paradigmatic tensions

Despite these implementation challenges, the single materiality approach of IFRS S2, which focuses solely on the financial impact on companies, has also been criticised as it contrasts with the dual materiality approach adopted by the European Union, which considers social and environmental impacts too [33]. The debate over single materiality versus dual materiality is one of the most important theoretical and practical issues in the development of sustainability reporting standards. Single materiality focuses on the financial impact on investors, while dual materiality broadens the scope to include the social and environmental impacts of a company's activities [73, 74]. The approach of single materiality adopted by IFRS S2 has been criticized for contrasting with dual method applied by European Union through the Corporate Sustainability Reporting Directive (CSRD), which also comprehensively considers social and environmental impacts [75]. The European Union's choice to apply dual materiality reflects significant regulatory and ideological changes [76], although empirical evidence shows that the adoption of this approach has not yet had a significant impact on ESG risk management, possibly because reporting practices are still symbolic or the implementation stage is still in its early stages [77].

The way to align IFRS S2 with CSRD, European Sustainability Reporting Standards (ESRS), and TCFD are critical steps towards establishing a unified worldwide reporting environment. Although IFRS S2 adopts the TCFD structure to improve global consistency, gaps arise with CSRD and ESRS that demand more in-depth disclosure of external impacts, creating methodological tensions and double reporting burden for multinational companies [15, 65]. Other challenges include the complexity of data collection, interoperability issues with regional standards, as well as implementation barriers of scenario analysis where many companies tend to produce scenarios that are more competitive than substantive [78]. This transition towards harmonization of reporting standards is not simply a technical adjustment but reflects a fundamental shift in how companies view their role in society, in line with demands for greater accountability and the achievement of global sustainability goals such as the

Sustainable Development Goals (SDGs) [79, 80].

The case studies show a variety of institutional readiness across the context. For instance, Air Canada as an experienced company with climate reporting was more ready to adopt IFRS S2 due to investor encouragement and internal readiness [81], while a study in the Colombian agriculture sector showed that institutional support, ongoing training, and active management involvement were key factors for successful adoption, with the main constraints being complex asset recognition and valuation processes [82]. In contrast, companies in Palestine and Indonesia show low levels of voluntary disclosure, requiring strengthened regulatory and reporting capacity [83, 84]. In Europe, although many companies claim to apply double materiality, evidence shows non-compliance with guidelines indicating symbolic adoption [33, 77].

This tension includes another discussion on the validation and openness of corporate reporting alongside the other stakeholders interested besides just investor in reporting framework [85]. Further criticism centers on "regulatory imperialism", where developing countries expand their institutional capacity and data infrastructure to adopt frameworks designed for more developed economies [86]. This misalignment of frameworks can divert a country's focus from more relevant and direct sustainability reporting initiatives that address the inequalities associated with the sustainability regulatory capture paradox [87]. This explains the findings from cluster #8's analysis of "ISSB first exposure" with an average publication of 2022, which confirms that this critique is recognized in contemporary scholarship.

#### 5.5 Policy opportunities and academic contributions

It highlights the requirement for policies that encourage academic contributions to sustainability reporting. Policies promote more structural disclosure, such as those outlined in IFRS S2, prompting academic institutions to develop theories and practices aligned with evolving regulations. It can also accelerate collaboration across academic institutions, industry, and government, ultimately enriching research focused on development transparent, accountable reporting standards [54, 55]. An interdisciplinary approach used to strengthen this study. It allows for the integration of various perspectives, such as economics, environment, and governance, resulting in more comprehensive and holistic solutions for corporate social and environmental impact. Collaboration between various disciplines has proven effective in addressing the complex challenges the corporate sector faces in dealing with climate and sustainability risks [12, 85].

## 6. CONCLUSIONS

This study indicates that sustainability reporting standards have shifted from voluntary disclosure practices aligned with CSR to more widely accepted and compulsory reporting norms, especially post-IFRS S2. Scientometric evidence reveals a remarkable rise in publication volume from 2017 onwards with a more distinct surge after 2020. This trend aligns with the observed timeframe with the generation of international regulatory initiatives such as the setting up of the ISSB and the issuance of IFRS S1 and IFRS S2, that is, the increasing academic interest in sustainability reporting problems.

The claim that the development of this literature is related

to the dynamics of international regulation is supported by measurable bibliometric indicators, not by normative inferences. Keyword burst analysis (Table 2) shows that terms related to regulation have experienced a strong and relatively recent surge in citations, such as “IFRS Foundation” (burst strength = 1.36; period 2022–2023), “standards” (period 2023–2025), and “non-financial disclosure” (period 2023–2025). This surge coincided with the institutionalization phase of ISSB standards, indicating a temporal co-occurrence between the global regulatory agenda and the shift in academic discourse, without claiming a direct causal relationship.

Additional support for this paradigm shift is obtained from co-citation analysis, which identifies cluster #0 (compliance) and cluster #10 (mandatory disclosure) as dominant and central clusters in the knowledge network. The high modularity value ( $Q = 0.8543$ ) and average silhouette score (0.8875) indicate that regulation-oriented clusters have a strong structure and play an important role in shaping the intellectual landscape of sustainability reporting research. These findings indicate a shift in research focus from voluntary reporting towards compliance with standardized standards and mandatory disclosure.

Moreover, bibliometric analysis results also point towards new research opportunities in emerging fields. The analysis of keyword networks led to the identification of nine thematic clusters formed from 273 nodes and 1,169 links with a modularity value of 0.4672 and a silhouette score of 0.8028, which suggest high quality of clustering. Specifically, cluster #8 (early exposure of ISSB) that had an average publication year of 2022 turned out to be an emerging hotspot, showing increasing academic concern about the early adoption, interpretation, and critique of ISSB and IFRS S2 standards. Additionally, the themes of climate risk disclosure and circular economy have also been characterized as developing ones, as evidenced by the relatively short and recent burst periods.

The inter-country collaboration analysis supports these conclusions by revealing that among the Western European nations, the United Kingdom, Germany, and Italy were the most important ones in the international research network. Their position at the center of this network indicates that there was an active regulatory environment, which in turn led to the production of scientific knowledge and also it weakening in developing countries, where institutional and empirical readiness is still limited but where collaboration and research development are possible areas.

Overall, the findings indicate that the evolution of sustainability reporting research has been closely tied to the international regulatory agenda and is now moving towards a period of regulatory consolidation and at the same time thematic diversification. This study does not claim deterministic causality but provides quantitative support for the alignment in time, convergence in theme, and centrality in structure in the literature, which together confirm a paradigm shift towards IFRS S2 and point out sustainability reporting as a future research area.

According to the finding regarding the transformation of reporting standards, this research has profound strategic implications for policymakers, regulator, practitioners and the academic community in navigating the transition to IFRS S2. The result above highlight the value of global governmental convergence in minimizing reporting dispersion, with government police aligning with the IFRS S2 requirement to

increase the openness and comparison of ESG’s information. In poorer nations, where preparedness is still low, authorities should take a staged approach beginning with workforce development through specialized instruction and fiscal incentives for conformity. For executives, practical consequences involve the requirement to encompass emission disclosure into company planning, which necessitates the expenditure in digital systems for Scope 3 emission monitoring and third party for verification. Expenditures and stakeholders can use the data to evaluate the standard of reporting, promoting investments to businesses with developed disclosure. Aesthetically, this study contributes to the attainment of the SDGs, including SDG 13 (Global Warming Action), by enhancing responsibility for ESG impacts.

Although this research makes substantial contributions to our comprehension of the history of environmental report requirements, various limitations must be addressed deciphering the findings. First, reliance on only one database (Web of Science) confines the coverage whereas additional database including Scopus and working papers may catch significant papers in developing nations. Second, the study period (2015-2025) is insufficient to capture the long-term evolution of sustainability reporting standards, especially considering that IFRS S2 will only come into effect in January 2024, implying that empirical literature on its actual implementation remains restricted. Nevertheless, this methodology provides a strong foundation for intellectual mapping, with limited potential for generalization in the domain of global sustainability reporting.

There are possibilities and challenges that need to be explored to enrich our understanding of the dynamics of sustainability reporting, considering these limits and the complexity of implementing IFRS S2. Future studies could compare different developing markets to uncover contextual variations, including cultural and regulatory barriers in each region. Future research could also conduct in-depth analysis at the industry level (e.g., financial sector versus manufacturing) to identify the best sectoral practices. Finally, qualitative empirical studies, such as interviews with stakeholders, could be conducted to investigate the success of corporate strategies in addressing greenwashing and improving disclosure quality, as well as to explore how technology and digital transformation such as blockchain for emissions data verification, artificial intelligence for climate risk analysis, IoT sensors for real-time monitoring, and the digital IFRS Taxonomy can facilitate a more advantageous and accurate implementation of IFRS S2.

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