

ESG Integration and Climate Risk in Sustainable Finance: A TCCM-Based Systematic Literature Review and Bibliometric Analysis

Devarshi Singh

Research Scholar, Department of Commerce,
Banaras Hindu University, Varanasi 221005.
Orcid Id :0009-0005-8048-6075

Email id: devarshi4925@bhu.ac.in

Ravi Kant Yadav

Research Scholar, Department of Commerce,
Banaras Hindu University, Varanasi 221005.
0009-0003-2334-7568

Email id: ravikant@bhu.ac.in

Balkrishna Chaubey

Research Scholar, Department of Commerce,
Banaras Hindu University, Varanasi 221005.
Orcid Id :0009-0005-7263-9828

Email id: balkrishna@bhu.ac.in

Gobind Narayan Singh

Research Scholar, Department of Commerce,
Banaras Hindu University, Varanasi 221005.
Orcid Id: 0009-0002-1565-2127

Email id: gobindgns@bhu.ac.in

Diwakar Tiwari

Research Scholar, Department of Commerce,
Banaras Hindu University, Varanasi 221005.
Orcid Id :0009-0001-8054-7801

Email id: diwakar@bhu.ac.in

Corresponding Author: Ravi Kant Yadav

Abstract

This study examines how ESG integration and climate-related financial risk are represented in a selected sustainable-finance literature corpus. It combines reported bibliometric outputs for 27 records with a Theory–Context–Characteristics–Methodology (TCCM) synthesis of 23 studies. The annual publication counts increase from three in 2022 to nine in 2025, while the reported country citation table is concentrated in India. The thematic synthesis identifies substantial attention to ESG investing, green bonds, sustainability reporting and digital finance. Physical and transition risks receive limited explicit attention within the supplied coding, but this sample-level observation does not establish their absence from the wider literature. After correcting one study classification, the working methodological distribution comprises 11 bibliometric or scient metric studies, nine other reviews, two conceptual studies and one

empirical study. The synthesis distinguishes established theories from organising frameworks and topic labels, and develops a research agenda linking climate exposure, disclosure quality and financial outcomes. Interpretation remains conditional on reconciliation of the 27-record bibliometric dataset with the 23-study coding set and recovery of the search and screening audit trail. The contribution is therefore a focused, provisional evidence synthesis and a more explicit agenda for integrating climate-risk analysis into ESG research.

Keywords: ESG integration; climate risk; sustainable finance; green finance; green bonds; bibliometric analysis; TCCM framework; systematic literature review

1. Introduction

Sustainable finance research encompasses responsible investment, ESG integration, green bonds, sustainability reporting and the financing of environmental transitions. Reviews of these topics describe a literature that spans financial markets, corporate governance and technological change (Kapil & Rawal, 2023; Singhania et al., 2024; Bansal et al., 2025). These domains overlap, but their analytical purposes differ. ESG integration considers environmental, social and governance information in financial decisions, whereas climate-related financial-risk analysis examines how climate exposures may affect financial outcomes. Treating these concepts as interchangeable can obscure the mechanisms that connect sustainability information with risk and valuation.

Existing reviews provide useful accounts of sustainable investment (Singhania et al., 2024), green bonds (Abhilash et al., 2022; Kedia & Joshipura, 2023), corporate reporting (Diwan & Amarayil Sreeraman, 2024) and digital finance (Dar et al., 2024; Bansal et al., 2025). A comparative synthesis can examine how these research strands define their constructs, justify their theoretical choices and select their methods. The relevant question is how far the selected studies connect ESG practices with explicitly specified climate-related financial exposures and outcomes.

Bibliometric analysis describes publication patterns and relationships among bibliographic records, while structured content analysis examines what those records mean. Citation and co-occurrence indicators are useful for mapping a selected corpus, but do not independently establish theoretical strength, causality or the completeness of its coverage (Donthu et al., 2021; Zupic & Čater, 2015). The TCCM framework organises a synthesis around theory, context, characteristics and methodology (Paul & Criado, 2020). Combining these approaches allows bibliographic patterns to be interpreted alongside the substantive content and design of the selected studies.

Kumar et al. (2026) already combine bibliometric analysis and TCCM in a review of sustainable finance. The combination of methods is therefore not, by itself, a novel contribution. The present manuscript offers a narrower analytical emphasis: it examines the visibility of climate-related financial risk within a selected corpus spanning ESG integration and sustainable finance, and distinguishes broad sustainability themes from financial-risk mechanisms. This contribution depends on transparent sample construction and should not be presented as comprehensive coverage of the field. Four questions guide the analysis:

1. **RQ1.** What publication, citation and thematic patterns are visible in the selected bibliometric corpus?
2. **RQ2.** How do the selected studies use established theories, organising frameworks and interpretive perspectives?

3. **RQ3.** How are ESG integration, green finance and climate-related financial risk represented across research contexts and constructs?
4. **RQ4.** Which methodological limitations and unanswered relationships can inform a focused future research agenda?

Section 2 describes the method. Section 3 reports the bibliometric results and Section 4 the TCCM analysis. Section 5 discusses the findings, Section 6 sets out a research agenda, Section 7 states the limitations and Section 8 concludes.

2. Methodology

2.1 Research design

The review is organised using the assembling, arranging and assessing stages of SPAR-4-SLR (Paul et al., 2021). It combines bibliometric mapping with a TCCM synthesis. The available materials comprise manuscript-level bibliometric outputs for 27 records and study-level tables for 23 publications; the underlying Scopus export, screening log and coding audit trail were not available for this revision. Accordingly, the procedures below distinguish the reported workflow from details that still require author confirmation. Full compliance with a reproducible systematic-review protocol cannot yet be established.

2.2 Data source and search

The original manuscript identifies Scopus as the bibliographic source and reports an OR-based search covering ESG, sustainable finance and climate risk. The exact field code and search execution date are not documented. The following expression is a reproducible TITLE-ABS-KEY formulation of the supplied terms for verification or rerunning; it is not evidence that this exact syntax was used in the original search: TITLE-ABS-KEY("ESG Integration" OR "Environmental Social Governance" OR "Climate Risk" OR "Sustainable Finance" OR "Green Finance" OR "Climate Change Risk Assessment" OR "ESG Performance" OR "Climate-related Financial Risk" OR "Sustainable Investment" OR "Green Bonds" OR "Climate Risk Disclosure" OR "ESG Reporting" OR "Carbon Risk" OR "Transition Risk" OR "Physical Climate Risk" OR "Responsible Investment" OR "Climate Risk Management" OR "ESG and Financial Performance" OR "Low-carbon Finance" OR "Sustainable Banking")

The manuscript reports English-language, journal-review and business, finance, economics and management filters. Their exact Scopus codes and the initial retrieval count are unavailable. The observed publication span is 2019–2026; this is the span of the reported records, not a verified search restriction. Because the query connects all terms with OR, it retrieves a broad union of topics rather than requiring each record to address ESG and climate risk together. Search coverage and subsequent relevance screening therefore need to be documented explicitly.

2.3 Screening and selection

The reported workflow involved duplicate removal and screening of titles, abstracts and full texts. However, stage-specific counts, exclusion reasons and the identities of the screeners are not supplied. No SJR, ABDC or other journal-ranking threshold can be asserted from the available evidence. Journal peer review and thematic relevance should be distinguished from a formal quality appraisal, which requires explicit criteria and recorded decisions.

- ❖ The stated inclusion criteria were English-language journal reviews directly relevant to ESG, climate finance or sustainable investment. The actual coding set also contains conceptual publications and an empirical study, so it is best described at present as a

review-oriented mixed corpus. Final eligibility rules must be reconciled with the retained records.

- ❖ The stated exclusions were duplicates, irrelevant records, conference abstracts and non-scholarly documents. The authors must recover the screening record to establish how these rules were applied and whether studies on adjacent themes, such as reverse logistics and gender-sensitive climate adaptation, met a consistent finance-relevance criterion.

Bibliometric outputs are reported for 27 records, whereas Tables 2–5 identify 23 coded studies. The supplied materials do not identify the four uncoded records or document their exclusion from TCCM analysis; no reason is inferred here. Jain et al. (2019) is an empirical index-comparison study and therefore conflicts with a strict review-only rule. By contrast, De Silva et al. (2025) is a systematic literature review incorporating bibliometric analysis, as confirmed by its publisher, and is reclassified accordingly. The final dataset should either apply a consistent mixed-design eligibility rule or separate empirical contextual studies from a review-only synthesis and recalculate the affected outputs.

2.4 Analysis

The original manuscript reports use of Biblioshiny, the graphical interface to the bibliometrix R package, and VOSviewer (Aria & Cuccurullo, 2017; van Eck & Waltman, 2010). The retained outputs describe annual production, annualised citation averages, country citations, co-authorship and keyword co-occurrence. They are reproduced as reported outputs rather than independently regenerated results. Software versions, citation extraction date, counting method, normalisation, network thresholds and keyword-cleaning rules must accompany the final analysis.

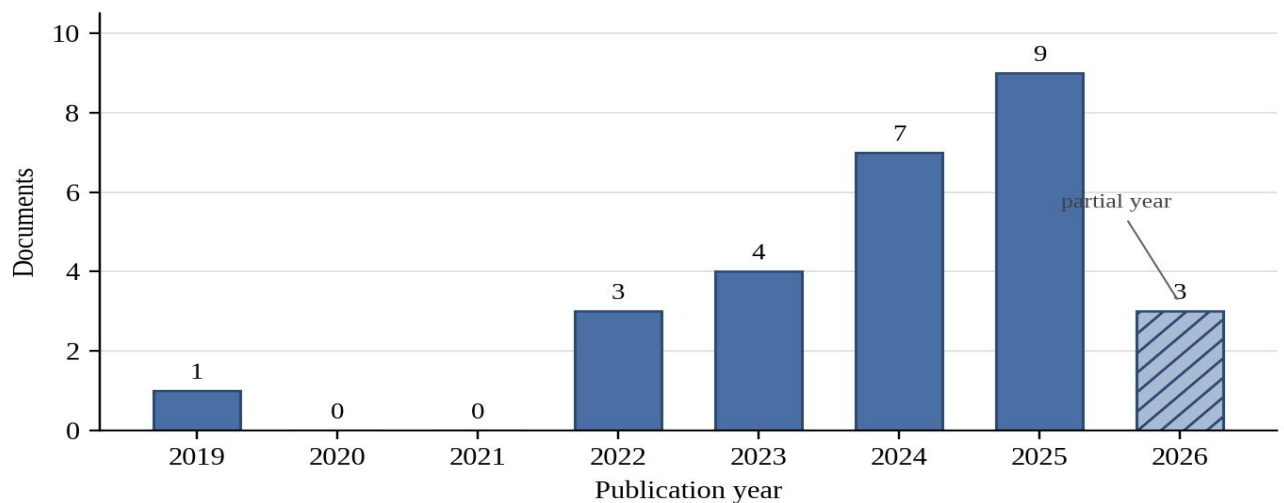
The TCCM tables organise each study by theoretical perspective, context, constructs and methodological approach. They are treated as working classifications because the original coding forms and evidence excerpts are unavailable. An established theory is distinguished from an organising framework, a thematic perspective and a label inferred by the reviewer. A suitable audit record would retain the relevant full-text passage and page number for each classification. Coder identities, independent coding procedures and disagreement resolution remain unreported; inter-coder reliability is therefore not claimed. Issue publication years are retained in the tables, but should be reconciled with the year convention used in the Scopus export.

3. Bibliometric results

3.1 Annual scientific production

The reported annual counts total 27 documents over 2019–2026 (Figure 1): one in 2019, none in 2020–2021, three in 2022, four in 2023, seven in 2024, nine in 2025 and three in 2026. The source figure labels 2026 as a partial year. Until the original search date is recovered, its count should not be compared with completed calendar years as a measure of growth or decline.

Figure 1. Annual scientific production (number of documents).



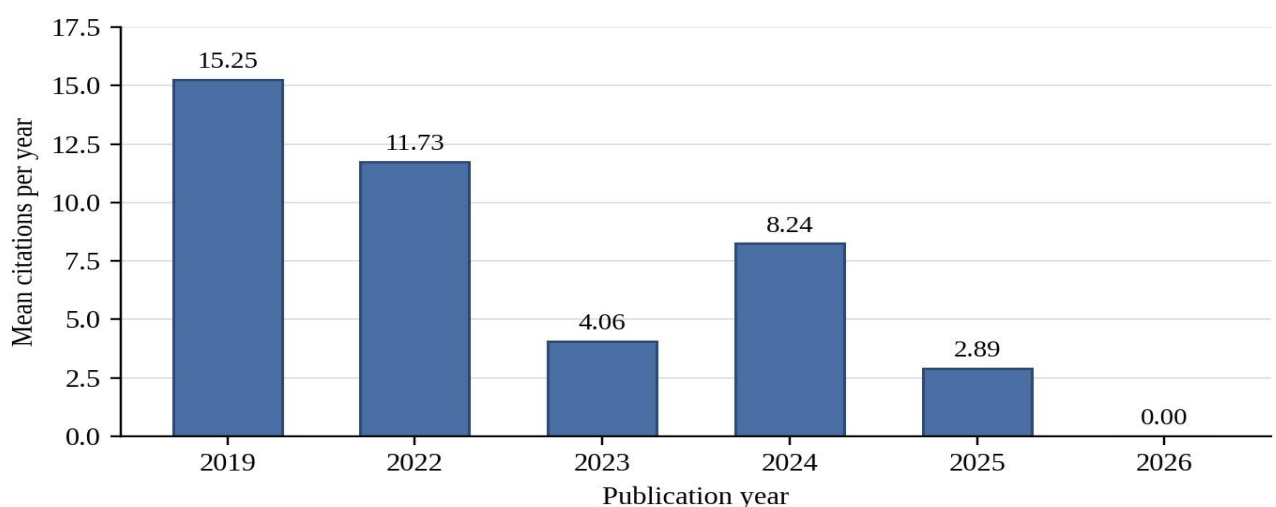
Source: authors' analysis of Scopus data.

Within this selected corpus, the count triples between 2022 and 2025. This is a descriptive change in a small sample rather than an estimate of growth across sustainable finance as a whole. Empty years may reflect search terms, eligibility decisions or database coverage. The 23-study table also has a different annual distribution from the 27-record figure, reinforcing the need to reconcile the two analysis sets.

3.2 Average citations per year

Figure 2 reports mean annualised citations of 15.25 for 2019, 11.73 for 2022, 4.06 for 2023, 8.24 for 2024, 2.89 for 2025 and 0.00 for 2026. Annualisation adjusts for citation exposure but does not eliminate citation lag or differences across publication cohorts. The 2019 value represents one document and is especially sensitive to that article. These values are retained from the supplied output; their calculation requires the record-level citation counts, extraction date and software denominator convention.

Figure 2. Mean citations per year by publication year. Years with no documents (2020, 2021) are omitted.



Source: authors' analysis of Scopus data.

3.3 Author metadata and reporting reliability

An author ranking is withheld because the earlier output reportedly displayed single-letter author labels. Such labels prevent reliable attribution and may indicate an import or parsing problem. A count of 13 publications is mathematically possible within 27 records and is not itself proof of an error. The correct validation is to compare imported author names and Scopus author identifiers with the source records, resolve name variants and regenerate the ranking. No substitute author ranking is inferred from the 23-study reference list.

3.4 Most cited countries

Among the four countries shown in the supplied output, India has the largest total citation count (524), followed by Sri Lanka (24), Australia (14) and the United Arab Emirates (2). The reported averages are 29.10, 24.00, 14.00 and 2.00 citations per article, respectively. Table 1 preserves these values. The article denominators are only approximate reconstructions and are not verified publication counts.

Table 1. Most cited countries.

Country	Total citations	Average citations per article	Implied denominator
India	524	29.10	≈18
Sri Lanka	24	24.00	1
Australia	14	14.00	1
United Arab Emirates	2	2.00	1

Note: approximate denominators are obtained by dividing total citations by the displayed average. For India, 524/29.10 is approximately 18; the discrepancy with exact rounding remains unresolved. The country assignment rule and completeness of the listing are undocumented.
Source: supplied bibliometric output; not recalculated from the raw export.

The implied denominators sum to approximately 21, rather than 27. The difference cannot be assigned to omitted countries, missing affiliations or any other cause without the underlying export. Citation totals also depend on publication volume and article age. India leads the reported four-country listing, but these data do not establish national research quality, a complete geographic distribution or the geographic settings examined by the studies.

3.5 Co-authorship network

The supplied co-authorship map displays a dense group of approximately 23 author nodes (Figure 3). The original manuscript associates this group with Roy et al. (2022). A single publication with a long author list can produce a fully connected component, so apparent density need not indicate repeated collaboration across studies. Without the underlying network file, counting rule and selection threshold, neither identical link strengths nor the reason other authors are absent can be verified.

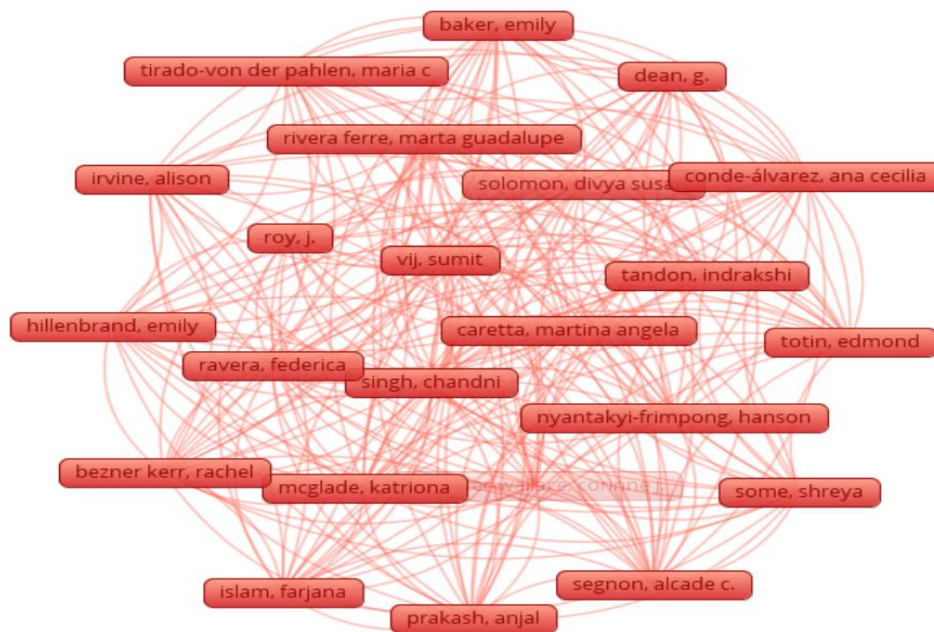


Figure 3. Co-authorship network. Source: authors' analysis of Scopus data.

Figure 3 is retained as an illustrative output. Its layout should not be used to rank scholarly influence or infer a field-wide collaboration structure. A reproducible analysis should report the number of authors before and after thresholding, document weights, disambiguation rules and whether only the largest connected component was displayed.

3.6 Keyword co-occurrence

The supplied overlay map places sustainable finance, green finance, sustainability and bibliometric analysis near the visible thematic core (Figure 4). The colour scale represents average publication year, approximately 2023.5–2025.0. Investment-related terms occupy the earlier portion of this interval, while digital finance, technological innovation and content analysis appear towards the more recent end. These patterns describe the displayed terms; they do not establish the emergence dates or relative importance of research areas.

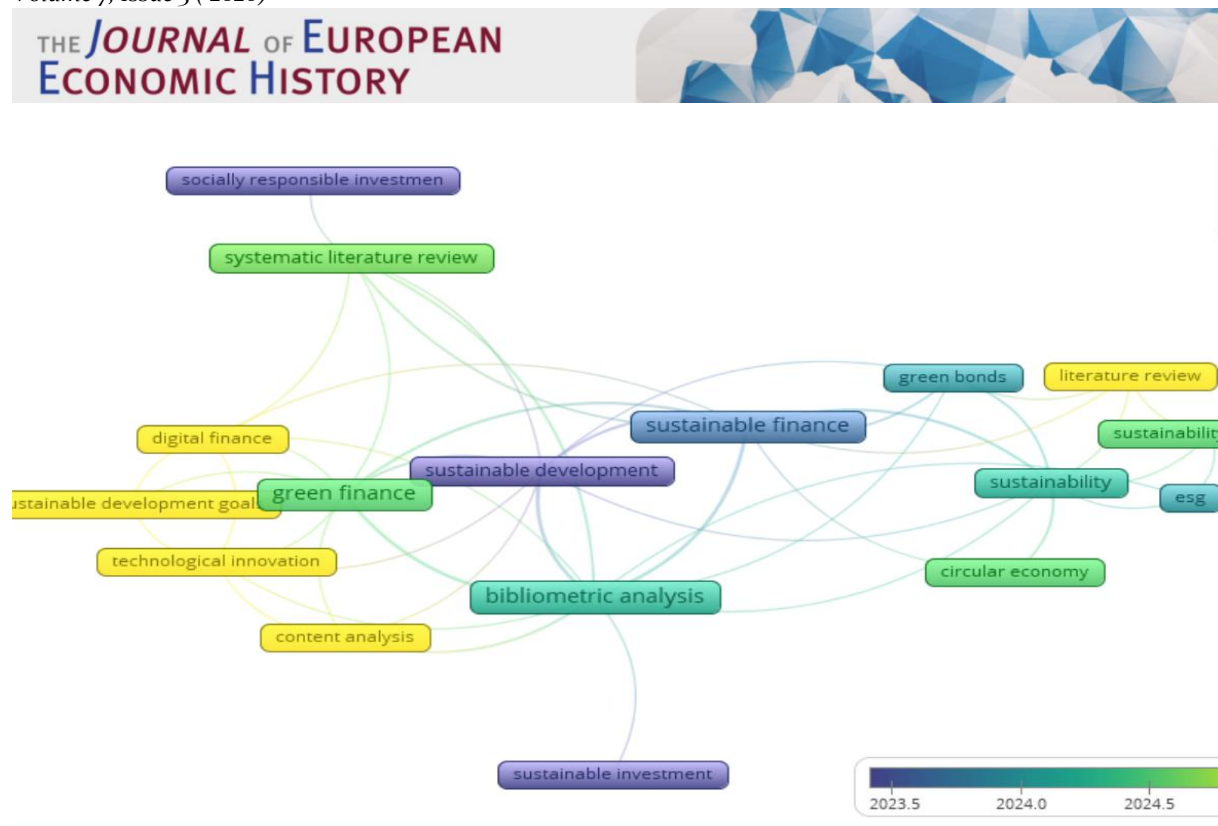


Figure 4. Keyword co-occurrence network (overlay visualisation; colour shows average publication year, 2023.5–2025.0). **Source:** authors’ analysis using VOS viewer.

The map includes methodological labels alongside substantive concepts, which is consistent with a review-oriented corpus. No explicit climate-risk term is visible in the displayed map. This may reflect keyword selection, frequency thresholds, synonym handling or corpus composition. It cannot demonstrate that climate-risk research is absent from sustainable finance. The original export is needed to report author versus indexed keyword selection, occurrence thresholds and any thesaurus-based merging; a higher-resolution export is also needed for labels close to the image boundary.

4. TCCM analysis

Tables 2–5 preserve the 23-study structure of the supplied manuscript while correcting identified classification problems. Topic and method labels are working descriptors unless supported by verified source information. The synthesis therefore interprets patterns within the selected studies without treating the tables as a complete inventory of sustainable-finance scholarship.

4.1 Theory

Table 2 distinguishes theories from broader perspectives and review frameworks. Nine rows in the original coding were labelled “Implied”; this describes the reviewer’s classification and does not establish that the corresponding papers lack theory. Labels such as “green bond theory”, “ESG integration theory” and “sustainable investment theory” are replaced with thematic descriptions because the supplied material does not establish them as defined theories. Institutional, stakeholder and legitimacy perspectives recur in the working coding, but their explicit use requires page-level verification.

The same distinction applies to digital and circular-economy studies. Technology adoption and innovation diffusion may provide explanatory lenses, whereas circular economy can also function as a substantive perspective. The antecedents–decisions–outcomes (ADO) framework

organises a review and should not automatically be counted as a tested explanatory theory. De Silva et al. (2025) is no longer described as an empirical test of the resource-based view; its verified design is a bibliometric literature review.

The working classifications suggest a widening range of governance, investment, technological and institutional perspectives over time. However, publication year alone cannot establish a theoretical progression. Jain et al. (2019) provides empirical investment comparisons, but empirical analysis should not be equated automatically with formal theory testing. A defensible theory contribution requires explicit propositions, operationalised constructs and evidence showing how the proposed mechanisms were examined.

Table 2. Theoretical grounding of the reviewed studies.

Study	Theory / theoretical lens	Use	Domain	Study type
Jain et al. (2019)	Portfolio and investment-performance perspectives	Empirical comparison	Investment returns	Comparative empirical
Abhilash et al. (2022)	Green Finance perspective; Innovation perspective	Inferred perspective	Green bond markets	Bibliometric
Bhattacharyya (2022)	Energy transition perspective	Provisional lens	Climate and energy finance	Systematic review
Roy et al. (2022)	Climate adaptation and gender-equity perspectives	Provisional lens	Climate and social sustainability	Systematic review
Kapil & Rawal (2023)	Stakeholder perspective; ESG Integration perspective	Inferred perspective	ESG investing	Bibliometric
Kedia & Joshipura (2023)	Green Bond Market perspective	Inferred perspective	Green bonds	Review
Manaswi et al. (2023)	Sustainable Investment perspective	Inferred perspective	Sustainable investing	Narrative review
Anand & Pandey (2024)	Technology Adoption Theory; Circular Economy Theory	Provisional lens	Blockchain and sustainability	Bibliometric + PRISMA
Choudhary & Thenmozhi (2024)	ADO framework (theory-building)	Organising framework	FinTech	Structured review
Dar et al. (2024)	Innovation Diffusion Theory; FinTech Adoption Theory	Provisional lens	FinTech and green finance	Bibliometric
Diwan & Amarayil Sreeraman (2024)	Legitimacy Theory; Stakeholder Theory	Provisional lens	ESG reporting	Bibliometric

Kumar et al. (2024)	Environmental Finance perspective	Inferred perspective	Green finance	Bibliometric + content analysis
Singhanian et al. (2024)	Stakeholder perspective; Sustainable Investment perspective	Inferred perspective	Sustainable investments	Scientometric
Alahdal et al. (2025)	Agency Theory; Legitimacy Theory	Provisional lens	ESG and earnings management	Systematic review
Anandhabalaji (2025)	Circular Economy Theory	Provisional lens	Reverse logistics	Structured review
Bansal et al. (2025)	Digital Finance perspective; Sustainable Development perspective	Inferred perspective	Digital sustainability	Integrative review
De Silva et al. (2025)	Explicit theoretical basis requires full-text confirmation	Not verified	Digital sustainability reporting	Bibliometric literature review
Jain & Sharma (2025)	Socially Responsible Investment (SRI) Theory	Provisional lens	Ethical investing	Conceptual
Mahna et al. (2025)	FDI perspective; Institutional perspective	Inferred perspective	Sustainable FDI	Bibliometric
Negi & Jaiswal (2025)	Green Bond perspective; Sustainable Capital Market perspective	Inferred perspective	Green bonds	Bibliometric + thematic
Joshipura et al. (2026)	Behavioral Finance Theory	Provisional lens	Ethical investing and sin stocks	Framework-based review
Kumar et al. (2026)	Institutional Theory; Sustainable Finance Theory	Provisional lens	Sustainable finance	Hybrid (bibliometric + TCCM)
Murty & Singh (2026)	Institutional Theory	Provisional lens	Green finance institutions	Conceptual study

Note: “Inferred perspective” records an interpretive label from the supplied coding. “Provisional lens” requires confirmation against the cited full text. An organising framework or substantive topic is not treated as an established theory merely because it appears in a review.

4.2 Context

Table 3 shows where the studies are set. Grouped by theme, they fall into seven areas. The two largest are sustainable and ESG investing, with six studies (Jain et al., 2019; Kapil & Rawal, 2023; Manaswi et al., 2023; Singhanian et al., 2024; Jain & Sharma, 2025; Joshipura et al., 2026), and green finance and green bonds, also with six (Abhilash et al., 2022; Kedia & Joshipura, 2023; Kumar et al., 2024; Negi & Jaiswal, 2025; Kumar et al., 2026; Murty & Singh, 2026). Digital and technology themes follow with four (Anand & Pandey, 2024; Choudhary & Thenmozhi, 2024; Dar et al., 2024; Bansal et al., 2025), then ESG reporting, disclosure and governance with three (Diwan & Amarayil Sreeraman, 2024; Alahdal et al., 2025; De Silva et al., 2025). Climate, energy

and social sustainability account for two (Bhattacharyya, 2022; Roy et al., 2022), and circular economy and international finance for one each (Anandhabalaji, 2025; Mahna et al., 2025).

These categories connect investment markets, reporting, governance and technology. They also include adjacent sustainability topics whose eligibility requires a clearer financial relevance test. Under the supplied coding, no study is classified primarily around measurement of physical or transition financial-risk exposure. This is a bounded observation about the selected studies. It should motivate a search-coverage check and a more focused synthesis rather than a claim that the wider literature neglects climate risk.

Table 3. Research contexts of the reviewed studies.

Study	Core theme	Research context / focus	Broader domain
Jain et al. (2019)	Sustainable returns	ESG versus conventional index returns	Investment performance
Abhilash et al. (2022)	Green bond markets	Technology-enabled growth of green bond markets	Sustainable capital markets
Bhattacharyya (2022)	Energy transition	Role of green finance in energy transition and the SDGs	Climate and energy finance
Roy et al. (2022)	Climate adaptation and gender	Trade-offs between adaptation options and gender equity	Climate finance and social sustainability
Kapil & Rawal (2023)	ESG investing	Development and integration of ESG in investment decisions	ESG and responsible investing
Kedia & Joshipura (2023)	Green bonds	Current pathways and new avenues in green bond markets	Capital markets
Manaswi et al. (2023)	Sustainable investment	Recent research insights on sustainable investing	Green investment
Anand & Pandey (2024)	Blockchain	Feasibility of blockchain in a circular economy	Green technology
Choudhary & Thenmozhi (2024)	FinTech sector	Research agenda on FinTech and the financial sector	Financial innovation
Dar et al. (2024)	FinTech and green finance	Role of FinTech innovation in promoting green finance	Digital sustainable finance
Diwan & Amarayil Sreeraman (2024)	ESG reporting	Shift from financial reporting to ESG disclosure	Corporate governance
Kumar et al. (2024)	Green finance	Bibliometric mapping of green finance literature	Climate and green finance
Singhania et al. (2024)	Sustainable investments	Intellectual structure and evolution of sustainable investment research	Sustainable finance
Alahdal et al.	ESG and earnings	ESG and earnings management	Corporate finance

(2025)		research trends	
Anandhabalaji (2025)	Reverse logistics	Environmental impact and sustainability pathways	Circular economy
Bansal et al. (2025)	Digital finance	Digital finance as a driver of sustainability transformation	Sustainable development
De Silva et al. (2025)	Digital technologies	Sustainability accounting, reporting and assurance literature	Digital corporate reporting
Jain & Sharma (2025)	ESG to SRI	Conceptual link between ESG and socially responsible investing	Ethical finance
Mahna et al. (2025)	Sustainable FDI	Trends in sustainable foreign direct investment	International finance
Negi & Jaiswal (2025)	Sustainable bonds	Role of sustainable bonds in financing green development	Green bond market
Joshipura et al. (2026)	Sin stocks	Ethical investing and the sin-stock anomaly	Behavioral finance
Kumar et al. (2026)	Sustainable finance	Research frontiers and thematic evolution	Green finance
Murty & Singh (2026)	Institutional green finance	Institutional mechanisms promoting sustainable technology	Institutional economics

4.3 Characteristics

Table 4 separates substantive constructs from analytical focus and outcome orientation. In review studies, these entries generally refer to topics synthesised rather than variables directly estimated. Jain et al. (2019) compares sustainable and conventional indices. De Silva et al. (2025) maps digital technologies in sustainability accounting, reporting and assurance, rather than estimating a firm-level digital-capability effect. This distinction prevents review themes from being presented as causal findings.

The coding suggests continuing attention to investment and green bonds, alongside reporting, digital technologies and institutional settings. A stronger integration would specify how these constructs relate. For example, disclosure quality could affect the usefulness of climate-exposure information for pricing; governance could condition that relationship. These are proposed research mechanisms, not relationships demonstrated by the present synthesis.

Table 4. Constructs, variables and outcome orientation.

Study	Core constructs	Key variables examined	Analytical focus	Outcome orientation
Jain et al. (2019)	ESG financial performance	Return comparison, risk analysis	Sustainable versus traditional returns	Investment efficiency
Abhilash et al. (2022)	Green bond innovation	Technology-enabled financing	Market network mapping	Sustainable capital growth
Bhattacharyya	Energy transition	Green finance and	Climate-energy	Environmental

(2022)		SDGs	integration	performance
Roy et al. (2022)	Climate adaptation; gender equity	Policy trade-offs, social inclusion	Sustainability policy integration	Social sustainability outcomes
Kapil & Rawal (2023)	ESG integration	ESG investment trends, disclosure themes	ESG adoption in portfolios	Responsible investment growth
Kedia & Joshipura (2023)	Green bond markets	Market pathways, trends	Capital market analysis	Investment channel expansion
Manaswi et al. (2023)	Sustainable investing trends	Thematic insights	Narrative review	Research direction mapping
Anand & Pandey (2024)	Blockchain and sustainability	Technology feasibility, circular linkage	Green technology adoption	Operational sustainability
Choudhary & Thenmozhi (2024)	FinTech research agenda	Antecedents, decisions, outcomes	Structured review (ADO)	Theory-building insights
Dar et al. (2024)	FinTech and green finance	Innovation adoption, role of digital finance	Technology-enabled sustainability	Digital transformation impact
Diwan & Amarayil Sreeraman (2024)	ESG disclosure	Reporting evolution	Governance transparency	Corporate accountability
Kumar et al. (2024)	Environmental finance	Climate finance instruments	Bibliometric cluster mapping	Financial sustainability themes
Singhanian et al. (2024)	Sustainable investment structure	Citation clusters, thematic evolution	Intellectual mapping	Knowledge-structure identification
Alahdal et al. (2025)	ESG and earnings management	Disclosure quality, transparency	Financial reporting impact	Governance effectiveness
Anandhabalaji (2025)	Circular economy	Reverse logistics efficiency	Sustainability pathways	Resource optimization
Bansal et al. (2025)	Digital sustainability	Digital finance drivers	Innovation-sustainability linkage	Sustainable development support
De Silva et al. (2025)	Digital knowledge and technologies	Literature themes; not estimated firm-level variables	Bibliometric mapping	Research structure and future directions

Jain & Sharma (2025)	Socially responsible investment	Ethical investment linkage	ESG–SRI conceptual integration	Responsible portfolio design
Mahna et al. (2025)	Sustainable FDI	Investment flows, institutional factors	International finance mapping	Global sustainability trends
Negi & Jaiswal (2025)	Green bonds	Market growth, financing patterns	Sustainable capital markets	Green financing mechanisms
Joshiपुरa et al. (2026)	Behavioral ESG investing	Sin-stock anomaly	Behavioral finance approach	Ethical investment behavior
Kumar et al. (2026)	Sustainable finance evolution	Research clusters, thematic shifts	Frontier analysis	Emerging research domains
Murty & Singh (2026)	Institutional green finance	Regulatory frameworks	Institutional mechanisms	Sustainable technology promotion

4.4 Methodology

After reclassifying De Silva et al. (2025), the working distribution is 11 bibliometric or scient metric studies (47.8%), nine other reviews (39.1%), two conceptual studies (8.7%) and one empirical study (4.3%). The categories are mutually exclusive here: hybrid reviews containing bibliometric analysis are counted in the first group. These figures summarise Table 5 and remain conditional on final eligibility and full-text validation of the other study classifications.

The source table frequently identifies Scopus, but database use should not be inferred from the database in which an article was found. Study-level data sources and analytical tools require direct verification from each paper. PRISMA is a reporting guideline, SPAR-4-SLR is a review protocol and ADO and TCCM are organising frameworks; none should be counted as a statistical technique. Combining bibliometrics with content analysis may broaden a synthesis, but does not by itself make the study a mixed-methods empirical design.

Because the corpus was assembled with an emphasis on reviews, its methodological composition cannot estimate the prevalence of empirical designs in the wider field. The remaining empirical article also requires an explicit eligibility decision. Conclusions about a general shortage of empirical sustainable-finance research are therefore not supported by this sample.

Table 5. Methodological approach, data source and tools.

Study	Methodological approach	Data source	Tools techniques /	Nature of study
Jain et al. (2019)	Comparative empirical	Secondary financial data (verify)	Comparative index analysis (verify)	Quantitative
Abhilash et al. (2022)	Bibliometric review	Scopus (verify)	Network visualization (verify)	Review

Bhattacharyya (2022)	Systematic review	Scopus (verify)	Thematic analysis (verify)	Review
Roy et al. (2022)	Systematic literature review	Scopus / WoS (verify)	Thematic coding (verify)	Review
Kapil & Rawal (2023)	Bibliometric analysis	Scopus (verify)	Co-citation and keyword networks (verify)	Review
Kedia & Joshipura (2023)	Review study	Scopus (verify)	Descriptive mapping (verify)	Review
Manaswi et al. (2023)	Narrative review	Scopus (verify)	Descriptive analysis (verify)	Review
Anand & Pandey (2024)	Bibliometric + PRISMA	Scopus (verify)	Bibliometric mapping; PRISMA reporting (verify)	Review
Choudhary & Thenmozhi (2024)	ADO framework review	Scopus (verify)	ADO model (verify)	Structured review
Dar et al. (2024)	Bibliometric analysis	Scopus (verify)	Bibliometric mapping (verify)	Review
Diwan & Amarayil Sreeraman (2024)	Bibliometric study	Scopus (verify)	Citation and co-authorship analysis (verify)	Review
Kumar et al. (2024)	Bibliometric + content analysis	Scopus (verify)	Cluster analysis (verify)	Review
Singhania et al. (2024)	Scientometric analysis	Scopus (verify)	VOSviewer (verify)	Review
Alahdal et al. (2025)	Systematic review	Scopus (verify)	Thematic classification (verify)	Review
Anandhabalaji (2025)	Structured review	Scopus (verify)	Descriptive classification (verify)	Review
Bansal et al. (2025)	Integrative review	Scopus (verify)	Framework building (verify)	Review
De Silva et al. (2025)	Systematic review with bibliometrics	Literature records; database details to verify	Bibliometric performance and thematic mapping	Review
Jain & Sharma (2025)	Conceptual framework	Secondary sources (verify)	Theoretical modelling (verify)	Conceptual

Mahna et al. (2025)	Bibliometric review	Scopus (verify)	Biblioshiny (verify)	Review
Negi & Jaiswal (2025)	Bibliometric thematic +	Scopus (verify)	Network visualization (verify)	Review
Joshipura et al. (2026)	Framework-based review	Scopus (verify)	Conceptual synthesis (verify)	Review
Kumar et al. (2026)	Hybrid bibliometric TCCM +	Scopus (verify)	Biblioshiny; TCCM (verify)	Review
Murty & Singh (2026)	Conceptual study	Secondary literature (verify)	Institutional framework (verify)	Conceptual

5. Discussion

5.1 Main findings

The bibliometric outputs and TCCM tables describe a selected literature organised around investing, bonds, reporting and digital finance. Their combined value lies in distinguishing the visibility of a theme from the strength of the evidence supporting a relationship. A frequently occurring keyword indicates bibliographic prominence, while a theoretical explanation requires specified mechanisms and an empirical conclusion requires an appropriate study design. The current coding does not consistently separate these levels, so theory frequencies should be treated cautiously.

Climate-related financial risk is weakly represented in the supplied coding and is not visible in the displayed keyword network. The appropriate interpretation is a coverage gap in the selected evidence base. Broad OR-based retrieval, document-type restrictions, subject-area filters and unknown network thresholds could all contribute to this result. The claim that climate-finance reviews are generally scarce must therefore be withdrawn pending a dedicated search. The research opportunity is to connect explicitly measured climate exposures with ESG integration and financial outcomes, rather than to infer novelty from an absent keyword.

Three distinctions govern interpretation. Country citation attribution is not the same as the geographic context of research. A dense co-authorship component is not evidence of a cohesive field when one multi-author paper may account for it. A sample dominated by reviews does not establish that primary research is scarce. Recovering the raw export and screening record is essential to determine whether the patterns remain after eligibility and metadata corrections.

5.2 Implications

For researchers, the synthesis supports clearer definitions, source-linked coding and research questions that connect climate exposures with financial mechanisms. For investors, lenders and reporting professionals, it suggests that ESG scores and general sustainability disclosures should be examined separately from directly measured physical and transition exposures. These are implications for evidence assessment, not investment recommendations or tested policy effects. No claim about the effectiveness of a financial product or regulatory intervention follows from the present bibliometric counts.

6. Future research directions

Table 6 translates the observed coverage and reporting limitations into research questions and feasible designs. These proposals are intended to guide subsequent work; they do not represent findings established by the selected corpus. Empirical studies should distinguish association from causation and explain how measurement error, selection effects and reverse causality are addressed.

Table 6. Research agenda by TCCM dimension.

Dimension	Gap observed	Suggested directions
Theory	Theory labels and causal mechanisms are insufficiently distinguished.	How does disclosure credibility affect the pricing of climate exposure? Specify competing mechanisms using information asymmetry, stakeholder or institutional perspectives; verify theory fit and test stated hypotheses.
Context	Physical and transition financial-risk contexts are weakly represented in this corpus.	Compare banks, insurers and investment funds across regulatory settings. Separate physical hazard exposure from transition-sensitive activities; assess whether disclosure rules change the use of this information.
Characteristics	Review topics are often treated as if they were measured variables.	Use explicit measures of climate exposure, disclosure quality, ESG integration, financing cost and downside risk. Test governance as a moderator; distinguish a proposed mediator from a merely correlated variable.
Methodology	Eligibility, coding and network settings require a reproducible audit trail.	Replicate searches across databases; retain exclusions and source-linked coding. For primary studies, use longitudinal panels or justified quasi-experimental designs, address endogeneity and test sensitivity to alternative ESG measures.

7. Limitations

The main limitation is an incomplete audit trail. The search date, exact filters, screening counts and rationale for the 27-to-23 reduction are unavailable. The reported review-only rule conflicts with the inclusion of an empirical study, while some adjacent sustainability topics need a clearer eligibility rationale. Bibliometric results have not been regenerated from the raw export, author metadata require validation, and country denominators are unreconciled. Network thresholds and keyword-cleaning decisions are also unreported. TCCM classifications depend on reviewer judgement and lack documented coding reliability; many study-specific theory and tool labels remain provisional. Finally, the small, English-language, single-database and review-oriented corpus limits generalisation. These issues must be resolved before the manuscript can be represented as a reproducible systematic review.

8. Conclusion

This review links reported bibliometric patterns with a TCCM synthesis of selected ESG and sustainable-finance studies. The supplied evidence highlights investment, green bonds, reporting and digital-finance themes, while explicitly financial climate-risk constructs are less

visible within the coding. The revised analysis distinguishes theories from topic labels, corrects a review that had been classified as empirical and limits conclusions to the selected corpus. Its research agenda focuses on measurable links among climate exposure, disclosure quality, governance and financial outcomes. The interpretation remains provisional until the search, screening and coding records are reconciled and the bibliometric outputs are reproduced.

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