https://journals.insightpub.org/index.php/imj
Insight Management Journal
Volume 6, Issue 1, May 2026, pages 132-148

# Mapping ESG disclosure (2004-2025): a bibliometric review and evidence-based core metric set

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Article info

*Article history:*
Submitted [05-04-2026]
Revised [07-05-2026]
Accepted [11-05-2026]

*Keywords:*
ESG disclosure
Bibliometric analysis
Co-citation
Core set
Assurance

A b s t r a c t

This study maps the intellectual landscape of ESG disclosure research and proposes a concise set of auditable and comparable ESG indicators. Using a Scopus corpus covering 2004–2025 (n = 681), the study applies bibliometric analysis with VOSviewer and Biblioshiny through co-occurrence, co-citation, and citation network analysis. The findings show sustained publication growth, increasing international collaboration, and thematic concentrations around financial performance, corporate governance, CSR, and sustainability reporting. Citation structures further reveal strong linkages between governance mechanisms, disclosure quality, and firm value. Based on these network patterns, the study develops a core metric set using four selection criteria: financial materiality, auditability, comparability through alignment with ISSB, GRI, and ESRS, and proportionality for SMEs. The proposed indicators include GHG emissions intensity, energy intensity, total recordable injury rate (TRIR), employee turnover, board independence, audit committee activity, ESG risk-management policy, and machine-readable reporting formats. This study contributes by consolidating twenty-one years of ESG disclosure scholarship and translating bibliometric evidence into a practical starting point for standardized, decision-useful, and assurance-ready reporting. However, the study is limited to Scopus-indexed publications and does not empirically test the proposed indicators in organizational practice. Future research should expand the database, include non-English and regional publications, and validate the proposed indicators across sectors, jurisdictions, and firm sizes, particularly in SMEs and developing economies.

## Introduction

Over the past decade, the global push for sustainable development and corporate accountability has placed environmental, social, and governance (ESG) disclosure as a component of organizational governance and reporting strategies (Mihalciuc et al., 2024). However, despite increasing adoption, the comparability and consistency of ESG information remain weak. Differences in automotive regulations and diverse frameworks have led to inconsistent reporting practices (Ilori et al., 2023; Ma, 2024). On the assessment side, ESG scores across third parties often deviate due to variations in indicators, weightings, and methodologies (Ermokhin et al., 2023), and XBRL-based findings reinforce material methodological differences (Suta et al., 2023). This combination of factors results in metrics that are difficult to compare and potentially undermine stakeholder trust.

The literature offers three avenues for improvement. First, converged standards under ISSB/IFRS to strengthen transparency and usability of information (Wahyuni, 2025). Second, a cross-standards mapping framework (meta-framework) linking GRI, SASB/VRF, TCFD, and IFRS to better align terminology/indicators (Jang et al., 2023). Third, technology-based taxonomies such as XBRL to ensure data is easily auditable, machine-readable, and comparable across reporters (Chopra et al., 2024).

Despite the rapid growth of ESG disclosure research, at least three areas remain unclear. First, there is no comprehensive bibliometric mapping from 2004–2025 that directly links the field's knowledge structure to the formulation of a concise, audit-ready core set of metrics. Second, the linkage between ESG disclosure and accounting tools (e.g., environmental cost tracking and integration of life cycle assessment into budgets/KPIs) is still limited, so transparency does not automatically lead to improved performance (Xia et al., 2025). Third, MSMEs face cost, capacity, and regulatory constraints; they require proportional minimum disclosures—simple, feasible, yet still informative (Apanel, 2025).

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With this perspective in mind, this study combines three bibliometric approaches—co-occurrence, co-citation, and citation analysis—to comprehensively map the knowledge structure of ESG disclosure for the period 2004–2025 using VOSviewer and Bibliometrix/Biblioshiny. This study goes beyond mapping, but rather generates structured bibliometric evidence to create an ESG core set: a concise collection of core metrics linked to costs, revenues, and risks, and easily auditable.

This study has two contributions. First, it provides a consolidated map of the main trends, actors, and themes in ESG disclosure research (2004–2025). Second, it offers an evidence-based starting point for an ESG core set that aligns with the principles of financial materiality, auditability, comparability, and proportionality for reporters across scales, including MSMEs.

This research aims to identify publication trends and literature growth patterns; the distribution of influence (authors, institutions, countries), and collaboration networks; and derive evidence from bibliometric maps to develop a more measurable and useful ESG core set for decision-making.

This study articulates four guiding questions in narrative form. First, it examines the publication trends and growth patterns of the ESG disclosure literature from 2004 to 2025 based on Scopus, tracing the evolution, momentum, and inflection points of the field. Second, it identifies the most influential authors, institutions, and countries while uncovering their collaboration patterns, thereby mapping the intellectual and geographic networks that shape the discourse. Third, it explores the main themes and thematic clusters derived from co-occurrence and co-citation mapping to reveal the conceptual structure and knowledge frontiers of ESG disclosure research. Finally, it investigates how these bibliometric insights can be translated into an ESG core set that enhances comparability, auditability, and usability for decision-making, ensuring that the synthesized evidence informs practical measurement and reporting choices.

ESG disclosure refers to the practice of organizations disclosing environmental (E), social (S), and governance (G) policies, performance, and impacts to strengthen transparency and accountability to stakeholders (Oncioiu et al., 2020). The environmental dimension encompasses carbon footprint, energy, water, and waste management (Zhou & Nian, 2024); social encompasses labor practices, human rights, safety, and community engagement (Khamisu et al., 2024); while governance relates to decision-making structures, internal controls, and compliance (S. Li et al., 2022). Within the current harmonization framework, IFRS S1–S2/ISSB emphasizes financial materiality—information relevant to assessing a company's economic value from an investor perspective (Z. Li, 2024).

The development of ESG disclosure is influenced by both internal and external factors. Internally, the effectiveness of internal controls correlates with the breadth and reliability of reporting (Tao et al., 2023). Externally, media scrutiny and pressure from investors, regulators, and consumers shape disclosure practices across sectors (Nguyen & Hoang, 2025). However, heterogeneity across countries/industries—in frequency, content, and quality—still undermines comparability and credibility (Kaplan & Ramanna, 2021; Singhania et al., 2024), exacerbated by regulatory constraints and resource constraints (Nguyen & Hoang, 2025).

Numerous studies have shown that consistent and transparent ESG disclosure is associated with operational efficiency, reduced cost of capital, resilience to volatility, and enhanced reputation (Alsayegh et al., 2020; Huang et al., 2024). Therefore, a more standardized and credible reporting framework is needed to improve the effectiveness of the reporting system (Kalyani & Mondal, 2024).

ESG disclosure is now understood not simply as a reporting tool, but as a managerial mechanism for managing risk, enhancing company value, and meeting stakeholder expectations (Chen et al., 2018; Ma, 2024; Mihalciuc et al., 2024). Positive impacts tend to materialize when ESG metrics are integrated into management control tools—budgets, KPIs, and performance evaluations—thus directly impacting costs, revenue, and risk (Alsayegh et al., 2020; Parveen, 2025; Xia et al., 2025). Frequently successful practices include tracking energy/waste costs, integrating life-cycle assessments into efficiency targets, and safety indicators that influence downtime.

The credibility and comparability of information are also significantly influenced by governance and assurance. A more independent and active audit committee correlates with better disclosure quality and readiness to obtain assurance (Bravo & Reguera-Alvarado, 2019). Globally, the proportion of companies seeking assurance on ESG reports is increasing—generally limited assurance—although practices across countries are not uniform (O'brien et al., 2023). In line with the push for IFRS S1–S2, the use of machine-readable data taxonomies (e.g., XBRL) strengthens auditability and interoperability (Chopra et al., 2024).

Divergence in ESG assessments across institutions—due to differences in indicators, weightings, and methodologies—is reducing the usability for investor decisions. Several jurisdictions (e.g., the UK, the European Union, India, and Japan) are beginning to establish transparency rules for rating providers

to enhance accountability (Ermokhin et al., 2023). For MSMEs, limited costs, human resources, and data capabilities demand a proportionate approach. Starting with a core set—lean, performance-relevant, and easily auditable metrics—provides a feasible implementation path without losing the value of information for investors and supply chain partners (Apanel, 2025).

Bibliometric analysis is a quantitative approach to measuring, analyzing, and visualizing the scientific corpus in a field, including ESG disclosure (Kumar, 2025). In the ESG context, bibliometrics helps identify publication patterns, thematic trends, and influential contributors (authors, institutions, countries), while also mapping global collaborations (Cai et al., 2024; Debnath & Chellasamy, 2024).

The use of tools such as VOSviewer, CiteSpace, and Biblioshiny facilitates the visualization of co-citations, keyword co-occurrences, and the evolution of themes over time (Sklavos et al., 2024; Zhou & Nian, 2024). This visualization clarifies how concepts develop and interact, highlights underexplored topics, and helps formulate future research agendas (Abdullah et al., 2023; Kai et al., 2023; Khaw et al., 2024). In addition to mapping themes, bibliometrics also uncovers intellectual structures—key articles that form the theoretical/methodological foundation—so researchers can identify relevant research gaps (Ellili, 2022; Khamisu et al., 2024; Singh et al., 2022).

The above review highlights three interrelated issues: the fragmentation of standards/practices (single vs. dual-scale) impacting metric selection and comparability across jurisdictions (Z. Li, 2024; Lokuwaduge & De Silva, 2022); divergence in ESG assessments due to differences in indicators, weightings, and methodologies, which reduces decision-making effectiveness and drives the need for transparency among rating providers (Ermokhin et al., 2023); and the urgency of auditability/assurance to strengthen credibility, while assurance practices remain uneven across countries (O'brien et al., 2023).

At the same time, consistent impacts emerge only when ESG metrics are linked to management accounting tools—energy/waste cost tracking, life-cycle assessment integration into budgets/KPIs—thus influencing costs, revenues, and risks (Apanel, 2025; Bravo & Reguera-Alvarado, 2019; Xia et al., 2025). Therefore, this study positions the ESG core set as a minimal set of decision-worthy, audit-ready metrics that can serve as a baseline across contexts and be gradually enhanced according to industry needs and evolving standards. The criteria for establishing the core set were formulated with financial materiality as the primary foundation, aligned with ISSB/IFRS S1–S2, ensuring each indicator has a clear causal link to performance through pathways to costs, revenues, and risk or capital. Each item must be auditable, with identified data sources, a documented audit trail, and standardized methods. At the same time, indicators were selected for comparability and interoperability, allowing them to be mapped to GRI/ESRS and data taxonomies such as XBRL. The entire design also emphasizes proportionality, meaning it remains feasible for various organizational capacity levels, including MSMEs.

## Research Methods

This study employs bibliometric analysis to map the research landscape on the ESG disclosure–performance relationship and to generate evidence for designing a core set of indicators. The bibliometric approach enables the tracking of publication trends, influential actors, citation relationships, and thematic structures through network modelling (Aria & Cuccurullo, 2017; van Eck & Waltman, 2010). Data were sourced from Scopus and downloaded on March 12, 2025, covering the years 2004–2025. The final query was: TITLE-ABS-KEY (("ESG" OR "environmental" OR "social" OR "governance") AND ("disclosure" OR "reporting" OR "transparency" OR "communication") AND ("firm performance" OR "corporate performance" OR "financial performance" OR "business performance") AND ("impact" OR "effect" OR "influence" OR "relationship")), with the filters: document type = article, language = English, subject areas = BUSI/ECON/SOCI/ENVI, and Open Access = all.

The selection process followed PRISMA 2020 (Haddaway et al., 2022). The initial search yielded 2,369 records. After filtering by field, document type, language, and title/abstract relevance, 1,028 records were sought for retrieval (reports sought for retrieval), 347 were not retrieved (reports not retrieved), and 681 articles were assessed for eligibility. No articles were excluded at the eligibility stage, resulting in 681 articles included in the analysis (see Figure 1). The PRISMA 2020 flowchart presents the identification, screening, and inclusion stages, including the removal of duplicates and the automatic flagging of ineligible entries, as well as the initial exclusion of 1,341 records.

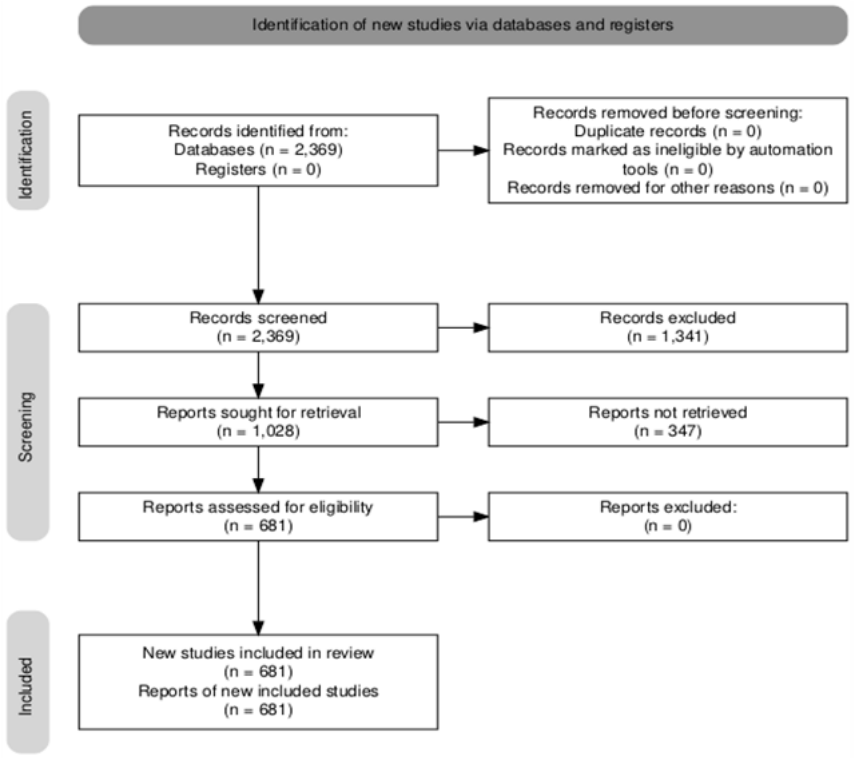


Figure 1. PRISMA Flow Diagram for Literature Search and Screening Process

All metadata (title, author[s], affiliations, keywords, abstract, sources, cited references) were exported in CSV format. Data cleaning included deduplication; keyword normalization (alignment of singular–plural forms and merging of synonyms, for example, "ESG disclosure" and "sustainability reporting" when contextually equivalent); and disambiguation of author names and affiliations, especially for the most frequent entries. A summary of the dataset (year distribution, top sources, and top keywords) is provided as a supplementary file. The analysis was conducted using R 4.4.3 (RStudio) with the bibliometrix/Biblioshiny package, VOSviewer 1.6.20 for network visualization, and PRISMA2020 (Shiny) for PRISMA flowcharts.

The analysis plan was designed for replication. The scope comprised: (i) descriptive statistics and citation impact; (ii) keyword co-occurrence; (iii) reference co-citation; (iv) direct document-citation networks; (v) conceptual structure using MCA and thematic maps; and (vi) country/author/source collaborations. Standard VOS/Bibliometrix settings were applied—full counting, association-strength normalization, VOS layout and clustering (resolution = 1.0), and minimum frequency/citation thresholds. All operational parameters and network metrics (thresholds; numbers of nodes, links, and clusters; ΣTLS; and top hubs) are presented in Table 1 to enable replication.

Table 1. Summary of parameters and network metrics (co-occurrence, co-citation, direct citation)

| Analysis | Key parameters | Nodes | Links | Clusters | ΣTLS / note | Top hubs (metric) |
|---|---|---|---|---|---|---|
| Co-occurrence (keywords) | unit = all; full counting; min-occ = 3; top 157 by TLS; association strength; VOS resolution = 1.0 | 157 | 1,023 | 12 | ΣTLS 1,826 | financial performance; corporate social responsibility; sustainability; corporate governance; firm performance |
| Co-citation (cited references) | unit = references; full counting; min-cit = 10; association strength; VOS resolution = 1.0 | 262 | 5,132 | 7 | ΣTLS 6,600 | Nollet (2016) (TLS 102); Xie (2019) (91); Platonova (2018) (63); Chen (2018) (44) |

| Analysis | Key parameters | Nodes | Links | Clusters | ΣTLS / note | Top hubs (metric) |
|---|---|---|---|---|---|---|
| Direct citation (documents) | unit = documents; full counting; min-cit = 10; largest connected set | ≈ 76 | ≈ 85 | ≈ 15 | Largest connected set | Nollet (2016) Citations 420 (Links 18); Xie (2019) 60 (Links 8); Chen (2018) 80 (Links 5); Platonova (2018) 30 (Links 11) |

## Results and Discussion

### Descriptive Landscape (RQ1)

Based on Scopus baseline data, the publication landscape on ESG disclosure exhibited a consistent expansionary phase from 2004 to 2025. Article production increased sharply after 2017 and peaked in 2024; the decline in the number of documents in 2025 reflects the partial nature of the current year rather than structural weakness. Over the same period, bibliometric characteristics indicate a relatively young field that already demonstrates sufficient scientific visibility, as evidenced by an average document age of 4.13 years and an average of 24.74 citations per article. Collaboration patterns also strengthened, marked by an average of 3.13 authors per article, only 63 single-author articles, and an international co-authorship rate of 31.28%. Taken together, these indicators signal an expansion of knowledge-production capacity, increased networking intensity, and accelerated diffusion across national and disciplinary boundaries.

The corpus parameters supporting this assessment are summarized in Table 1. The composition of 681 articles published in 277 sources, written by 1,943 authors, with an annual growth rate of 15.6%, demonstrates a large and sustainable scale of production. The broad thematic spectrum—reflected in 1,800 author keywords and 41,781 references—indicates a breadth of issues spanning accounting, finance, governance, and sector-specific topics. However, this breadth has the potential to lead to fragmentation of concepts and metrics. Therefore, the findings of RQ1 emphasize the urgency of developing a core set of indicators grounded in financial materiality, with clear data traceability for audit purposes, and capable of enhancing comparability through the establishment of a standards framework.

Table 2. Descriptive Analysis of ESG Disclosure Publications

| Information Aspect | Value |
|---|---|
| Timeframe | 2004–2025 |
| Sources | 277 |
| Documents | 681 |
| Annual Growth Rate | 15.6% |
| Number of Authors | 1,943 |
| Documents with Single Authorship | 63 |
| International Co-Authorship | 31.28% |
| Co-Authors per Document | 3.13 |
| Author Keywords (DE) | 1,800 |
| References | 41,781 |
| Average Document Age | 4.13 years |
| Average Citations per Document | 24.74 |

The annual growth trajectory confirming the above interpretation is shown in Figure 2. The visualization indicates a gradual increase in the initial phase, followed by acceleration after 2017 and a peak in 2024 (139 documents). The consistency between quantitative indicators and visual evidence reinforces the conclusion that the field is advancing to a new scale and depth. In this context, bibliometric mapping serves as a basis for identifying core patterns and guiding conceptual consolidation, while the standardization of indicators is a prerequisite for enhancing the comparability and decision-usefulness of findings in subsequent stages of analysis.

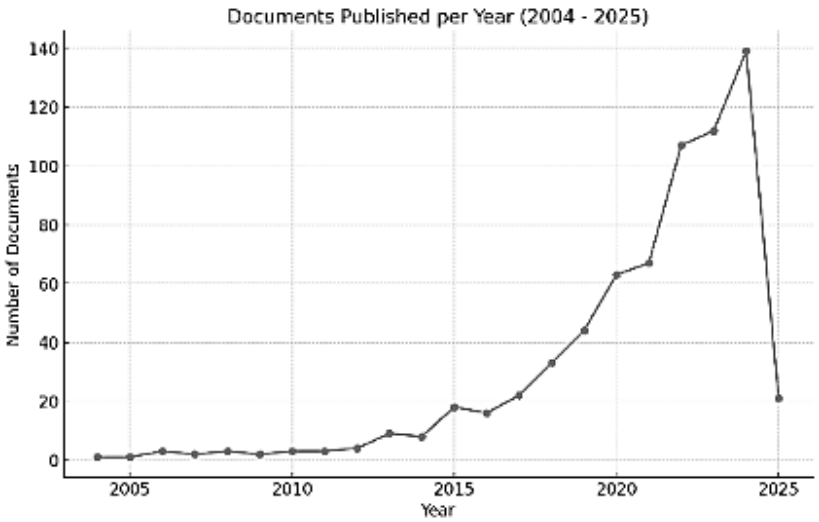


Figure 2. Documents published by year (2004–2025, Scopus).

The distribution of author productivity is consistent with Lotka's law: the empirical curve exhibits a sharp decline in the proportion of authors as the number of publications per author increases and closely follows the theoretical curve. This "fat-tailed" pattern indicates a predominance of one-time contributors accompanied by a small core of highly productive authors—a typical structure of a growing yet consolidating field. This evidence complements the annual growth figures and suggests that knowledge production is driven by a broad community with a clear center of competence.

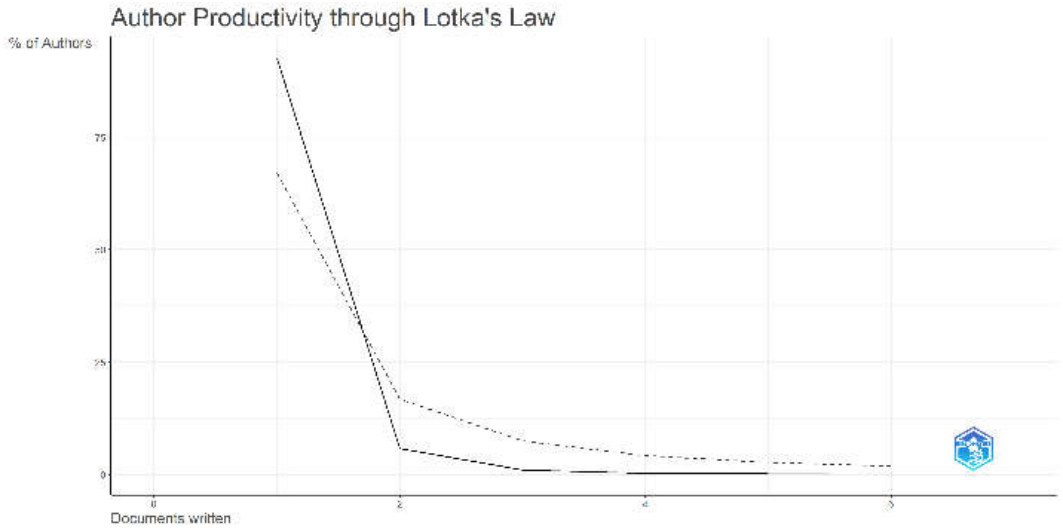


Figure 3. Author productivity through Lotka's Law (empirical vs theoretical curve).

The consistency among quantitative indicators, Lotka curves, and annual trend visualizations reinforces the conclusion that the field is advancing to new levels of scale and depth. In this context, bibliometric mapping provides a foundation for distilling core patterns and structuring conceptual consolidation, while indicator standardization is a prerequisite for enhancing the comparability and usability of findings for decision-making in subsequent analytical phases.

**Influence & Collaboration Structure (RQ2)**

Bibliometric findings indicate a concentration of influence among a core group of actors that support knowledge flows and cross-jurisdictional collaborative networks. At the author level, a stable core of productivity and local impact is evident; at the institutional level, an institutional bloc consistently supplies publications; and at the country level, Western European citation dominance is accompanied by increasing visibility in East and Southeast Asia. This structure demonstrates an increasingly integrated and relevant network for strengthening regional collaboration and methodological bridging to global standards centers.

Table 3. Most relevant authors and local impact (H-index, corpus)

| No | Most Relevant Authors | Articles | No | Authors' Local Impact (H-index) | H-index |
|---|---|---|---|---|---|
| 1 | Li X | 6 | 1 | Khuong NV | 5 |
| 2 | Khuong NV | 5 | 2 | Li X | 5 |
| 3 | Damn MS | 5 | 3 | Damn MS | 5 |
| 4 | Wang Y | 5 | 4 | Cherian J | 4 |
| 5 | Cherian J | 4 | 5 | Hussainey K | 4 |
| 6 | Hussainey K | 4 | 6 | Abdi Y | 3 |
| 7 | Li J | 4 | 7 | Càmara-Turull | 3 |
| 8 | Li Z | 4 | 8 | Gholami A | 3 |
| 9 | Wedari LK | 4 | 9 | Gutiérrez-Ponce H | 3 |
| 10 | Zhang J | 4 | 10 | Li J | 3 |

Table 4. Most productive affiliations

| No | Affiliation | Articles |
|---|---|---|
| 1 | Bucharest University of Economic Studies | 18 |
| 2 | Airlangga University | 16 |
| 3 | Bina Nusantara University | 14 |
| 4 | Universiti Utara Malaysia | 14 |
| 5 | Universiti Putra Malaysia | 12 |
| 6 | University of Economics and Law | 12 |
| 7 | University of Zaragoza | 12 |
| 8 | University of Portsmouth | 11 |
| 9 | Ferdowsi University of Mashhad | 10 |
| 10 | Valahia University | 10 |

Table 5. Most cited countries

| No. | Country | Total Citations |
|---|---|---|
| 1 | United Kingdom | 2,921 |
| 2 | Spain | 1,836 |
| 3 | Italy | 1,222 |
| 4 | Hong Kong | 1,016 |
| 5 | China | 1,009 |
| 6 | Japan | 606 |
| 7 | Malaysia | 597 |
| 8 | Indonesia | 447 |
| 9 | USA | 437 |
| 10 | Finland | 429 |

This direct citation network (min. citations = 10) in Figure 4 is anchored by four hubs—Nollet (2016), Xie (2019), Chen (2018), and Platonova (2018). Nollet (2016) concentrates links around the performance–governance corridor; Platonova (2018) connects CSR/ESG disclosure to firm value; Chen (2018) channels citations toward reporting practice and policy; and Xie (2019) serves as a bridging node across clusters. The density of cross-cluster edges indicates a shift from compliance-oriented reporting toward decision-oriented integration, marking priority corridors for collaboration and for selecting indicators in the core set.

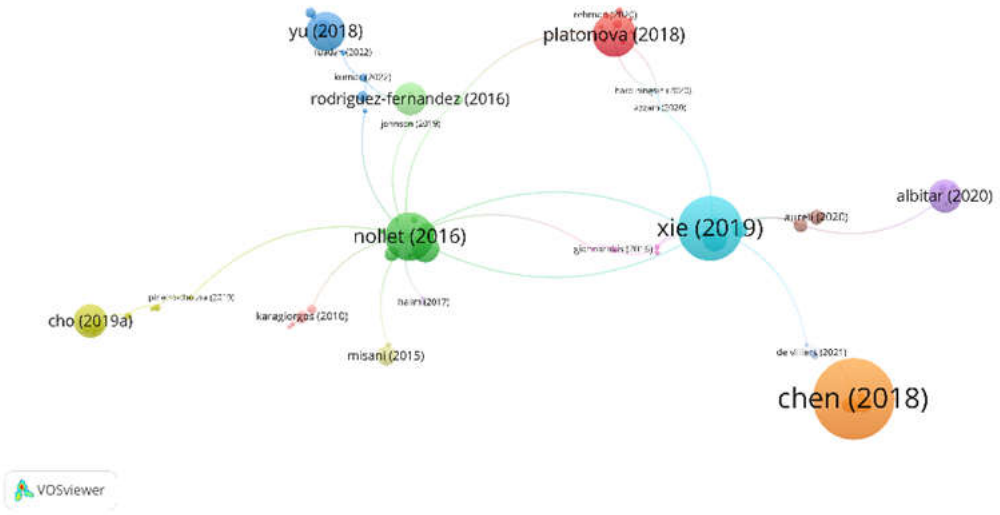


Figure 4. Citation network visualization (VOSviewer)

**Thematic & Intellectual Structure (RQ3)**

Keyword co-occurrence mapping (VOSviewer; unit = all keywords; full counting; min-occ = 3; top 157 keywords by total link strength) yielded a network of 157 nodes, 1,023 links, and 12 clusters, with a TLS of 1,826. The network structure is anchored by prominent thematic links—financial performance, corporate social responsibility, sustainability, corporate governance, and firm performance—which together form a complex landscape of interconnections among the CSR/sustainability–stakeholder, financial/firm performance, and governance clusters. The density of connections between key nodes indicates a shift in the literature's focus from compliance-oriented reporting to more decision-making-friendly performance measurement (see Figure 5).

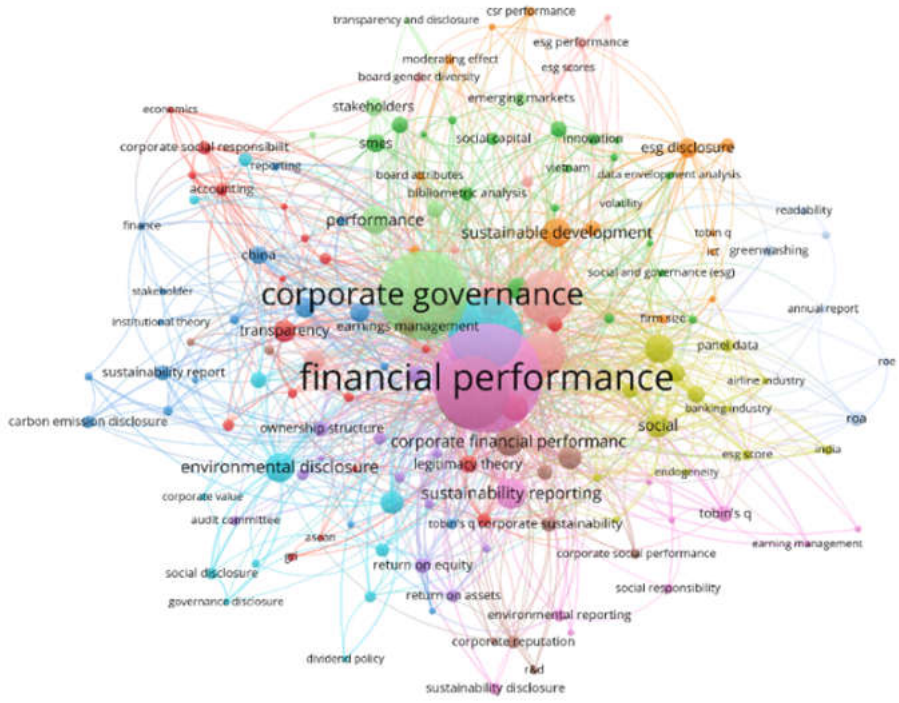


Figure 5. Keyword co-occurrence network (author keywords)

The co-citation map of cited references (VOSviewer; full counting; min-cit = 5) displays the largest connected component, encompassing 264 references with a clear clustered structure (see Figure 6). The co-citation pattern forms a performance–governance–disclosure corridor, with recurring anchors—Cheng, Ioannou & Serafeim (2014), Nollet et al. (2016), Xie (2019), Platonova (2018)—that rest on the theoretical pillars of Freeman (1984), Jensen & Meckling (1976), and the meta-review by Orlitzky et al.

(2003). This configuration confirms the intellectual foundation linking governance mechanisms and stakeholder interests to performance and capital market consequences, as depicted in Figure 6.

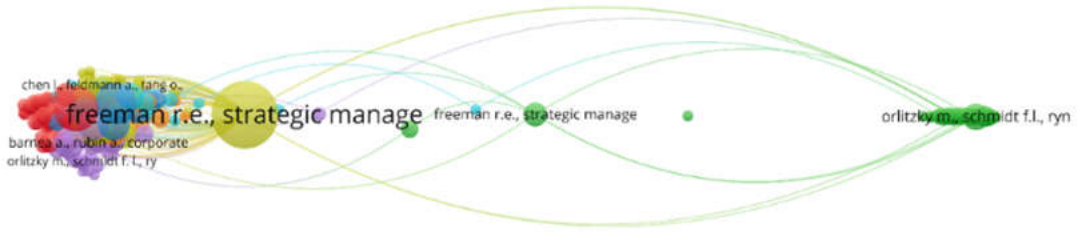


Figure 6. Co-citation map (cited references)

The direct citation network between documents mapped with VOSviewer (full counting; min-cit = 10; largest connected set) displays approximately 76 items, 85 links, and 15 clusters. Within it, the anchor nodes—Nollet (2016), Xie (2019), Platonova (2018), and Chen (2018)—are located at the intersection of the themes of performance, governance, and disclosure, thus confirming the corpus's practical relevance to issues of cost of capital, access to funding, and transparency. This pattern of connectedness suggests a thematic ecosystem concentrated on the causal pathways flowing from governance/CSR to disclosure and ultimately to performance. These findings also provide a direct basis for refining indicators into a core set in RQ4—with an emphasis on financial materiality, data traceability for audit purposes, and comparability across frameworks—as depicted in Figure 7.

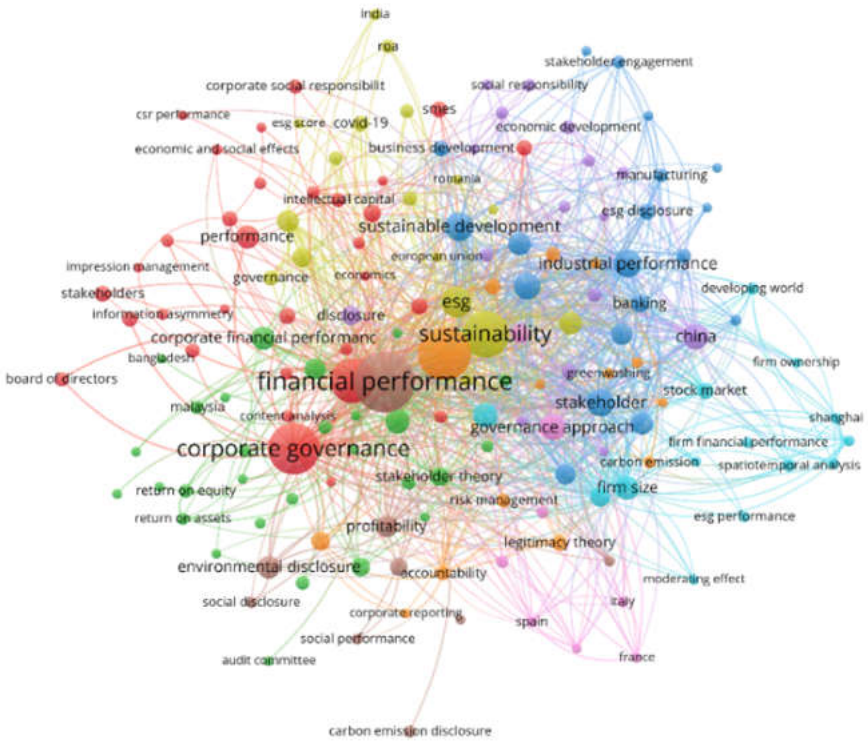


Figure 7. Direct citation network (documents)

**Translating Evidence To A Core Set (RQ4)**

The mappings from RQ1–RQ3 provide three complementary evidence pathways for an "evidence-to-core-set" translation. First, the thematic structure from the co-occurrence map indicates a concentration of discourse in three interlinked clusters—CSR/sustainability–stakeholder, financial/firm performance, and corporate governance—with prominent thematic anchors such as financial performance, corporate social responsibility, sustainability, corporate governance, and firm performance. Second, the co-citation network delineates a performance–governance–disclosure corridor grounded in classical theoretical pillars and anchor studies, thereby clarifying the conceptual mechanisms that connect disclosure practices

with capital-market consequences. Third, the direct citation network reveals articles situated at the intersections of these three clusters, underscoring practical relevance to cost of capital, access to financing, and transparency—domains directly related to business decision-making.

The Multiple Correspondence Analysis (MCA) mapping (see Figure 8) displays three conceptual groupings: (i) a theoretical cluster centered on stakeholder theory, legitimacy theory, and voluntary disclosure (the normative foundation); (ii) a practice–measurement cluster aggregating CSR/ESG disclosure, sustainability reporting, firm/financial performance, and stakeholder engagement (reflecting a shift toward measurement and decision usefulness); and (iii) a more fragmented cluster that places environmental, social, and governance relatively apart (indicating that full E–S–G integration within a single operational framework has yet to be achieved).

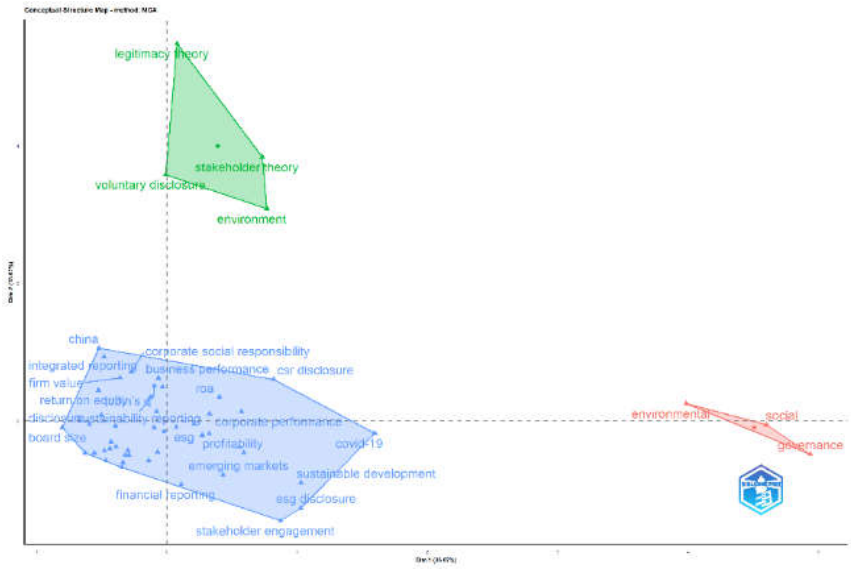


Figure 8 Conceptual structure map (MCA)

The overlay map (see Figure 8) signals a thematic evolution toward emerging topics—e.g., carbon emission disclosure, the green economy, and integrated reporting—yet their conceptual linkages to the theoretical corridor and performance metrics remain tenuous. This pattern suggests two research gaps: (i) the need for methodological bridges that connect the E–S–G dimensions to financially material performance measures (costs, revenues, risks), and (ii) governance mechanisms that ensure data traceability and assurance-readiness.

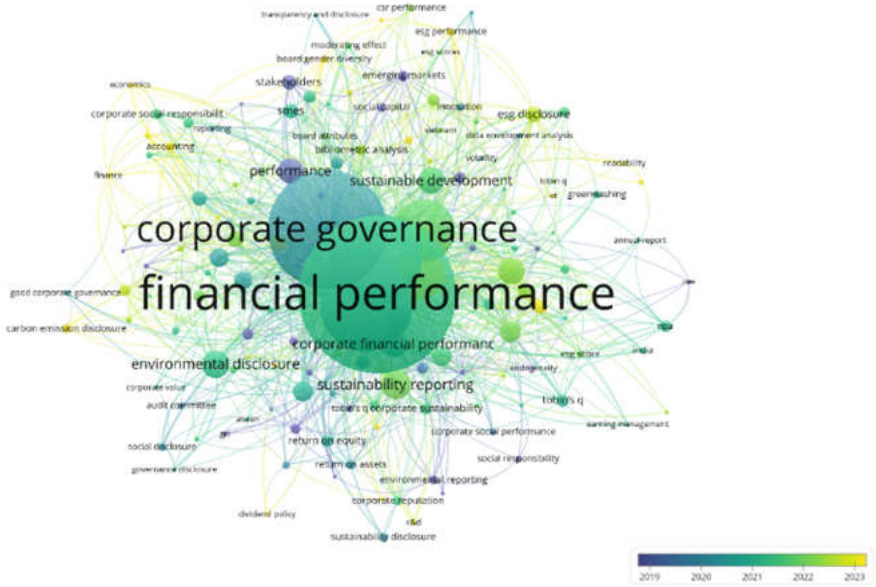


Figure 9. Overlay map of author keywords (average publication year)

Based on this evidence, the translation principles for the core set are formulated as follows. (1) Financial materiality: indicators must provide signals that can be linked to cost, revenue, and risk flows—explaining why intensity-based indicators (emissions, energy, water) and human-capital capabilities (TRIR/LTIFR, turnover) are prioritized. (2) Assurance readiness: the strong governance theme requires precise definitions, standard units, and clear data traceability, including explicit labeling of assurance status. (3) Comparability and machine-readability: alignment with ISSB/GRI/ESRS and the use of digital taxonomies (XBRL) strengthen cross-jurisdiction comparability and reduce methodological bias. (4) Connection to managerial processes: each indicator must be translatable into KPIs or budgets—for example, energy intensity as an efficiency target, TRIR as a safety plan—so that ESG functions as an input to decision-making rather than mere compliance. On this basis, Table 5 presents a concise and modular ESG core set (a cross-sector baseline that can be supplemented by sectoral/jurisdictional add-ons where material), with columns for definition/unit, data source, causal pathway to performance, and assurance status to ensure comparability, auditability, and decision usefulness.

Table 6. Proposed ESG Core Set (Global Baseline; sectoral add-ons as needed)

| Dimension | Core indicator | Definition & unit | Primary data source | Pathway to performance | Assurance status |
|---|---|---|---|---|---|
| E | GHG emissions intensity | $tCO_2e$ per revenue or per unit of output | GHG inventory (ISSB S2 / GHG Protocol) | Energy cost & carbon pricing; regulatory exposure | None / Limited / Reasonable |
| E | Energy intensity | kWh per revenue or per unit of output | Energy meters; ERP | OPEX efficiency | None / Limited / Reasonable |
| E* | Water intensity | $m^3$ per revenue or per unit of output | Utility/production records | Supply risk & process cost (sector-specific) | None / Limited / Reasonable |
| S | TRIR / LTIFR | Workplace incident rate | HSE / OHS records | Productivity, downtime, claims | None / Limited / Reasonable |
| S | Employee turnover | % annual separations | HRIS | Recruiting/training costs; capability stability | None / Limited / Reasonable |
| S* | Suppliers audited to social standards | % of critical suppliers audited | SCM; supplier audit records | Compliance risk & supply continuity | None / Limited / Reasonable |
| G | Independent directors | % of board that is independent | Corporate secretary / governance filings | Oversight quality; cost of capital | None / Limited / Reasonable |
| G | Audit committee activity | Meetings per year & attendance | Board minutes / calendar | Audit readiness; reporting quality | None / Limited / Reasonable |
| G | ESG risk-management policy | Existence; year of adoption | ERM / risk policy documents | Integration of ESG into risk & strategy cycle | None / Limited / Reasonable |
| G | Reporting standard compliance | ISSB / GRI / ESRS applied | Sustainability report | Cross-entity comparability | None / Limited / Reasonable |
| G / IT | Machine-readable format (XBRL) | Yes/No; tag coverage | Reporting system / XBRL instance | Automation & data consistency | None / Limited / Reasonable |
| Data quality | Restatements / material findings corrected | Count per year | ICFR / internal audit | Maturity of reporting controls | None / Limited / Reasonable |

Note: Indicators marked with * are activated when material for the sector/entity (proportionality principle).
**Abbreviations:** GHG = greenhouse gas; TRIR = total recordable incident rate; LTIFR = lost-time injury frequency rate; HSE/OHS = health, safety and environment / occupational health and safety; HRIS = human resources information system; SCM = supply-chain management; ERM = enterprise risk management; XBRL = eXtensible Business Reporting Language; ICFR = internal control over financial reporting.

**Discussion**

The mapping of RQ1–RQ4 indicates a shift in ESG disclosure from compliance toward a managerial function that affects costs, revenues, and risks, consistent with empirical findings that ESG activities are positively associated with corporate financial performance (Xie et al., 2019). Consistent bibliometric footprints (Figures 5–7) show that governance and CSR drive disclosure quality, which is then associated with performance and reduced information asymmetry—aligning with empirical findings on the relationships among ESG, performance, and the cost of capital (Ellili, 2022; Kumawat & Patel, 2022; Nollet et al., 2016; Platonova et al., 2018; Xie et al., 2019).

These findings are consistent with the consolidation of the global standards architecture. IFRS S1–S2 place financial materiality as the foundation: sustainability information is selected insofar as it is relevant to investors' assessment of risks, opportunities, and performance and is connected to financial reporting (Avi, 2022; Millar & Slack, 2024). In Europe, the ESRS/CSRD apply double materiality—combining financial materiality and impact materiality—to serve a broader spectrum of stakeholders (Malinovskaya, 2022). Global investors' preference for cross-country comparability, while still debating the focus of materiality, indicates that the discourse on financial versus double materiality remains relevant for the design of future reporting systems (Millar & Slack, 2024). At the implementation level, many companies use the GRI as a bridge to map content to IFRS/ISSB or ESRS, thereby maintaining data continuity and controlling transition burdens (Matuszak et al., 2025). This direction is consistent with bibliometric evidence that the "performance—governance—disclosure" node forms the primary pathway for information value.

At the market level, methodological fragmentation among rating agencies produces "aggregate confusion": differences in indicator scope, measurement methods, and weightings can yield conflicting scores for the same entity (Berg et al., 2022). The downstream impacts are tangible—from widening analyst forecast dispersion and increased information asymmetry to frictions in digital transformation and innovation outputs (S. Li et al., 2022; Ren, 2025). In emerging markets, disagreement in scores even correlates with higher audit fees due to elevated risk and the need for additional procedures (Yuan, 2025). In this context, the findings of RQ3–RQ4 offer an operational answer: simplifying to a "core set" whose definitions are precise, traceable, and machine-readable—rather than proliferating indicators—is an effective strategy to reduce methodological variation while preserving decision relevance (Appelbaum et al., 2024; Ilori et al., 2023).

Report credibility rests on two pillars, namely governance and assurance. The literature shows that audit committee characteristics and audit quality are positively associated with ESG maturity and assurance readiness, although their effectiveness is sensitive to context, independence, and role overload (Bravo & Reguera-Alvarado, 2019; Sihombing & Nurhaliza, 2025). On verification, classic evidence shows that external assurance increases investor confidence and the quality of nonfinancial reporting, especially when performed by experienced auditors under formal standards (Simnett, 2012). Recent developments through the IAASB's ISSA 5000 provide a global framework for sustainability assurance—distinguishing between limited and reasonable assurance, emphasizing the role of materiality, and offering flexibility across reporting types (Hay et al., 2024; Malinovskaya, 2022; Velte, 2025). Adoption of this standard in non-European jurisdictions is expected to enhance reliability and accelerate assurance readiness under mandatory reporting regimes (Hoyos Giraldo et al., 2024). The network configuration in this corpus—placing the governance node at the center of influence flows—reinforces this urgency.

On metrics, thematic mapping reveals a concentration on the nodes of financial performance, governance, and sustainability reporting. This convergence explains why intensity-based indicators—GHG emissions, energy, and water—are strong candidates for the core set: their causal pathways to costs, regulatory risk, and operational efficiency are relatively short (Kalyani & Mondal, 2024; Pulino et al., 2022; Zhou & Nian, 2024). On the S dimension, human capital metrics such as TRIR/LTIFR and turnover link social practices with productivity, claims costs, and capability stability; however, measurement must rest on precise definitions and units to be assurance-ready and comparable across jurisdictions (Hossain et al., 2025; O'brien et al., 2023). On the G dimension, attributes such as audit committee independence

and activity, ESG risk management policies, data quality policies, and XBRL tagging function as credibility enablers—ensuring data lineage and facilitating audits and cross-system analytics (Arif et al., 2020; Bravo & Reguera-Alvarado, 2019; Fayad et al., 2024).

The context of developing countries—particularly MSMEs—requires proportionality. Constraints in costs, human capital capabilities, and regulatory uncertainty make a staged "on-ramp" strategy more realistic: begin with a cross-sector core set of the most financially impactful metrics (intensity indicators and human capital), then add sectoral supplements as data capacity and assurance readiness increase (Apanel, 2025). With such a design, the core set serves a dual role: maintaining comparability (aligned with IFRS/ISSB, ESRS, and GRI and machine-readable via XBRL) while facilitating linkage to budgets/KPIs so that ESG truly functions as an input to day-to-day decision-making rather than merely a compliance output. Thus, the bibliometric evidence implies that the informational value of ESG emerges when indicators, data governance, and assurance standards work in concert. Therefore, translating the RQ1–RQ4 findings into a concise and modular core set—grounded in financial materiality, decision-oriented, assurance-ready, and cross-framework compatible—is the most effective step to enhance the comparability, credibility, and usefulness of reporting, especially in jurisdictions that are building capacity.

## Conclusion

This study demonstrates the shift of ESG disclosure from a compliance-oriented practice to a managerial and decision-useful function. The bibliometric evidence from RQ1–RQ4 shows that ESG disclosure research is mainly structured around financial performance, corporate governance, CSR, and sustainability reporting. These findings indicate that the most useful ESG indicators are those that are financially material, supported by clear data lineage, comparable across reporting frameworks, and ready for assurance.

Based on these findings, this study proposes a concise and modular ESG core indicator set centered on environmental intensity indicators, human capital metrics, governance attributes, and machine-readability enablers. This core set is designed as a cross-sector baseline that can be proportionally expanded according to sectoral and jurisdictional needs. The practical implication is that ESG disclosure can become more comparable, credible, and useful for decision-making when indicators are linked to budgeting, KPIs, risk management, and assurance processes.

However, this study has several limitations. First, the analysis relies on Scopus metadata downloaded on March 12, 2025. Given the rapid development of ESG disclosure publications, relevant studies published after the extraction date may not be included. Therefore, the findings should be interpreted as a time-bound bibliometric evidence map rather than a definitive representation of the entire ESG disclosure literature. Second, the results are influenced by database coverage, indexing lags, selected mapping parameters, and the limitation of mainly English-language publications. These factors may affect the completeness and generalizability of the bibliometric findings.

Future research should update the corpus using more recent metadata and replicate the analysis across additional databases such as Web of Science, Dimensions, or regional databases. Further studies should also conduct multilingual sensitivity tests, examine whether recent publications change the thematic clusters and citation structures, and empirically validate the proposed ESG core indicators across sectors, jurisdictions, and firm sizes. In addition, future research may apply Delphi studies, XBRL trials, longitudinal analysis after the adoption of IFRS S1/S2, ESRS, and ISSA 5000, as well as cost-benefit assurance analysis. These directions are important to ensure that the proposed ESG core set becomes increasingly evidence-based, proportional for MSMEs, and useful for improving the comparability, auditability, and decision usefulness of ESG information.

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